Roadmap for Research &Technology Development of Small Aircraft Transport (SAT) Mode

Small Aircraft Big Challenge

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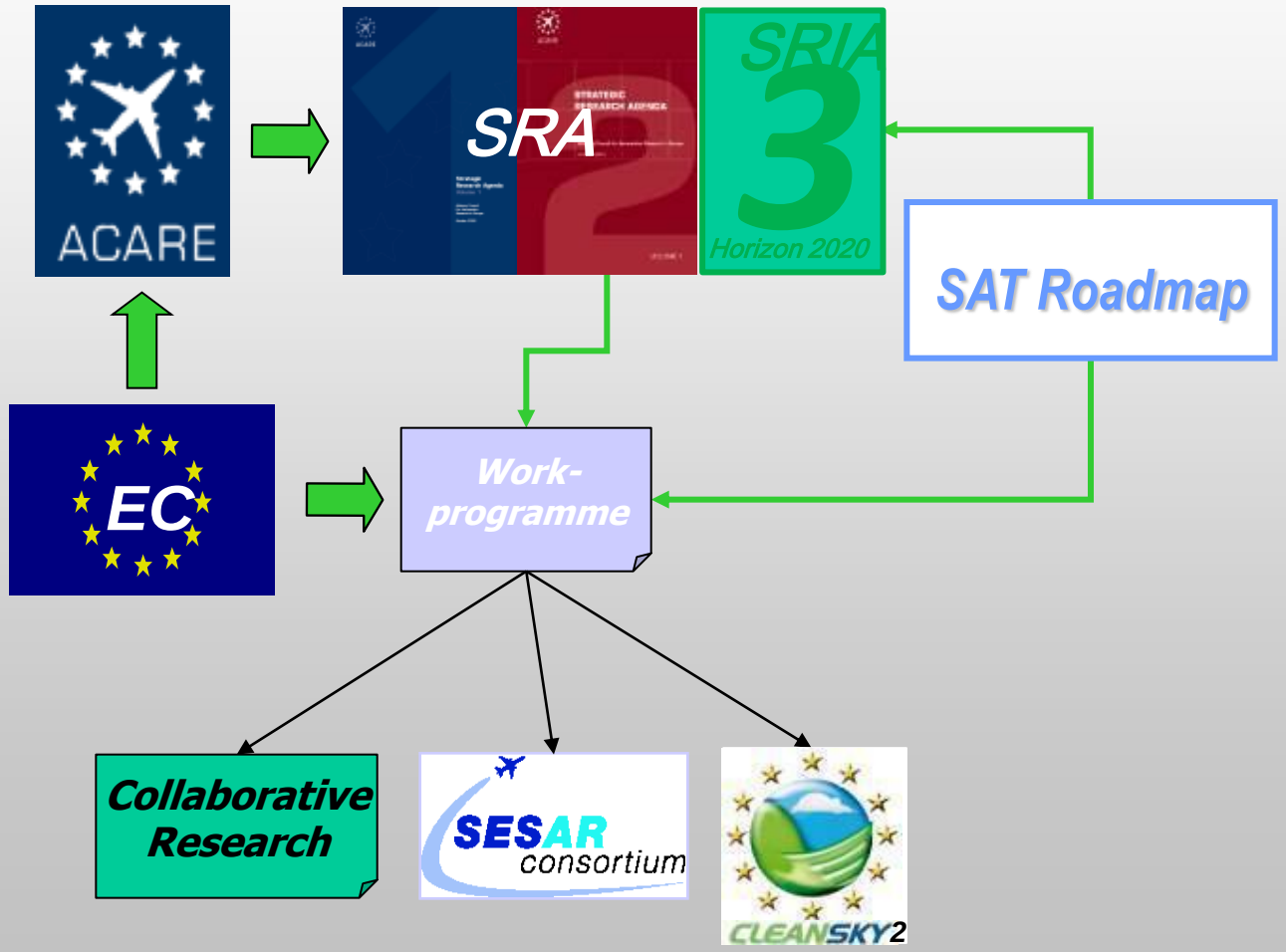
What's Technology Roadmap for SAT?

- The SAT Technology Roadmap aims to **identified research and technology issues** needed to be addressed in the future to enable the SAT system development.

