TIME
Program Framework

TANDEM TILT-WING MULTI-ENGINE (TIME) HYBRID-ELECTRIC VTOL

Combines the cruise efficient of a fixed-wing aircraft, with the ability to perform vertical take-off, optional hoovering, and landing of a rotorcraft.

(codename *Texo*, or hummingbird in *Yanomami* language)

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- This innovative aircraft is **in development since 2018**, involving intensive R&D, implementing, testing and refining new concepts and technologies (applying for three new patents) until achieving the actual stable design to be launched in 2022.
- The concept of producing a modular tilt-wing VTOL started at our Israel Homeland Security office, to address demands from local Israeli and US partners.
- The Program, **fully funded internally**, is **being confidentially conducted** due to its innovative design and technologies and a resulting need to avoid industrial theft.

Aircraft Architecture

Even though tilt-wing with multi-engine distributed propulsion architectures are complex and difficult to implement, we avoided more simple design approaches, like basic combos of electric engines for VTOL and a fuel engine for cruise flight, due to their lack of synergy, and added weight.

Why Tandem-wing?

- Tandem wings have a gap with wide are for the CG enabling great flexibility to cargo load and distribution.
- Tandem wings add to lifting, stability, control, and trim.
- Proper alignment between front and rear wings reduce the angle of attack of the read wing, causing the front wing to stall first, improving low speed flight.
- Four wings are smaller than two and cause less structural stress, and complexity. This allows better payload arrangement with less structural strain.

Early tandem design

- Even tough there were previous attempts, the first tandem wing was designed in 1907 by *Louis Peyret* with *Louis Blériot*.
  - *Peyret* obtained the tandem wing configuration patent in 1924.
  - He kept designing and building tandem airplanes until his death in 1933, in an accident flying his first *avionette*.
  - *Louis Peyret* was Daniel Dupré's mother's uncle…
- The tandem-wing design concept was not thoroughly explored due to the inherent interference between wings, that made this design less efficient in cruise flight than a conventional design..

