The MAAT Project – Multibody Advanced Airship for Transport

General Introduction

The Consortium

Project Leader:
Università degli Studi di Modena e Reggio Emilia

The University of Hertfordshire Higher Education

Southern Federal University

Engys Ltd.

Alma Mater Sudiorum – Università di Bologna

eDL S.A.

Universidade da Beira Interior

LogisticNetwork Consultants GmbH

Politecnico di Torino

University of Lincoln

Aero Sekur S.p.A.

Vrije Universiteit Brussel

The Consortium - Roles

Project Leader:
Coordination & Overall System Design

Flight Mechanics and PV Coverage

Controls and Telecommunications

CFDs Flight Mechanics

Overall System Design

Cabins, Cargo and Transfer Systems

Energy and Propulsive Systems

Dissemination and Logistics

Energy and Propulsive Systems

Energy and Propulsive Systems

Cabins, Cargos and Transfer Systems

Cruiser/Feeder Docking and Joints

Current Situation in Transport

Today, Transport of people and freight
is characterized by critical conditions such as …

- the emission of green house gasses,
- the consumption of fossile fuels,
- increasing transport costs related to fuel prices and to costs for environmental impacts,
- high costs for the construction and maintenance of transport routes (train, motorways, airports),
- Additionally, classic transport systems are facing an increasing number of people wishing to travel.

Current Situation in Transport

… these aspects inevitably result in:

- Traffic congestion,
- Large consumption of soil for new infrastructure-related projects,
- Noise pollution (cars, trains, aircraft),
- Increasing costs,
- Increasing emissions of greenhouse gasses.

Therefore, a new mode of transport - both economically and ecologically attractive - is necessary.

MAAT

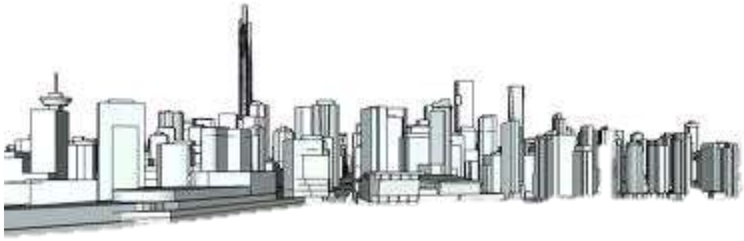
Multibody Advanced Airship for Transport

One answer to the manifold problems faced by modern society is the MAAT Project.

What is MAAT? Key features

MAAT is a …

- … zero emission,
- … low cost,
- … high capacity and
- … flexible aerial **transport solution** conceptualized as a cruiser/feeder system for
- … long and
- … middle range distances.

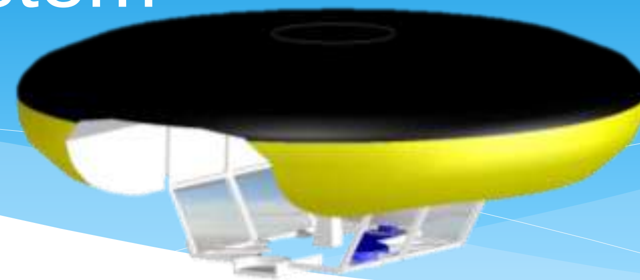


How is MAAT composed?

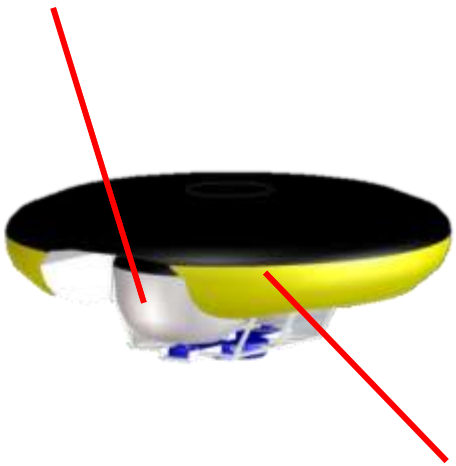
The MAAT system is composed by three modules:

- **PTAH (Photovoltaic Transport Airship for High-altitudes)** is a heavy payload and high quote cruiser which remains airborne on stable routes;
- **ATEN (Air Transport Efficient Network feeder)** is a VTOL feeder airship by gas buoyancy linking the cruiser to the ground;
- **AHA (Airship Hub Airport)** is a new concept of low cost vertical airport hub joinable by ATEN, easy to build both in towns and in logistic centres.

The Cruiser/Feeder System



Feeder: ATENs
(Aerial Transport Elevator Network)