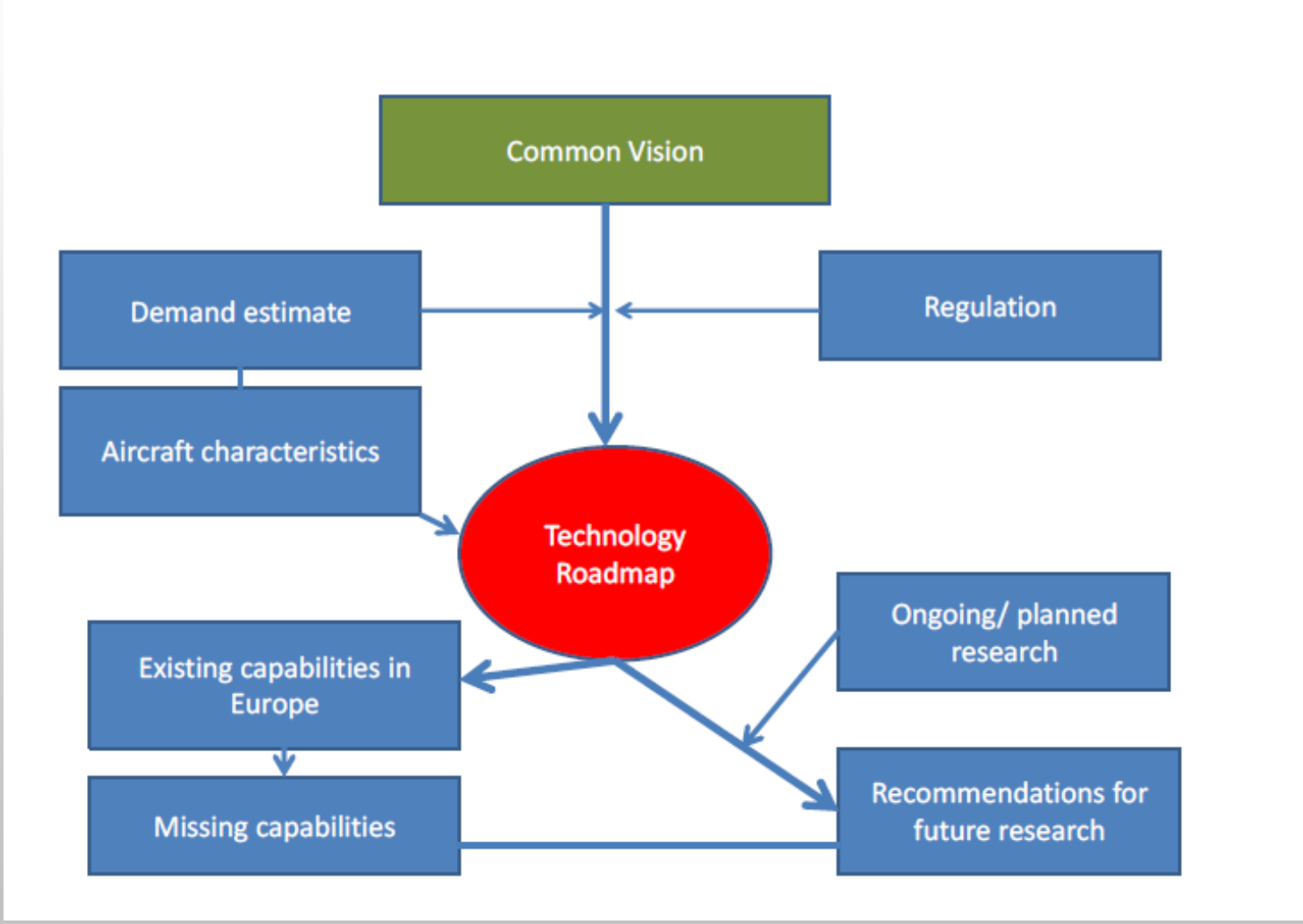
- The roadmap will address the technology needs for **future small aircraft** (4-19 seats) for on demand as well as scheduled air transport.

- The roadmap identifies the solution needed in the **2020-2035 timeframe** matching the already on going research to avoid overlaps.