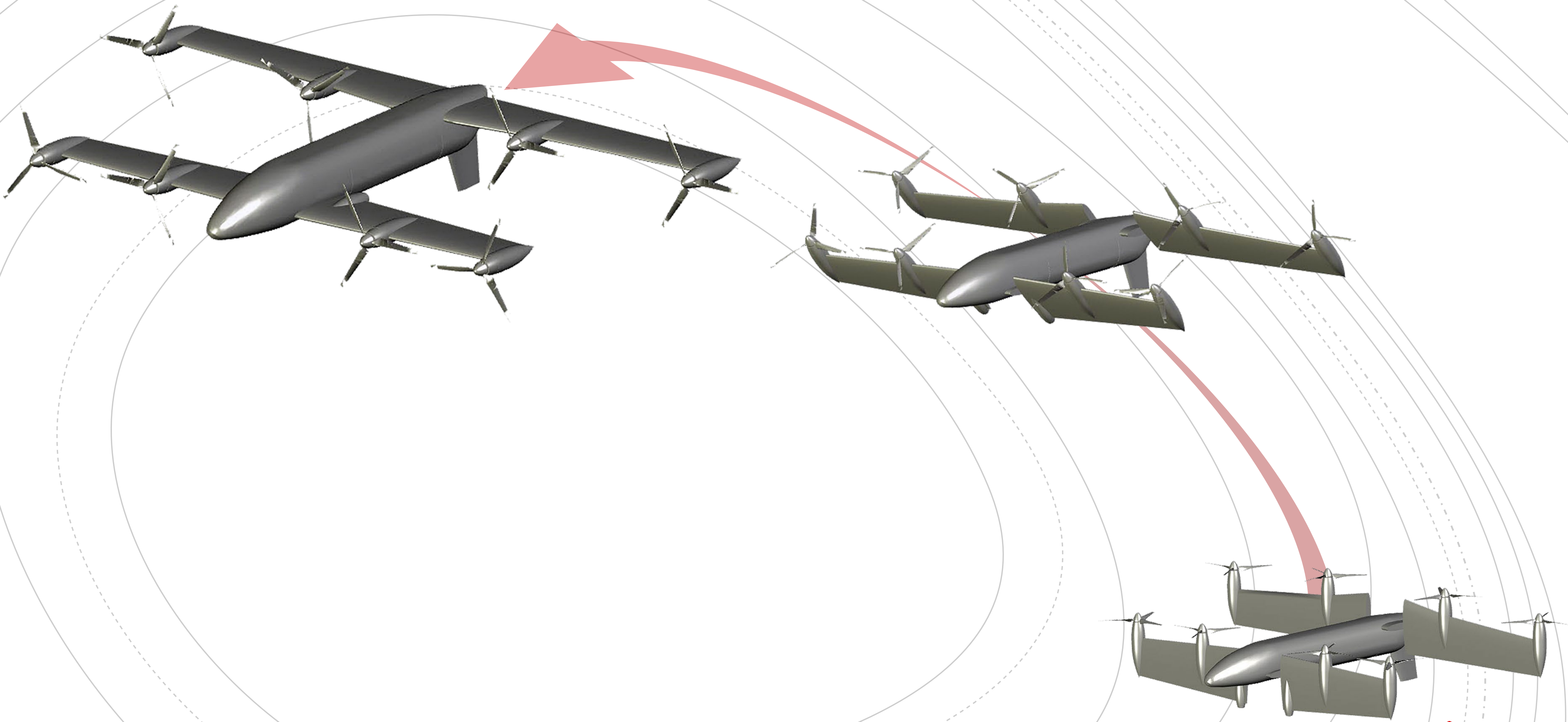
Recent tandem design

- Several attempts at tandem wings occur before and after WWII. Almost non were successful.
- Only in 1998 *Burt Rutan* designed the *Proteus*, the first successful tandem wing aircraft, using digital designing tools and advanced composite materials.
- With the advent of advanced control systems and avionics, the need for short-range flexible aerial mobility, several tandem wing designs, combined with tilting mechanisms and distributed propulsion, started to appear recently (i.e. *Airbus Vahana*).

Why Tilt-wing?

- Even though it is less efficient for VTOL than rotorcraft, the slipstream from the rotors goes through the wing, applying with higher lifting power.
- Easy transitions from VTOL to horizontal flight.
- Eliminates the need of for airstrip, or ground launching/catching equipment.
- Allows the use of low-tip speed, bigger propellers for reduced noise and better VTOL.

VTOL to fixed-wing cruise flight



TIME Key Features

- Hybrid-electric
  - Powered by a hybrid-electric system, where the combustion engine charges lithium-ion batteries, and powers eight distributed electric engines.
- Distributed propulsion
  - Electric multiengine propulsion along the wings, offers higher propulsion efficiency, and gliding performance.
  - Eight distributed smaller engines, with higher thrust to weight ration, adding safety in redundancy, and cheaper to acquire, service, and replace.
  - The distributed flow, reducing the effect of transversal winds.