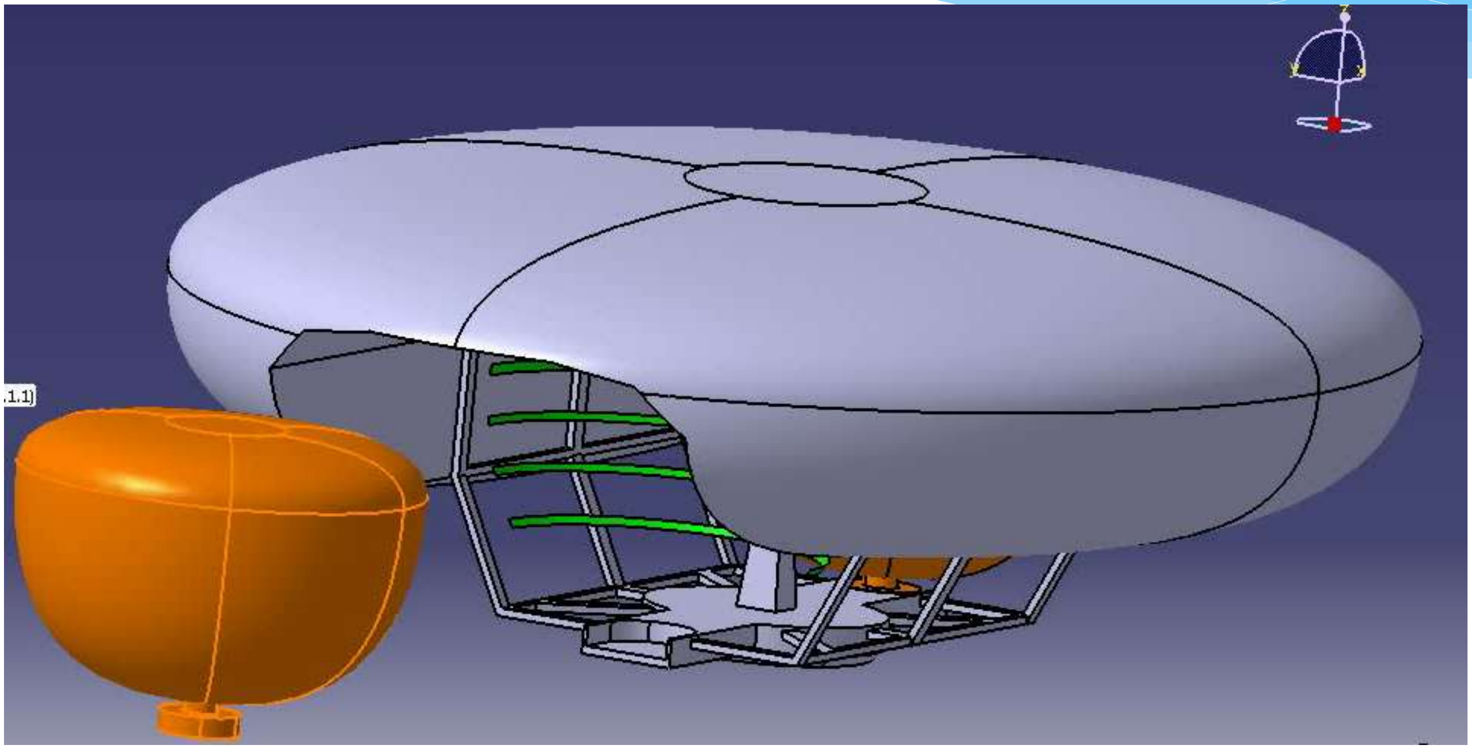
Cruiser: PTAH (Photovoltaic Transport Aerial High Altitude System)

Number of passengers: approx. 300

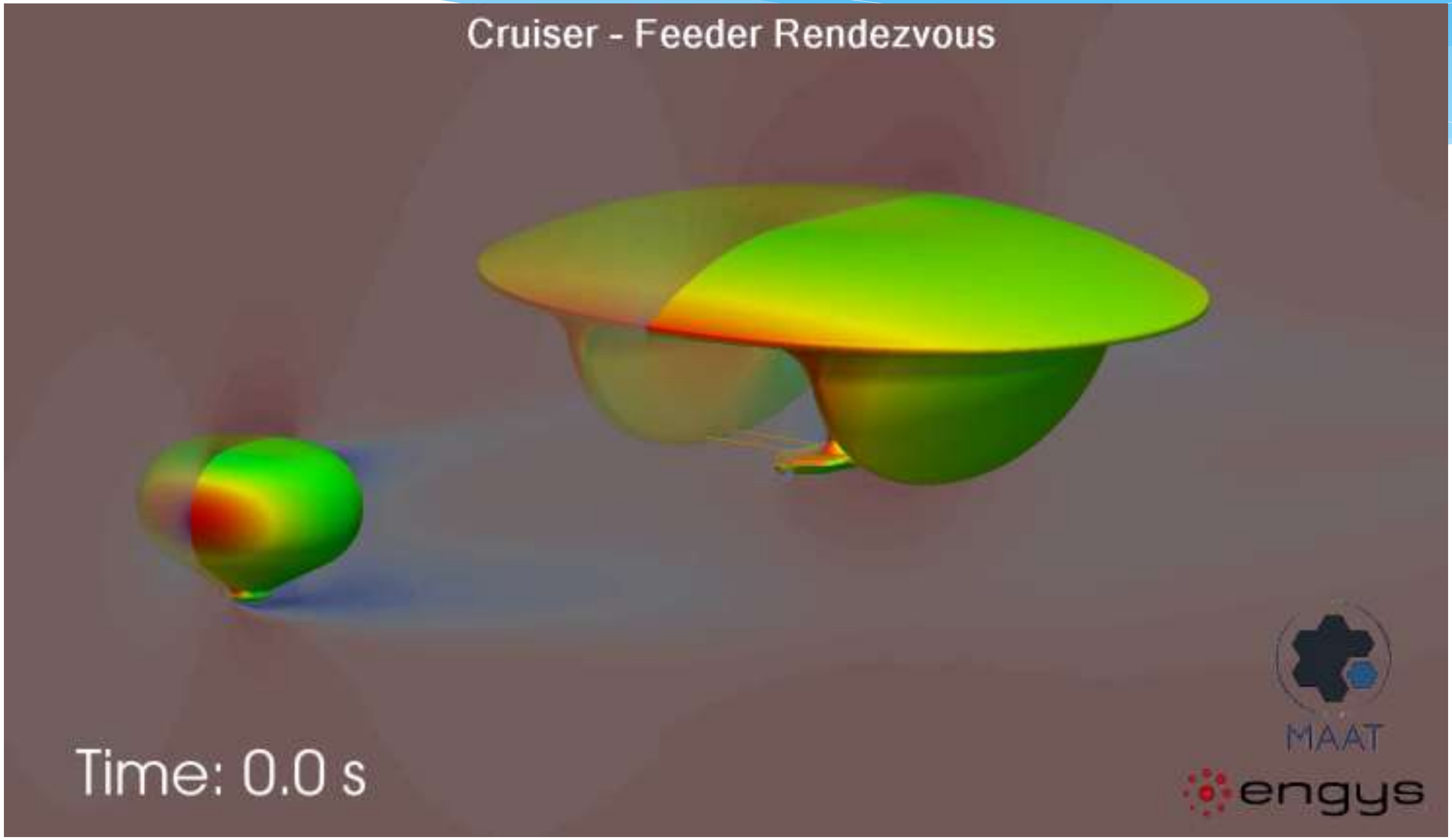
Capable of landing in urban, densly populated areas.