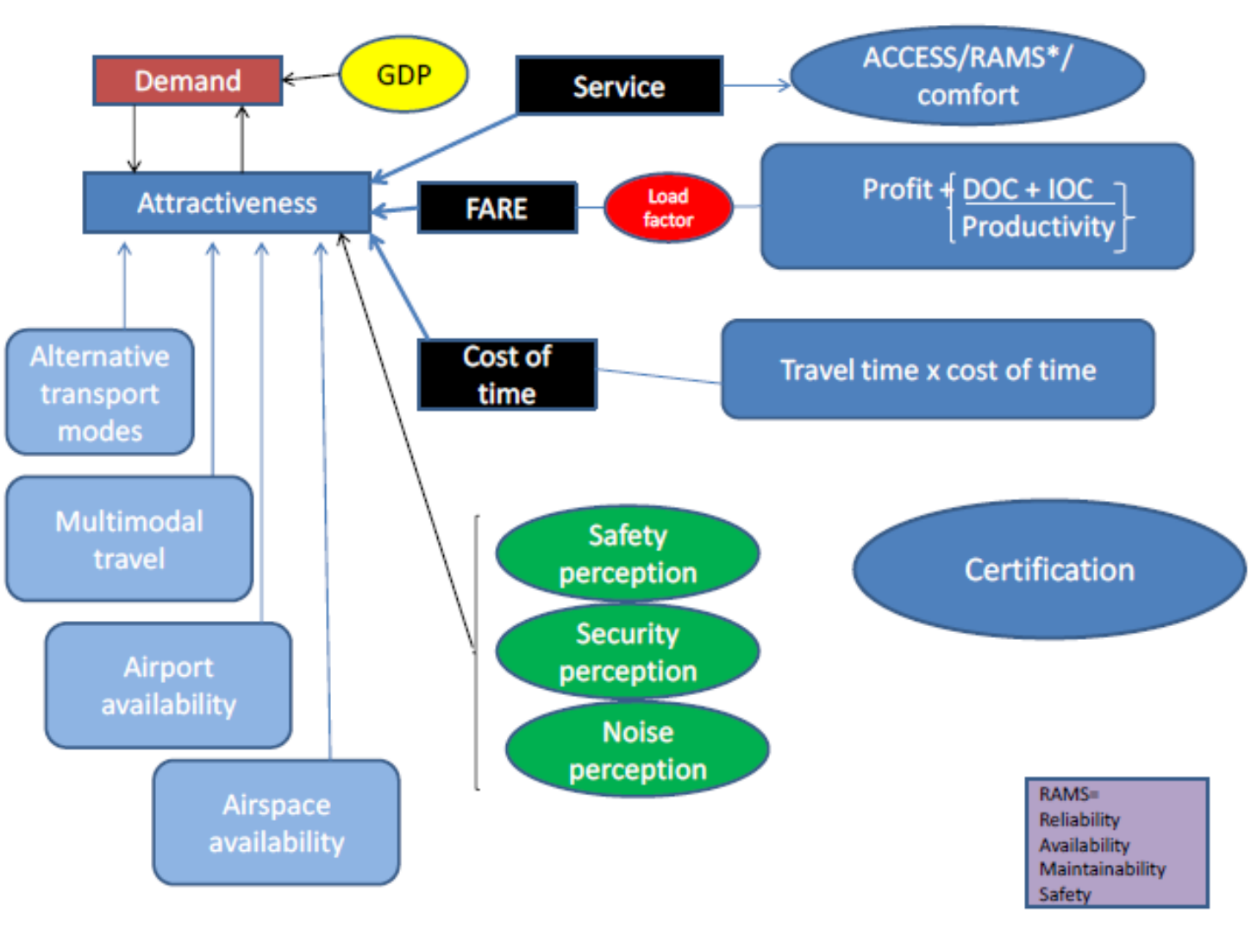
SAT Technology Roadmap output flow



Technology Roadmap workflow

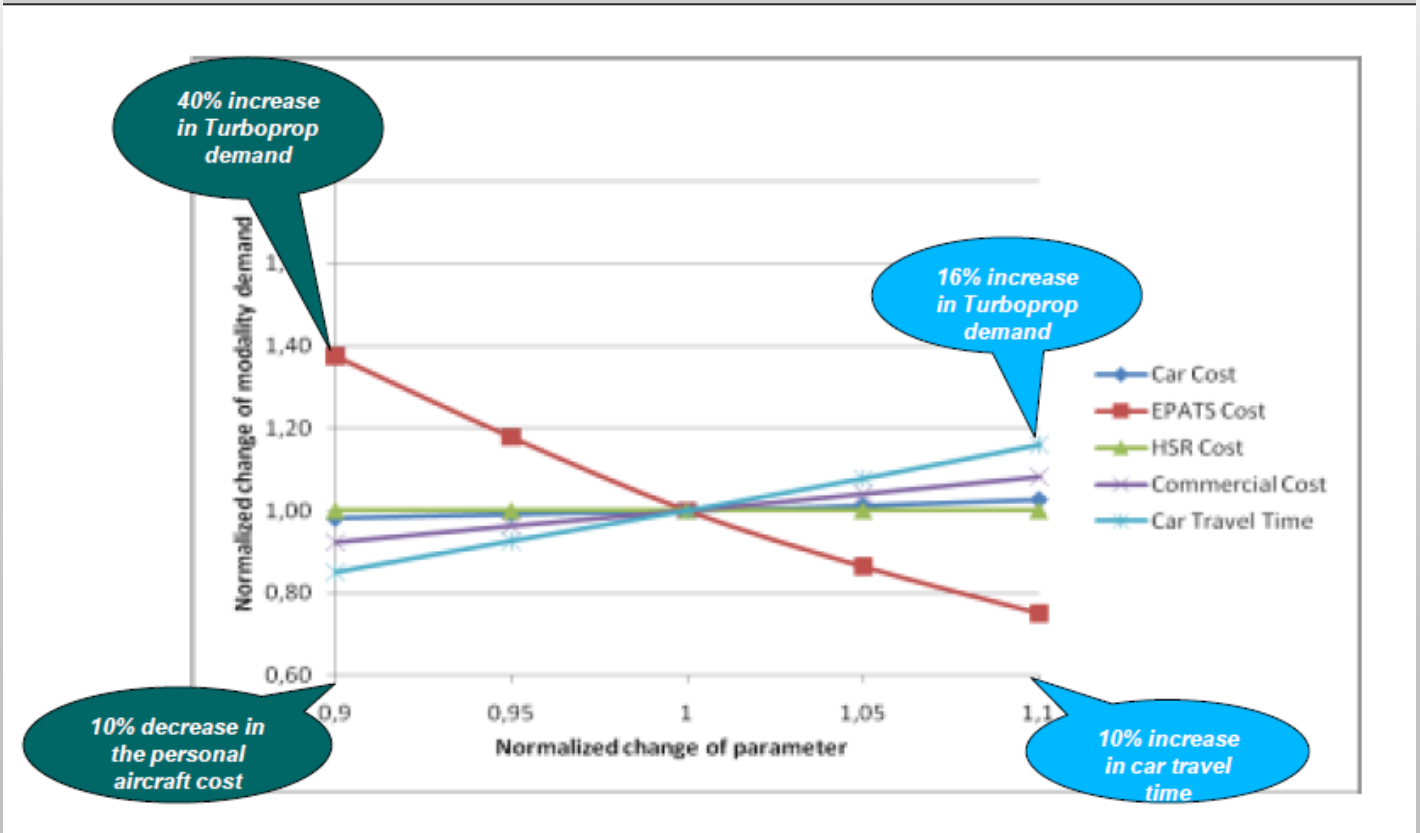


Demand Model and A/C Characteristics

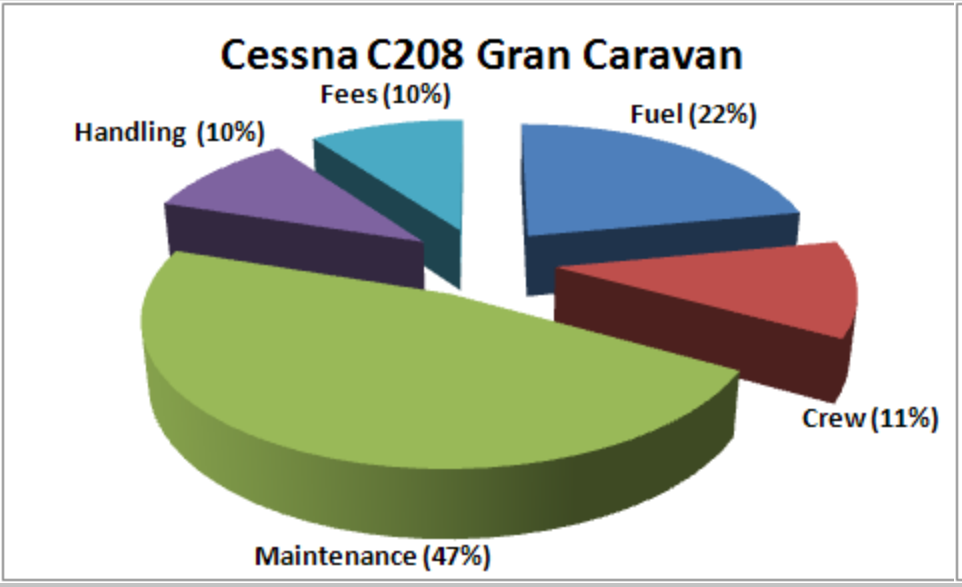


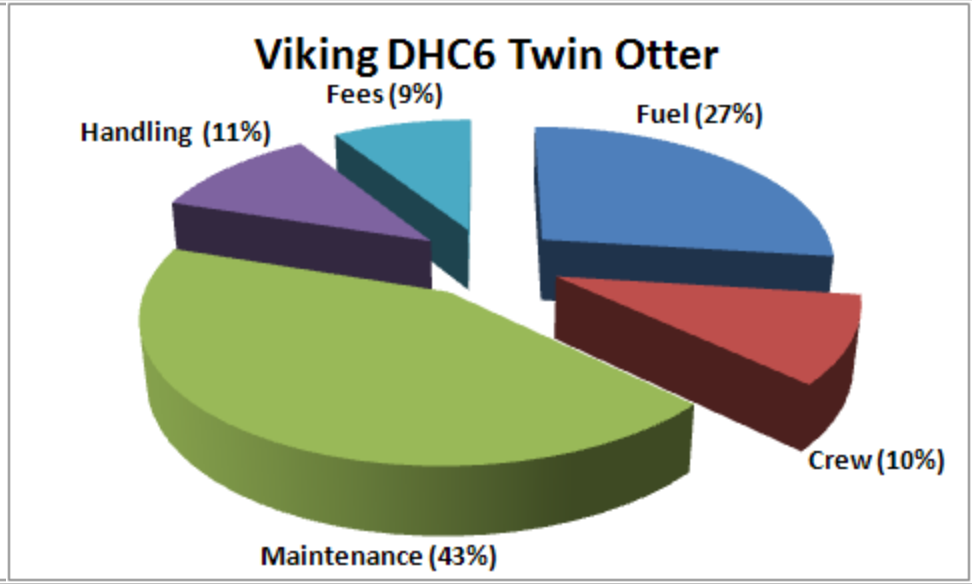
Elasticity of the demand with fare

- The analysis shows that a fare reduction has the biggest impact on demand for transportation by small aircraft.
- Turboprop powered aircraft cover larger distances of on average 400 Km. These aircraft seems to have a more stable customer base which includes scheduled services.



DOC: example of breakdown of a SAT





Indicative Fixed Costs for SATs

	1 A/C	5 A/C
Insurance	20,000	100,000
Lease Rate	200,000	1,000,000
Training	5,000	25,000