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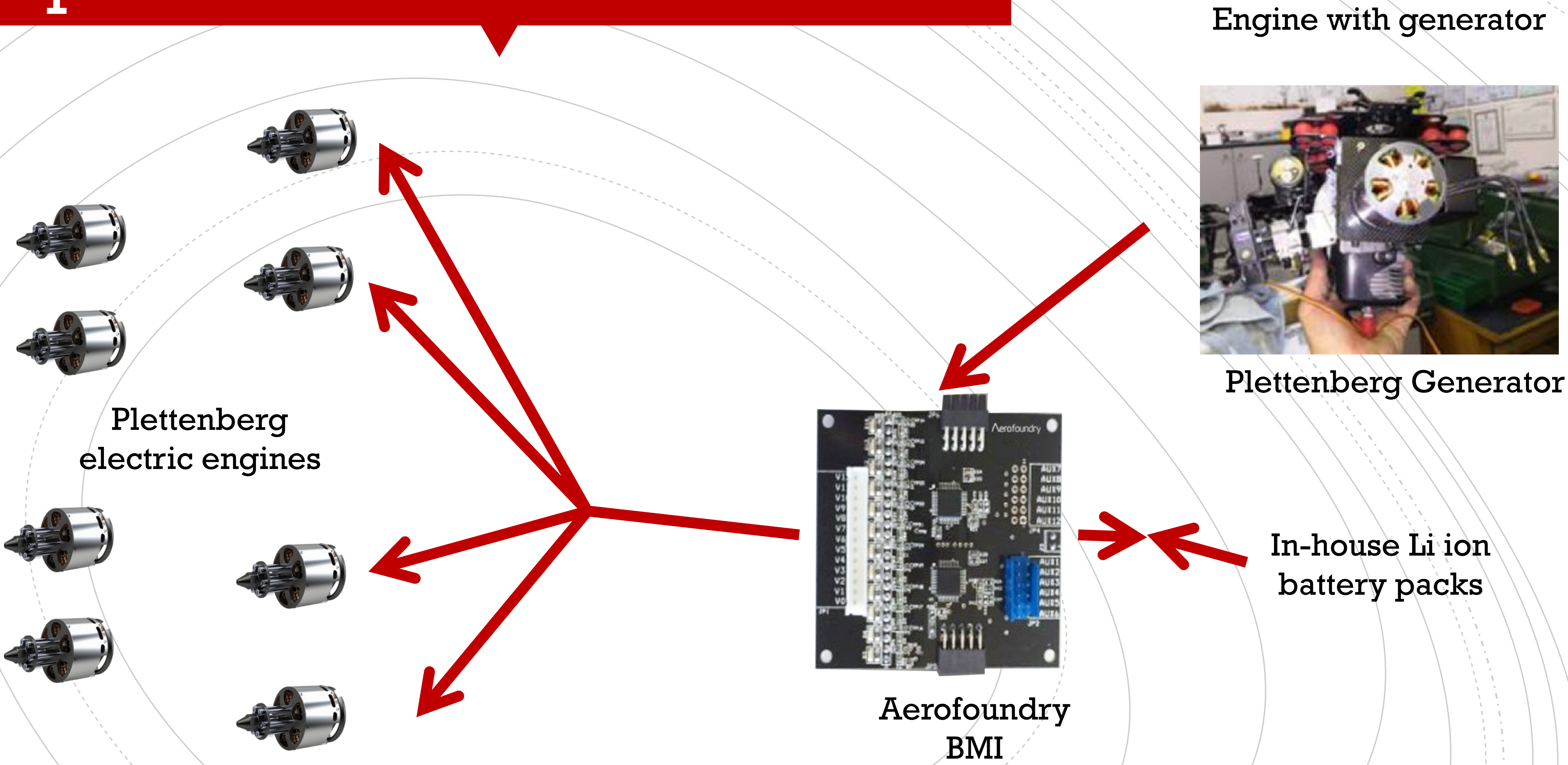
Hybrid-electric Rationale

- A hybrid electric aircraft is an aircraft with a hybrid electric powerplant.
- As the energy density of lithium-ion batteries is much lower than aviation fuel, a hybrid electric powerplants increase flight range compared to electric aircraft.

Implementation



Hybrid components

- The 50kg MTOW version uses an EFI engine with a Plettenberg generator.
- Eight Plettenberg electric engines.
- Brazilian Li ion batteries produced in-house by Aerofoundry (will be manufactured in Australia for this Progrma).
- Wankel Supertec and Safran ENGINeUS electric engines are being evaluated for the larger version.

TEXO Roadmap

1. 2018: Conceptual and preliminary design.
2. 2019: CFD analysis, and α1 4-engine prototype undergoes simulation and wind tunnel testing.
3. 2020: β1 4-engine prototype structural and flight testing.
4. 2021: β2 prototype validation finalized.
5. 2022: 8-engine integrates the final configuration of the control system and avionics. Manufacturing is structured.
6. Dezember 2022: ADF Program launched.

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2022 ADF FRAMEWORK

2022 Framework

- **Platform 1** - Enlarged TIME basic version, for a 50kg payload stable demonstrator.
- **Platform 2** - Due to its increased structural complexity, we will produce a scaled preliminary prototype demonstrator, emulating 1000kg payload.
- **Platform 3** – It is feasible to produce a CASEVAC prototype demonstrator, including avionics and control system to address '*manned*' platform certification requirements. The casualty compartment will be designed as a self-sufficient heated container.