Although limited in speed, the "airborne" exchange of passengers and goods via the feeders allow reduced transport times.

Docking Operation Animation

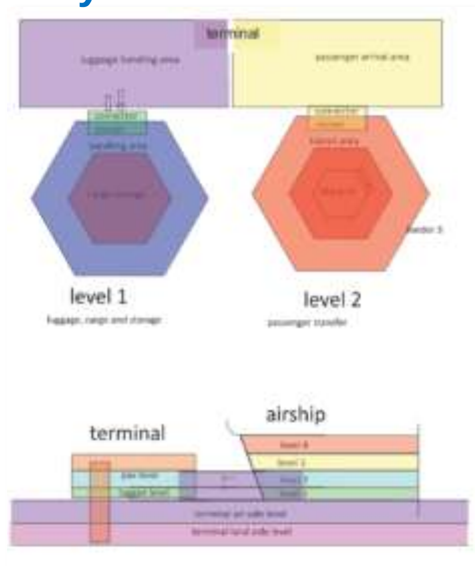


Docking operation simulation



Airship Hub Airport (AHA)

Layout of an AHA:



Examples of an Airship Hub Airport (AHA).

No soil consumption is necessary, as already existing facilities can be used (landing on skyscrapers, railway stations etc.).

Moving times for passengers will be reduced.

VTOL ground operations (Vertical take-off and landing).

What is the MAAT-Project aiming at in scientific terms?

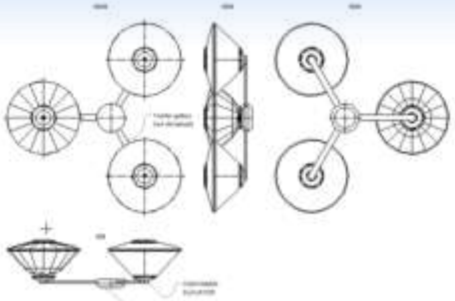
1. Identify and design the most **functional cruiser/ airship architectures** based on a discoid innovative airship able to remain airborne for long periods of time and to travel great distances.

2. Design the **best type of propulsion** both for cruiser and feeder so they can contribute together to the propulsion of an innovative modular airship.

3. **Minimizing environmental impacts** by annulling fossil fuels energy consumption as both cruiser and feeder are energetically autonomous.

4. Design the best procedure of **docking operations** in order to obtain the minimum disruption to passengers and the maximum safety for themselves and for goods.

5. Study the different **possible ways of approaching** and joining between ATEN and PTAH, and consequently the release of ATEN from PTAH.

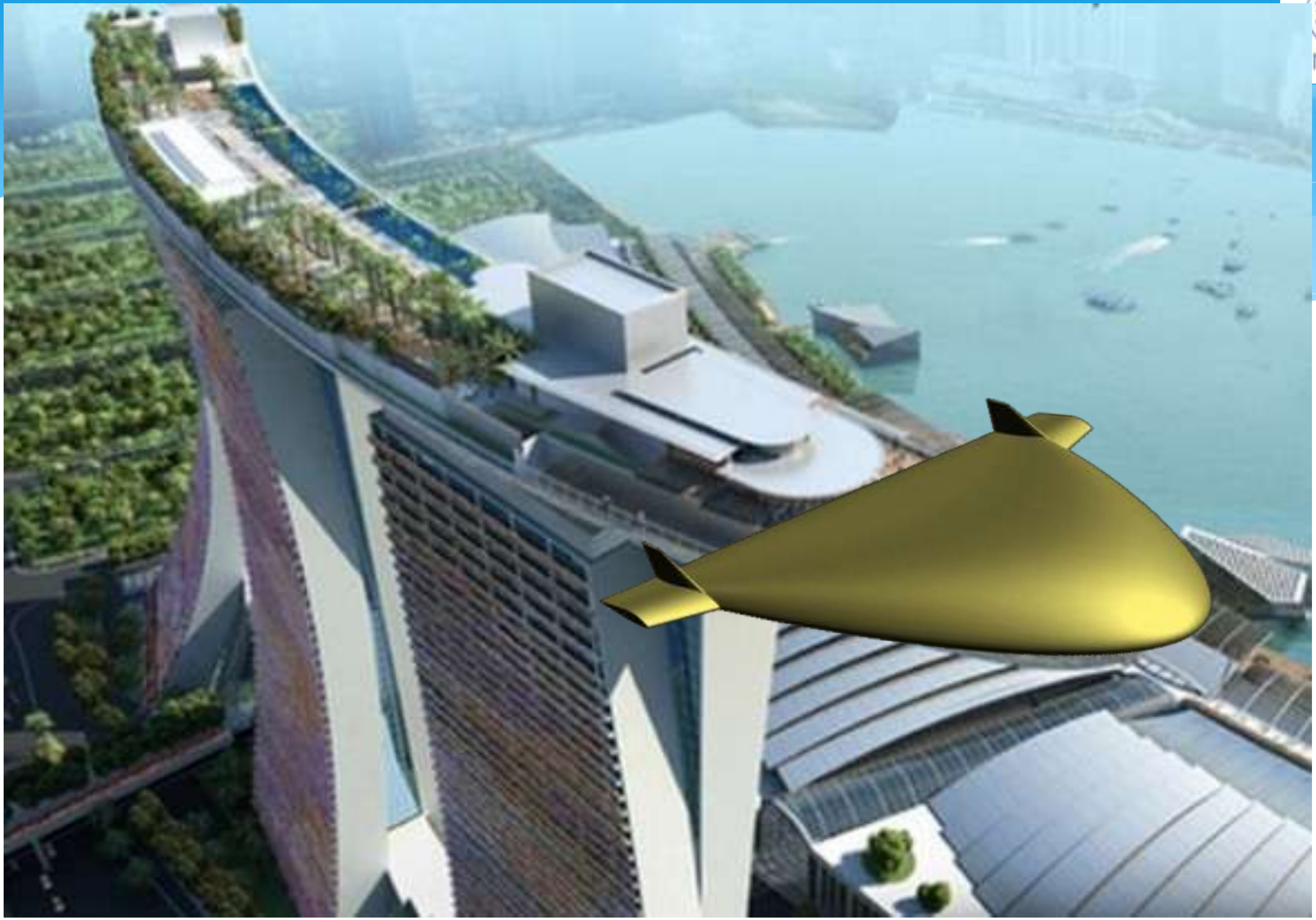


Alternative Configurations

How will MAAT perform?