Indirect Personnel (incl. AOC)	110,000	300,000
Commercial Costs-Marketing	30,000	50,000
General Costs	60,000	130,000
TOTAL	**425,000**	**1,605,000**

It is better to have a larger aircraft fleet.

Total cost per available seats km

0.39 € — ***Total cost*** — **0.27 €**

0.7 Load Factor

+

10% Profit Margin

0.61 € — ***Fare*** — **0.42 €**

Targets

- The target is the **reduction** of the **Total Operating Costs** of **50%**.
- To reach the target the indicative breakdown reported below has to be realized.

COST	ELEMENT	2035
DOC	Engine related	-/- 25%
	Airframe related	-/- 8%
	Systems related	-/- 2%
	Crew related	-/- 3%
IOC	Insurance	-/- 1%
	Leasing cost	-/- 7%
	Training	-/- 1%
	Other	-/- 1%

Relationship DOC- Tech. Road Map

DOC	Engine	Airframe	Systems	Crew
Fuel	***	**	**	
Crew			**	**
Maintenance	***	***	***	
Handling	*	*	*	**
A/C price	***	***	***	

Key Technologies short-medium term

- The economic performance of future Small Aircraft products depends on **efficient, less expensive aircraft power plant**.

- The acquisition cost will depend on **low cost production airframe**.

- To **improve safety** and reduce the pilot workload in all weather condition:
  - GPS navigation.
  - Flight envelope protection (FbW).
  - Less power consuming anti-ice.
  - Air traffic, weather condition, aerospace border easily displayed.

Ongoing EU Research Project

Technology Roadmap: ESPOSA project

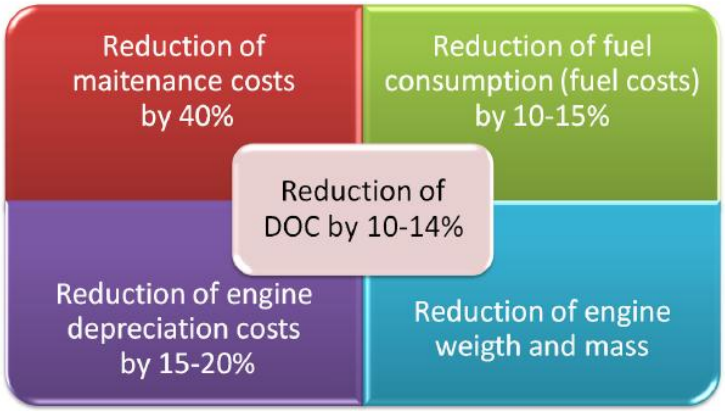
Reverse of obsolete aircraft engines (piston, old GTE types)