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Platform 1

200kg MTOW
50kg payload

ENDURANCE [h]	FUEL [kg]	Fuel [l]	Range [Km]	Payload [Kg]
1	10	12	116	66
2	17	22	229	59
3	24	31	337	52
4	31	39	443	45
5	37	48	545	39
6	44	56	646	32

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Platform 1

Specifications

MTOW	200 kg
Empty Weight	124 Kg
Wing Area	4 m^2
Wing load	50 Kg/m^2
Cruise speed	130 Km/h
Stall Speed	96 Km/h

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Platform 1

Powerplant

Maximum power required	100 w
Electric engines quantity	8
Required power per engine	12.5 Kw
Hovering time	5 min
Required energy to hover	4 Kw/h
Battery weight	39 kg
Complementary power from generator to reach the maximum required power	61 Kw
Complementary power from generator to reach the maximum required power	83 HP
Combustion engine power required, considering 20% loss in energy conversion	104 HP

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Platform 2

3800kg MTOW
800kg payload

ENDURANCE [h]	FUEL [kg]	Fuel [l]	Range [Km]	Payload [Kg]
1	184	235	108	1146
2	324	415	213	1006
3	462	592	316	868

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Platform 2 Aircraft Specifications

MTOW	3500 Kg
Empty Weight	2170 Kg
Wing Area	45 m^2
Wing Load	77 Kg/m^2
Cruise speed	170 Km/h
Stall Speed	115 Km/

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Platform 2

Powerplant

Maximum power required	1750 Kw
Eletric engines quantity	8
Required power per engine	218.8 Kw
Hovering time	5
Required energy to hover	68 Kw/h
Battery weight	681 Kg
Maximum available power from battery	681 Kw
Complementary power from generator to reach the maximum required power	1069 Kw
Complementary power from generator to reach the maximum required power	1455 HP
Combustion engine power required, considering 20% loss in energy conversion	1819 HP

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Platform 3
Single Stretcher

600kg MTOW
200kg payload

ENDURANCE [h]	Fuel [kg]	Fuel [l]	Range [Km]	Payload [Kg]
1	31	40	111	235
2	57	73	219	209
3	81	104	323	185

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Platform 3
Single Stretcher

Specifications

MTOW	700 Kg
Empty Weight	434 Kg
Wing Area	11 m^2
Wing Load	63 Kg/m^2
Cruise speed	144 Km/h
Stall Speed	105 Km/h

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Platform 3 Single Stretcher

Powerplant

Maximum power required	350 Kw
Eletric engines quantity	8
Required power per engine	43.8 Kw
Hovering time	5 min
Required energy to hover	14Kw/h
Battery weight	136 Kg
Maximum available power from battery	136 Kw
Complementary power from generator to reach the maximum required power	214 Kw
Complementary power from generator to reach the maximum required power	291 HP
Combustion engine power required, considering 20% loss in energy conversion	364 HP

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Platform 3
Tandem Stretcher

Specifications

MTOW	1250 Kg
Empty Weight	950 Kg
Wing Area	17 m^2
Wing Load	73.5 Kg/m^2
Cruise speed	158 Km/h
Stall Speed	113 Km/h

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Platform 3
Tandem-Stretcher

1250kg MTOW
300kg payload

ENDURANCE [h]	Fuel [kg]	Fuel [l]	Range [Km]	Payload [Kg]
1	72	92	105	366
2	122	92	207	315
3	171	92	306	266
4	219	92	403	219

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Platform 3

Tandem-Stretcher Powerplant

Maximum power required	625 Kw
Eletric engines quantity	8
Required power per engine	78.1 Kw
Hovering time	5 min
Required energy to hover	24 Kwh
Battery weight	243 Kg
Maximum available power from battery	243 Kw
Complementary power from generator to reach the maximum required power	382 Kw
Complementary power from generator to reach the maximum required power	520 HP
Combustion engine power required, considering 20% loss in energy conversion	650 HP

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CASEVAC considerations

- The wide body, tandem-stretcher configuration will carry:
  - Two casualties, side by side, with doors (with bullet proof windows) at both sides; or
  - One casualty with MEDVAC configuration.
- It will be a standalone plug-and-play container using energy and datalink from the aircraft.
  - Ventilation is passive, and A/C is supplied for a stable environment).