The cruiser constantly remains in the stratosphere (15 km height), only the feeders reach the earth's surface.

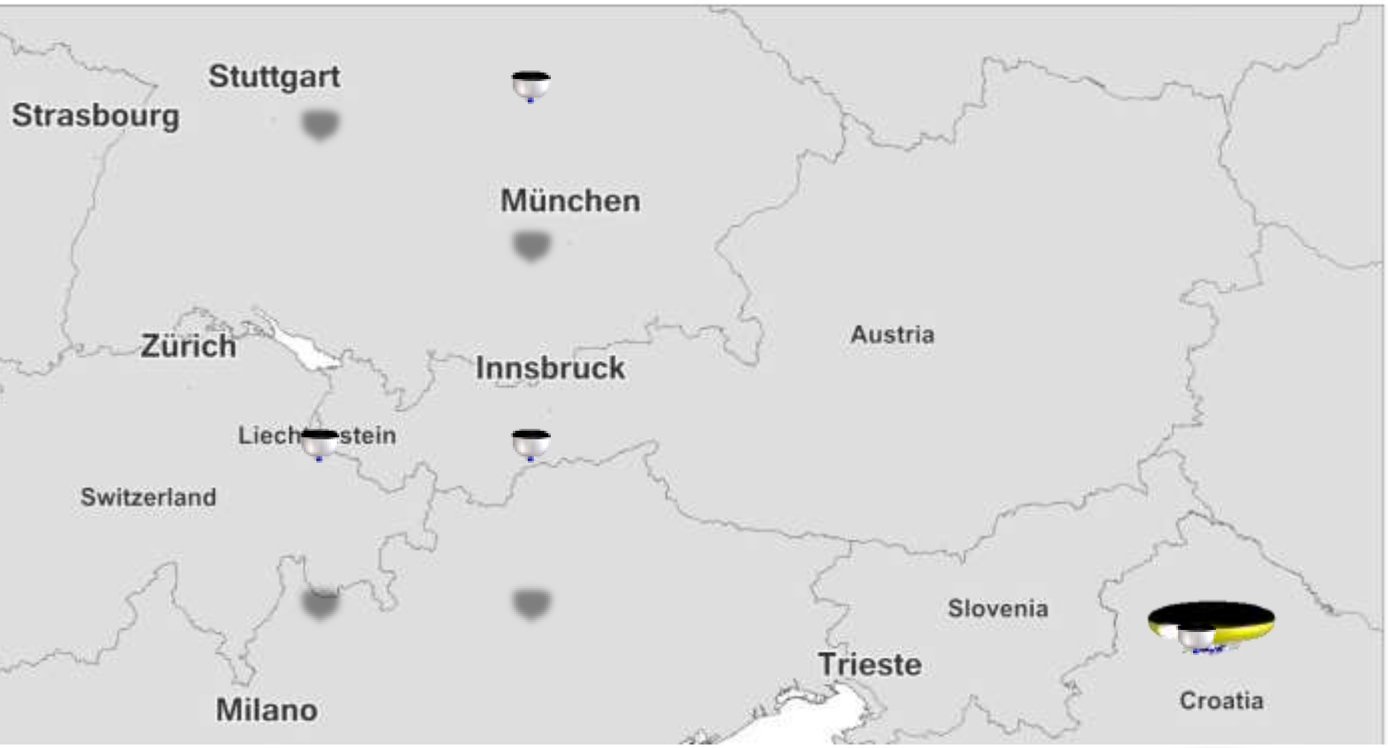
Exchange of feeders between 2 cruisers take place in motion!