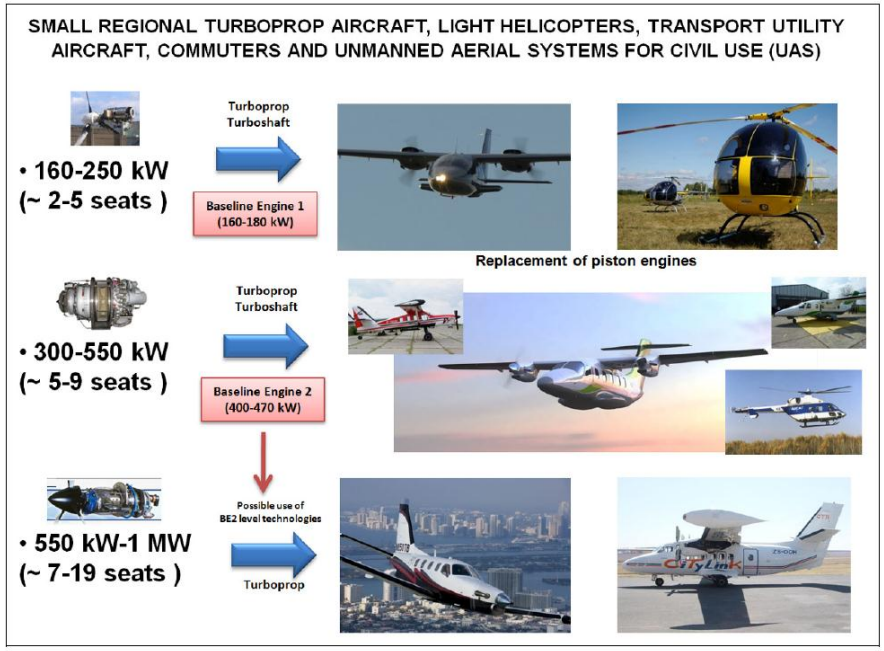
- Immense operational workload for the pilot
- Intensive and long maintenance, repair & overhaul
- Spare parts limited availability for older engine types
- AVGAS limited availability for piston engines
- Lead contamination in case of AVGAS fuel

Caused by

Out-of-date parts and engine technology

ESPOSA objectives for engine technologies



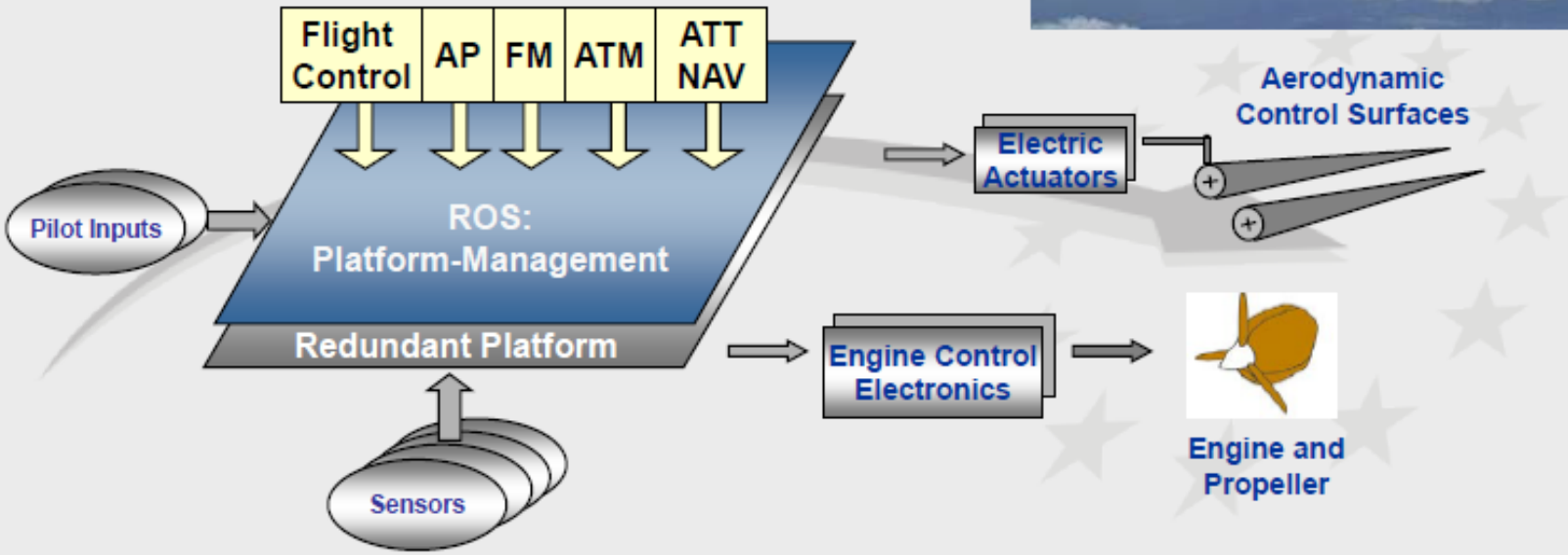


Technology Roadmap: SAFAR project
Small Aircraft Future Avionic Architecture

SAFAR – FBW Platform Concept 1/4

Platform includes

- Platform management
  incl. redundancy management (RM)
- All relevant applications