CASEVAC Playload Bay

- The payload pod is detachable and swappable (it can be left at the field hospital with the casualty, when required, and replaced by another, empty pod, ready to deploy, if necessary).
  - It rolls on wheels (folded into the pod when flying) for easier deployment.
  - The pod has a lifting mechanism to position it in the aircraft for latching (a redundant mechanism).
- The pod and fuel and fragile areas of the aircraft will be covered by ballistic protection.

Dimensions of aircraft under contract

		P1	P 2	P 3 Single	P 3 Tandem
Wingspan rear	A	6.60 m	22 m	10.9 m	13.6 m
Wingspan front	B	5.36 m	18 m	8.9 m	11.1 m
Length	C	4.66 m	16 m	7.7 m	7.65 m
Height	D	1.11 m	4 m	1.8 m	1.4 m
Fuselage width	E	0.66 m	2 m	1.1 m	1.6 m
Fuselage height	F	0.60 m	2 m	1.0 m	1.4 m
Height landed	G	1.69 m	6.0 m	2.8 m	2.97 m

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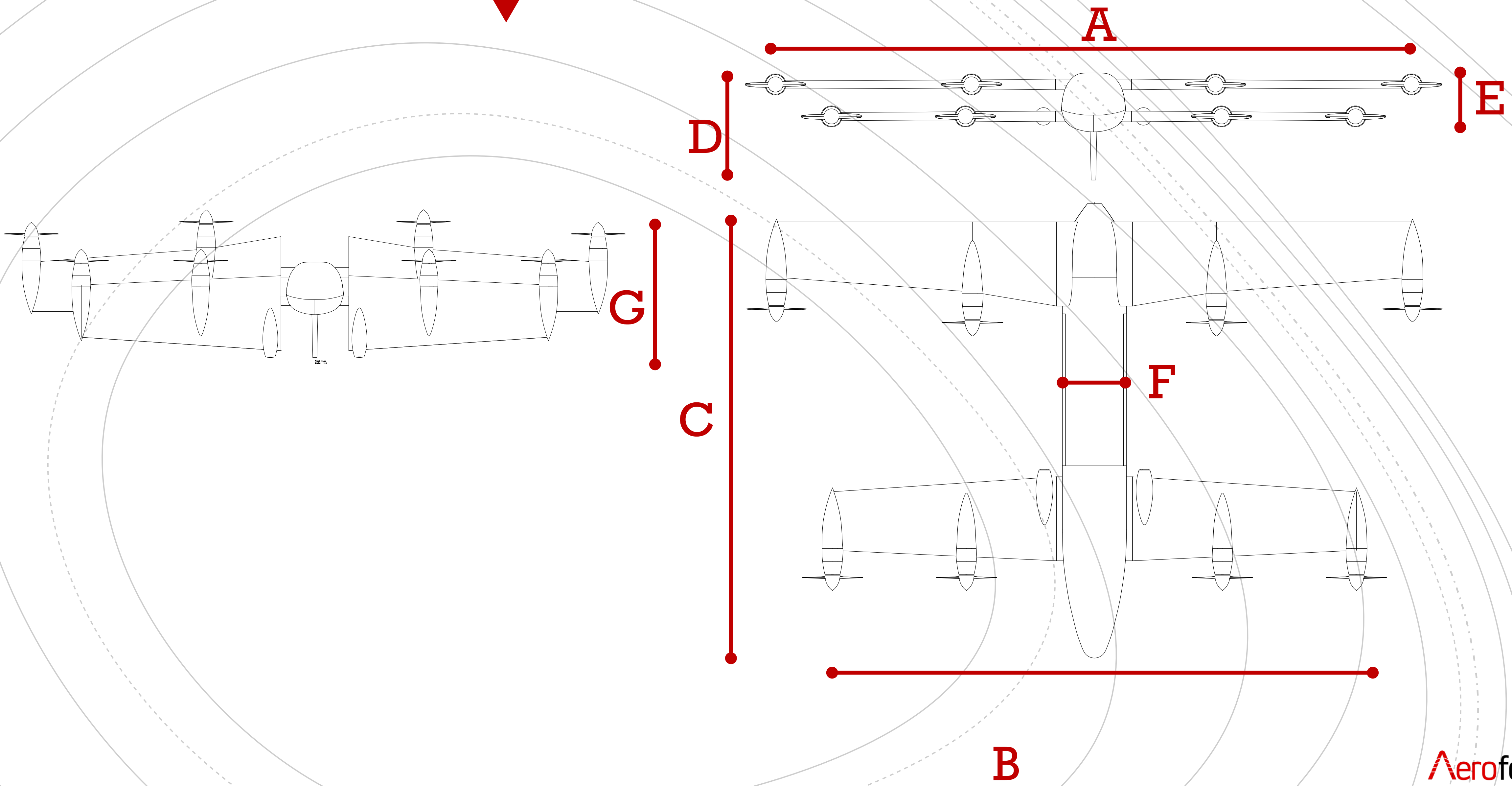
Dimensions