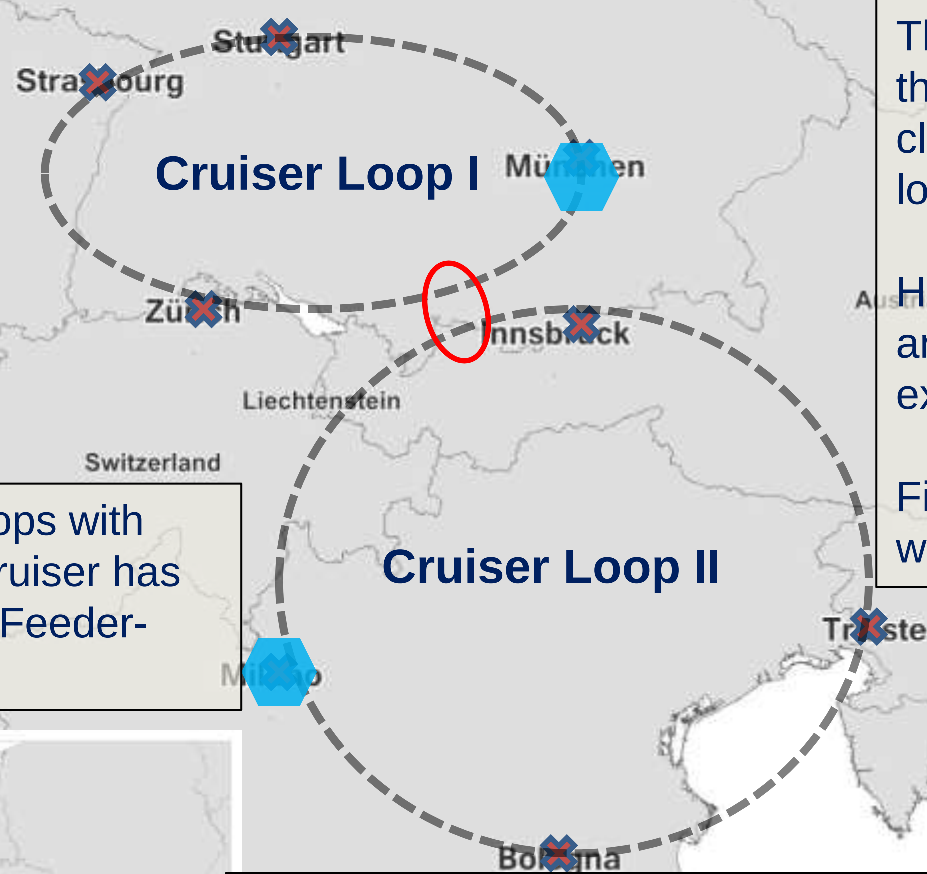
New transport networks

MAAT allows for new chains of transport

The exchange of passengers and cargo in the stratosphere allows new concepts of transport.



Example: How will MAAT perform?

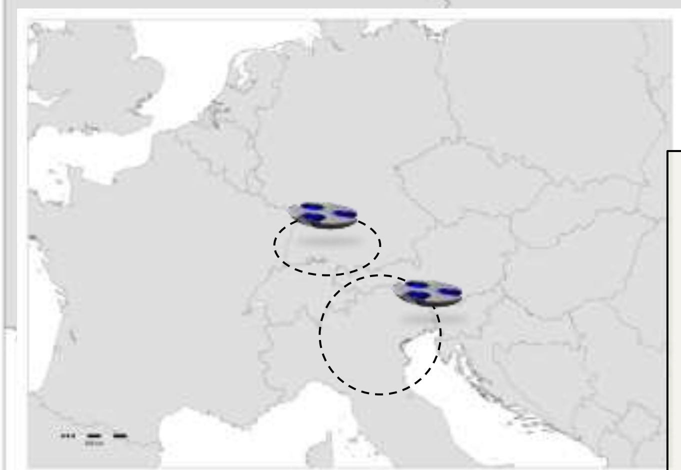


The interchange area of the two cruisers is the closest point of two loops.

Here, the passengers and cargo can exchange.

Finally, the Cruiser loop will start all over again

Two single Cruiser loops with each Cruiser: each Cruiser has its own path and one Feeder-Docking-Station



At the respective breakpoints two Feeders associate with passengers and cargo, which start simul-taneously, on the one hand towards the ground and the other hand from the Cruiser toward the ground

Cruiser
Feeder (AHA)

Comparison with Traditional Aircrafts

Comparison with traditional aircrafts

Aircraft name	B747-8	B777-300	A340	A380	MAAT	Units
Selling price	317	284	275	375	400	mln. USD
Passengers	467	365	380	525	510	Number
Empty weight (no fuel)	186	168	246	277	500	Ton.
Max range	14.8	14.7	14.4	15.2	20000	km*10^3
Service ceiling	13.7	13	12.5	13	16	km.
Max fuel capacity	64.2	47.9	43.1	85.5	0	US gal*10^3
Fuel price	4	4	4	4	0	USD/US gal
Fuel consumption for 1 km	15.6	11.7	10.8	20.2	0	l/km
Average cost for km	16.5	12.4	11.4	21.4	0	USD/km
Average cost for passenger and km	3.71	3.57	3.16	4.28	0	10^{-2} USD/(pass* km)
Other costs	3.5	3.5	3.5	3.5	4	10^{-2} USD/(pass*km)
Total costs	7.21	7.07	6.67	7.78	4	10^{-2} USD/(pass* km)
Lifetime	50	50	50	50	100	Hours*10^3
Annual cost	74	56	55	90	24	mln. USD