RESULT: Fulfillment of Safety Target

Technology Roadmap: SAFAR project
Small Aircraft Future Avionic Architecture

AUTOMOTIVE VS AVIATION - Safety

COMPARISON AUTOMOTIVE VS AVIATION SAFETY

▪ CS25	$P_{VEHICLE}\{CAT\} < 10^{-6}$	$P_{CONTROL}\{CAT\} < 10^{-9}$
▪ CS23 / Class 1	$P_{VEHICLE}\{CAT\} < 10^{-4}$	$P_{CONTROL}\{CAT\} < 10^{-6}$
▪ Automotive	$P_{VEHICLE}\{CAT\} \sim 5*10^{-6}$	$P_{CONTROL}\{CAT\} < 10^{-7(8)}$

DIFFERENCES AUTOMOTIVE VS AVIATION

▪ AUTOMOTIVE	Safety (Integrity) Reliability	Very High Fail/ Operational 10min
▪ AVIATION	Safety (Integrity) Reliability	Very High Very High

SAFAR OBJECTIVES

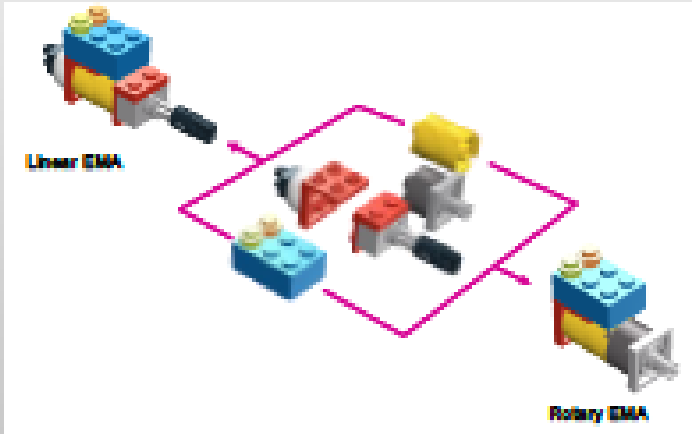
▪ CS23 / Class 2 scalable to	$P_{VEHICLE}\{CAT\} < 10^{-5}$	$P_{CONTROL}\{CAT\} < 10^{-7}$
▪ CS25	$P_{VEHICLE}\{CAT\} < 10^{-6}$	$P_{CONTROL}\{CAT\} < 10^{-9}$

Technology Roadmap: ACTUATION 2015 project

OVERALL OBJECTIVE

Achieve European leadership in Electric Actuation for Aerospace Industry:

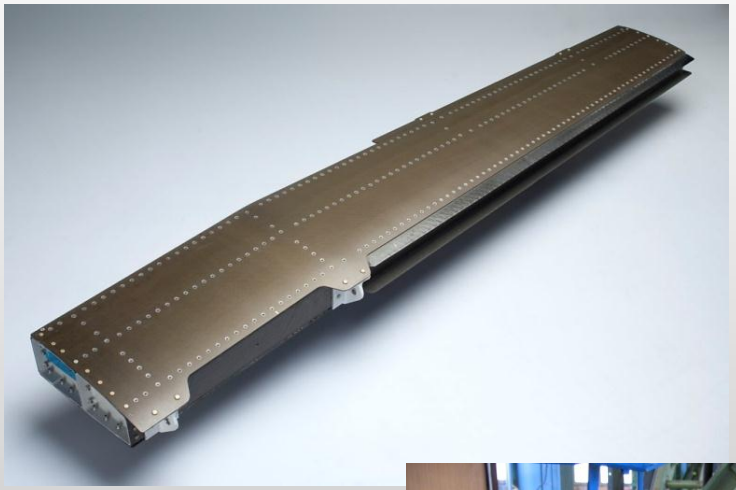
- ***driving the transition from "More" to "Full" Electric Aircraft.***
- ***developing a new Electrical Modular Standardized Actuation concept.***
- ***achieving a Cost and Reliability optimization.***