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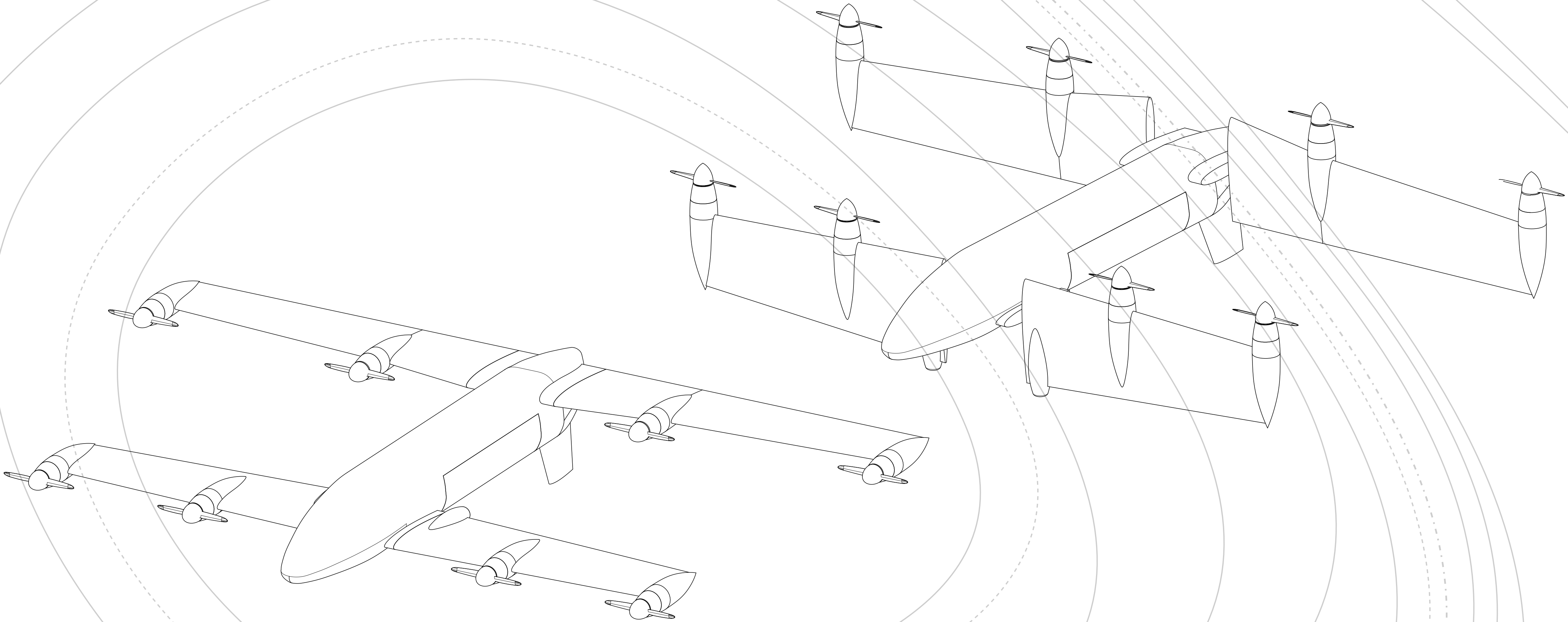