Operative Conditions of MAAT

Dimension of Cruiser: 70 m height, diameter 350m

Speed: approx. 200 km/h in calm air

Altitudes: 13 - 17 km

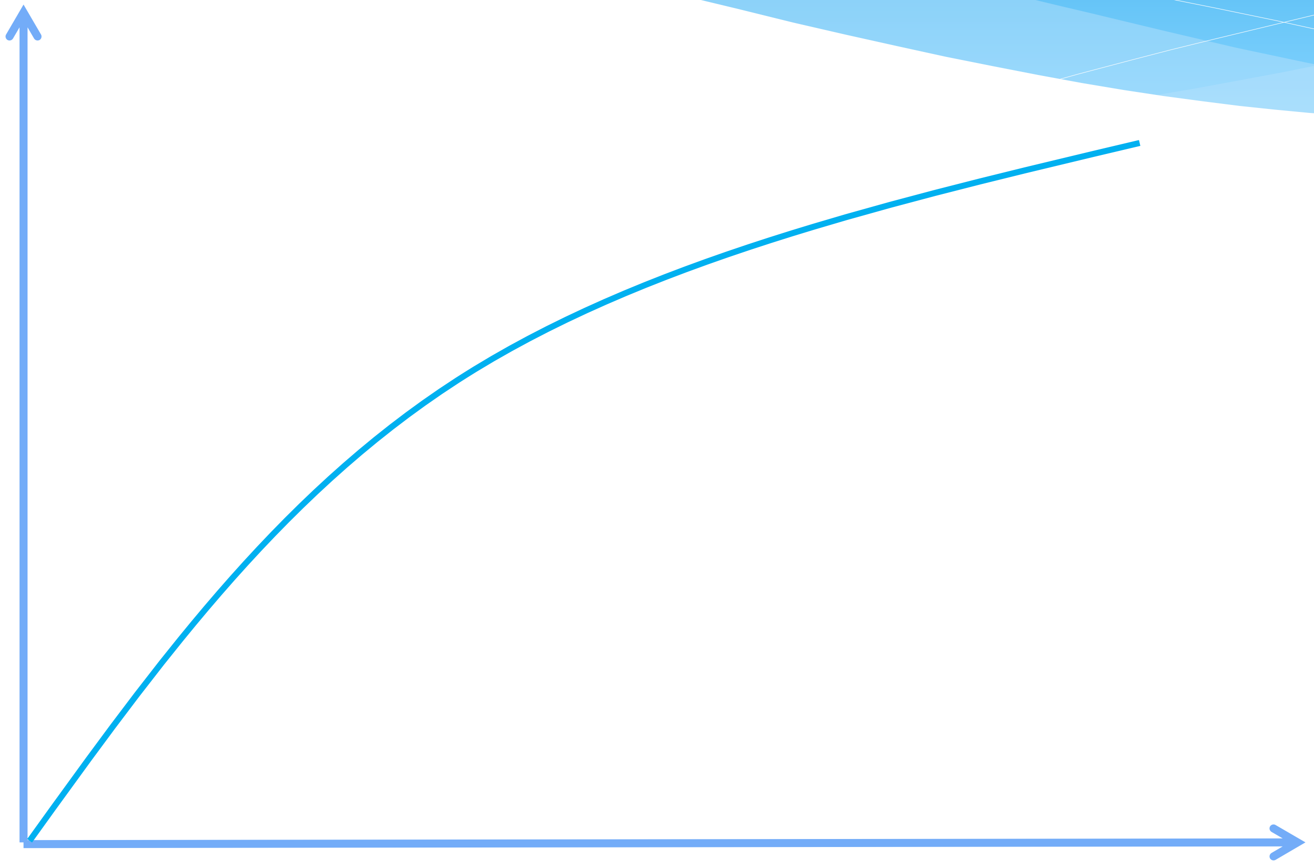
Annual Costs: 24 million US $ (estimated)

Lifetime: 10 Years (estimated)

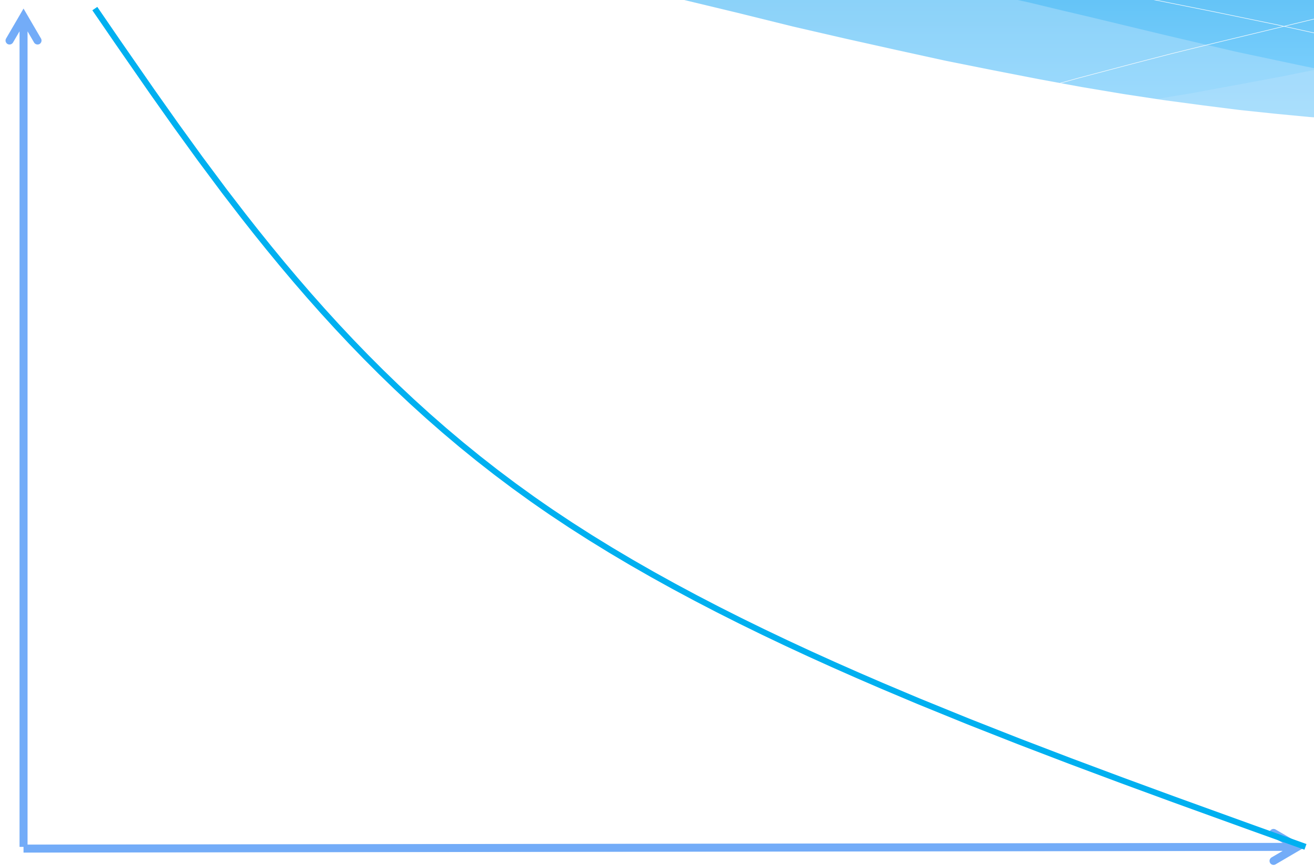
Maximum Range: 20 million km

Empty Weight: 500 tons

Comparison with other Means of Transport - Speed



Comparison with other Means of Transport - Fuel Consumption



Energy Requirements and Environmental Impact

The most significant advantage of the MAAT system is that it is **energetically self-sufficient**.