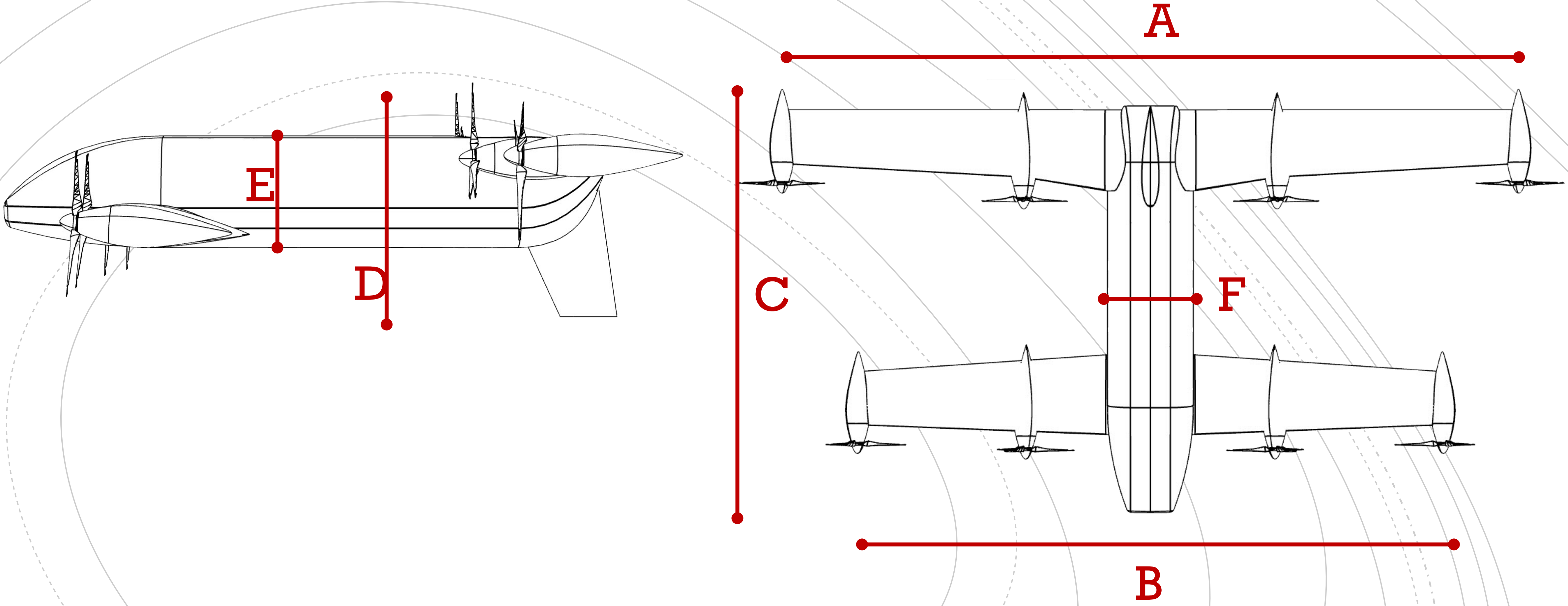
Perspective