Daytime: the photovoltaic system produces hydrogen and oxygen.

Night: hydrogen based fuel cells supply the needed electric energy.

If properly sized, the energy system allows for a practically 24/7-operation.

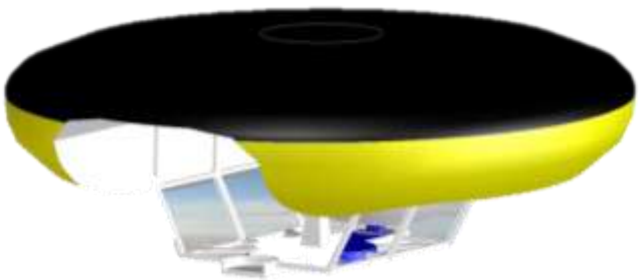
The Strengths of the MAAT Concept at a Glance

- VTOL Ground Operations (Vertical Landing)
- Operative altitudes higher than traditional civil routes
- Heavy payload, low cost of transportation and non-stop flight
- Possibility to act as a flying integrated logistics centre
- Self sufficient by photovoltaic propelling system
- Silent landing and take-off operations
- Reduced consumption of soil, no fossile fuels

Intended Demonstration of MAAT

A number of model airships will be built for demonstration purposes.

Targets:



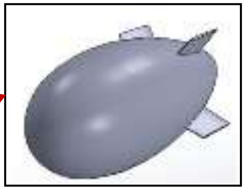
- Testing of long endurance
- Testing of Docking/undocking operations
- Testing of Materials
- Testing of Control Systems

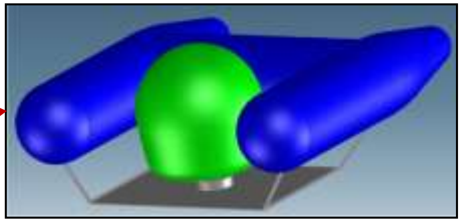
Intended Demonstration of MAAT

Reduced scale prototype to test different technical solutions.

Three types:

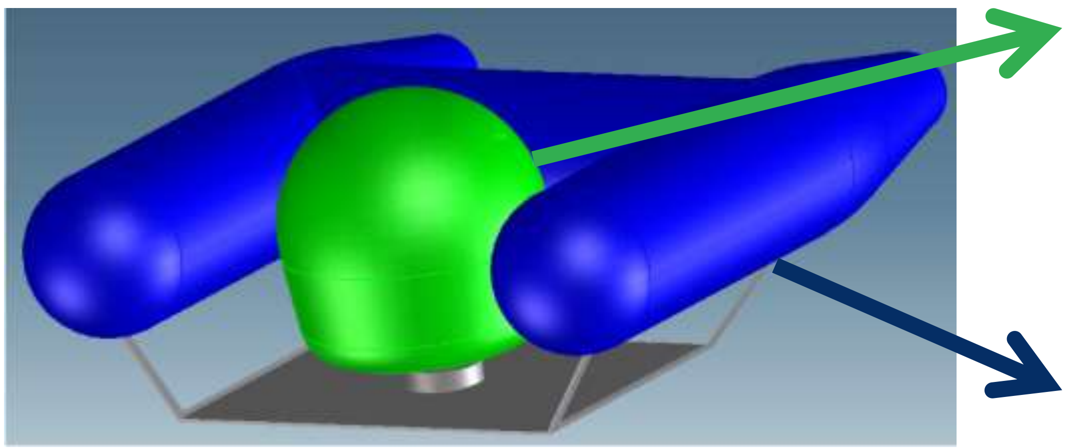
- Control Demonstrator
- Docking Demonstrator
- Cruiser Demonstrator





Control system demonstrator

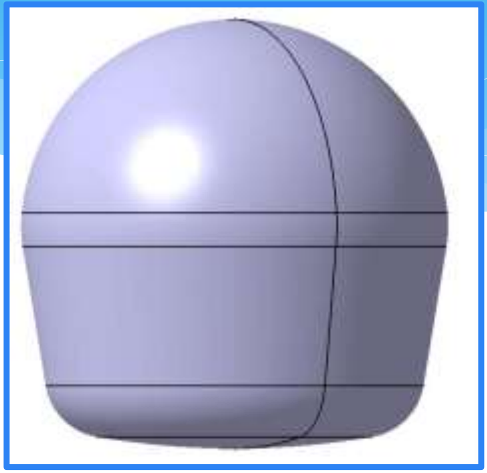
Docking demonstrator



- A muffin shape Feeder (green) very similar to the possible full scale Feeder's shape
- A horseshoe shape Cruiser (blue) which allow the docking manoeuvre both from front and from top

Demo feeder

Inverted truncated cone shape surmounted by a hemisphere. Cone radius ratio to maximize the volume: 0.85.



Two possible rigid structure to hold the payload:

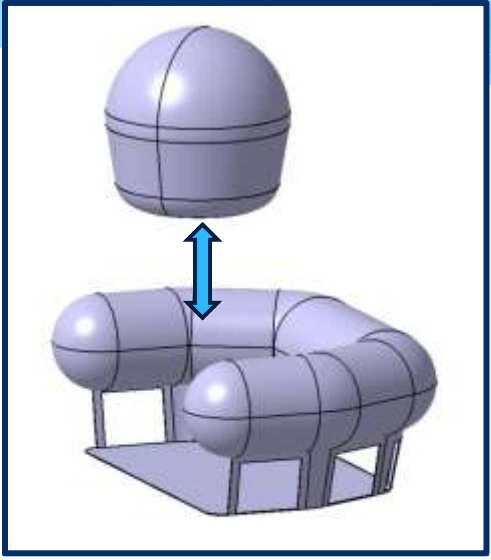
- Single vertical element
- Four elements