Wide-body CASEVAC



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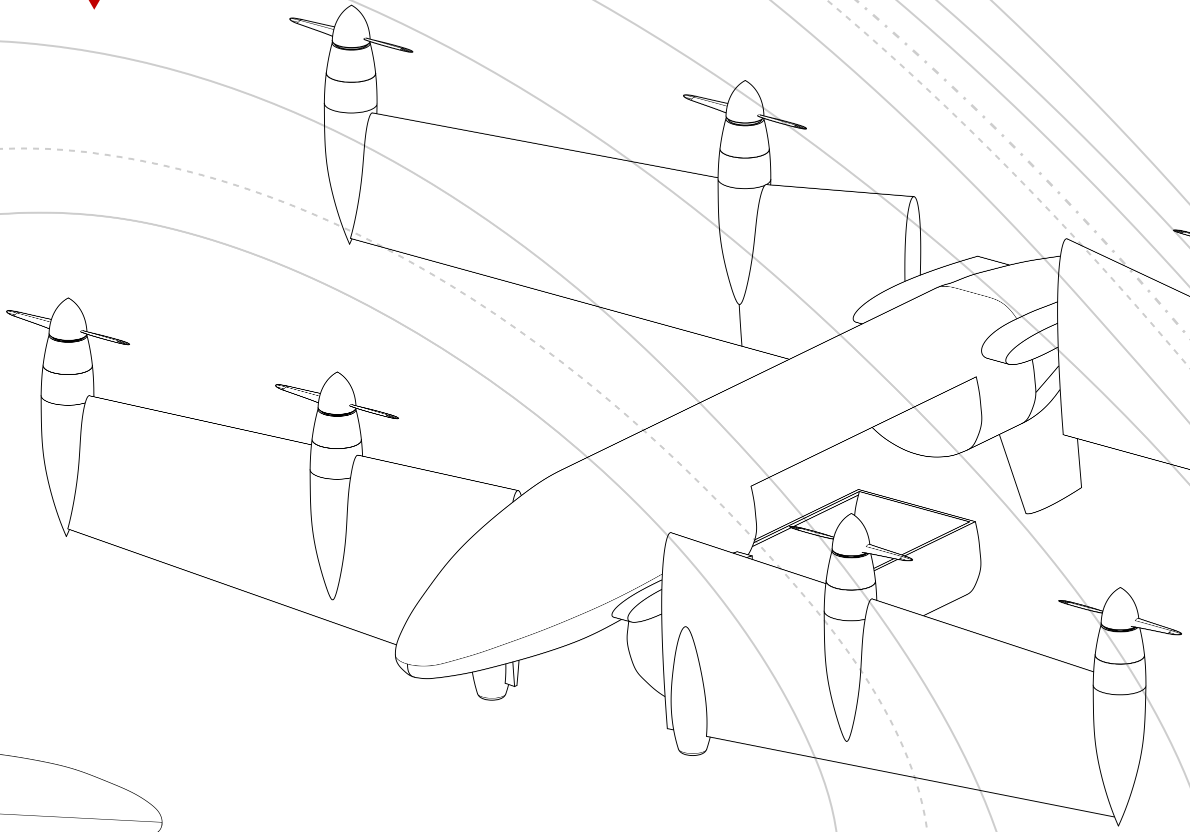
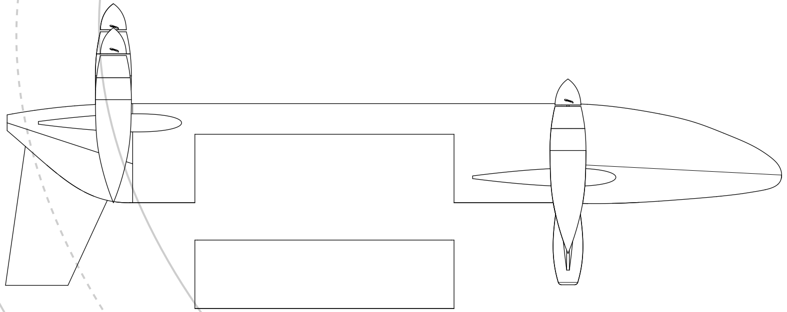
Detachable Cargo Bay





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Platform 3 - STOL option

- For a large aircraft like this, we consider the option of Short Take-off (STOL) to reduce energy expenditure.
- Small wheels can be added to the landing structure to enable the aircraft to roll a few meters (5-10m) to take-off.
- This could be a convenience optional, while VTOL will still be the main way of taking-off.