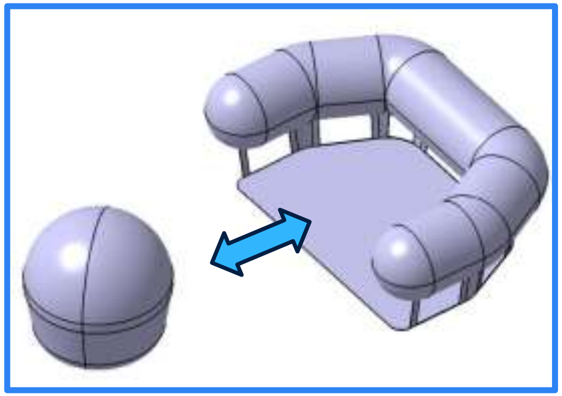
Two possible type of payload's shape:

- Rectangular
- Round

Demo docking system

Two possible procedures:
1. Horizontal operations: both cruiser following feeder or feeder following cruiser.
2. Vertical operations: feeder over cruiser (with feeder moving in the cruiser downward).



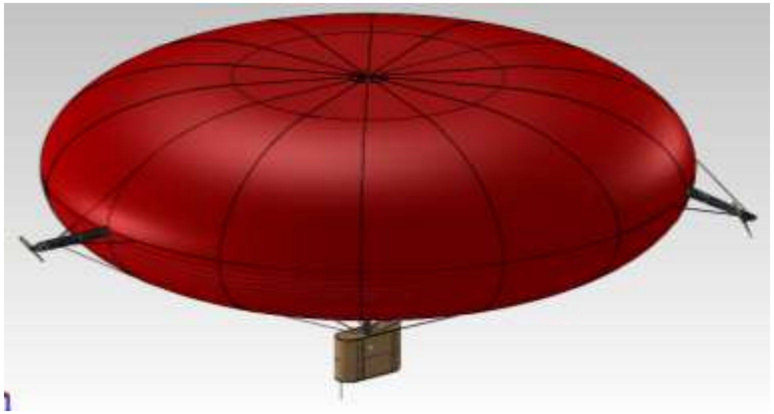


Horizontal rendezvous can be done also in movement while vertical rendezvous operations require to be performed only in static hovering conditions.

Cruiser demonstrator

- Discoid airship with engines mounted on the balloon in an external position, on the vertices of an ideal circumscribed equilateral triangle.
- A lower cabin suspended by ropes and a central vertical column are adopted to lower the centre of mass of the system as much as possible.
- This technical choice is conceived to increase the intrinsic stability of the system.

Material	Application	Unit weight
Polyurethane, Nylon ripstop	Balloon	50 - 170 g/m^2
ABS, carbon fiber, epoxy resin, balsa, aluminum	Nacelle and structure	70
Hydrogen	Buoyancy	0.09 kg/m^3



Specifications	Unit
weight	310 Kg
Volume	310 m^3
Height	6 m
diameter	12 m

Time Schedule

August 2012:
- preliminary mathematical models
- energetic system evaluation
- preliminary design of cruiser/feeder propulsion system
- preliminary analysis of cruiser/feeder engagement/disengagement

September 2012:
Project Start

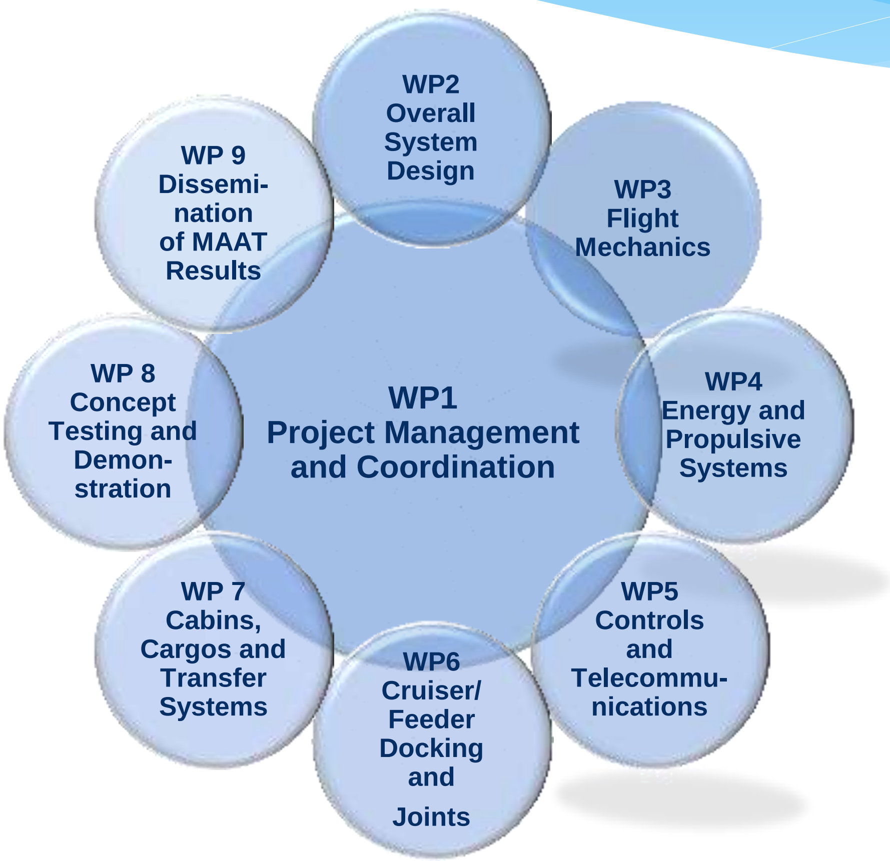
Feb. 2013:
Preliminary design of:

- telecommunications
- position control systems
- control system hardware

Detailed studies of:
- safety systems
- design of pressurization system

August 2014:
Demonstration of prototype models.
Project End.

The Work Package Structure



Contact

A project within the Seventh Programme „MAAT – Multibody Advanced Airship for Transport“

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