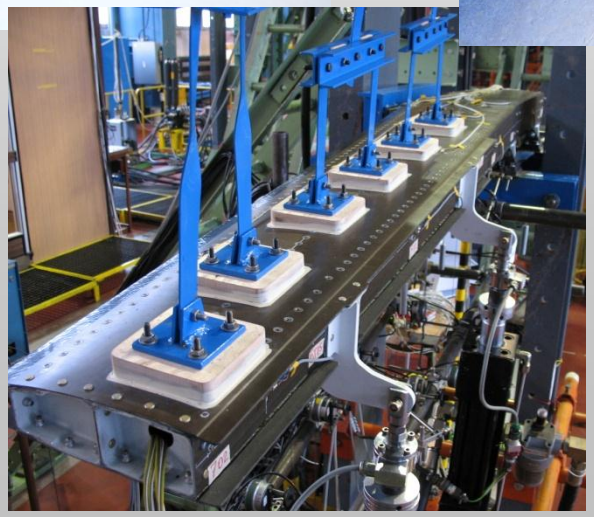


SPECIFIC OBJECTIVES

- ***Reducing the overall A/C LCC (development, certification, maintenance and operation).***
- ***Improving the actuation Reliability.***
- ***Maturing the Technology (from TRL3 to TRL5).***
- ***reducing the actuation Weight (fuel burn reduction).***

• P180 Fwd wing AFP technology with concurred spars and RTM ribs.





Main results vs metallic

- ***Weight saving 24%***
- ***Part number saving 22%***
- ***Cost reduction 20%***

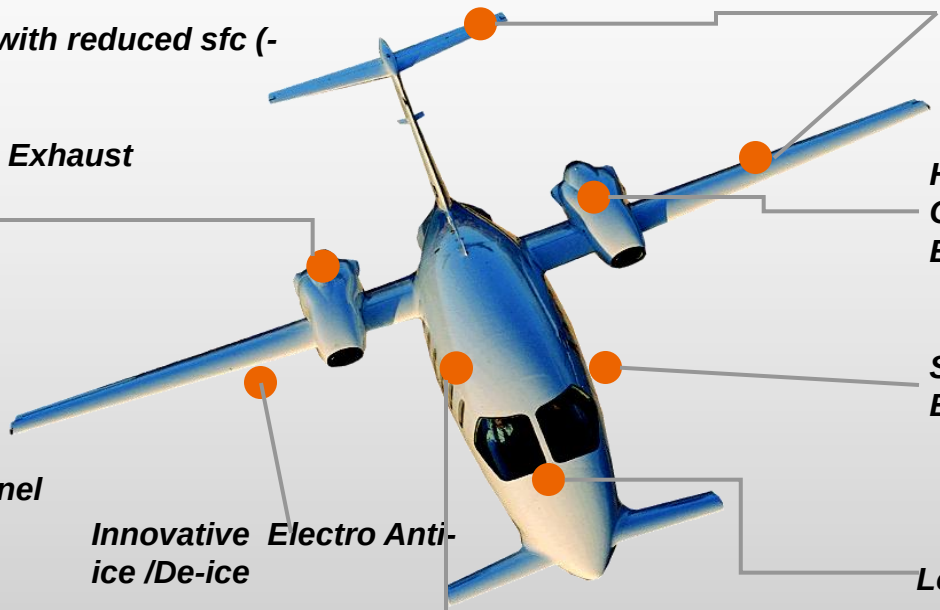
Small A/C needs not only Technology

- Analyzing the **effect of LSA regulation on sport aircraft** more than 30 new manufacturer entry in the market:
  - The Small Aircraft need new **simplified CS/FAR23 rules for certification**.
  - EASA raised the issue of a new concept for regulation of non complex aircraft, used in non-commercial activities.
- **Pilot training:** The accident analysis suggests that the majority are caused by pilot error. This impose to look at how training is done and how it can be improved.
- **Airport & Aerospace accessibility:** Despite efforts, the number of public-use small airports continues to decline and the air traffic management is not getting benefit by the ADS-B technology due to its cost (still too expensive for Small Aircraft application).

Conclusions

- Small aircrafts are a transportation tool and, ranging from light single piston engine up to larger turboprop, have got the potential to service within a flexible transportation system (SATS) answering to medium and long term needs.
- Technology has to be focused on reducing operating cost, pilot workload and improve safety without increasing the acquisition cost like:
  - Propulsion TP with reduced fuel consumption, maintenance and acquisition cost
  - Low cost composite airframe (out-of autoclave)
  - Simplified FbW to improve safety
  - Low power consumption anti-ice
- New concept and new configuration are exotic but the real need are

Technologies for Small aircraft Demonstrator



New Engine (no bleed) with reduced sfc (-15%) FADEC
Increased TBO
Low Noise Propeller & Exhaust

Low Cost Composite Airframe

High Voltage Electrical Generation for More Electric Aircraft

Smart Landing Gear with Electro Mechanical Actuation

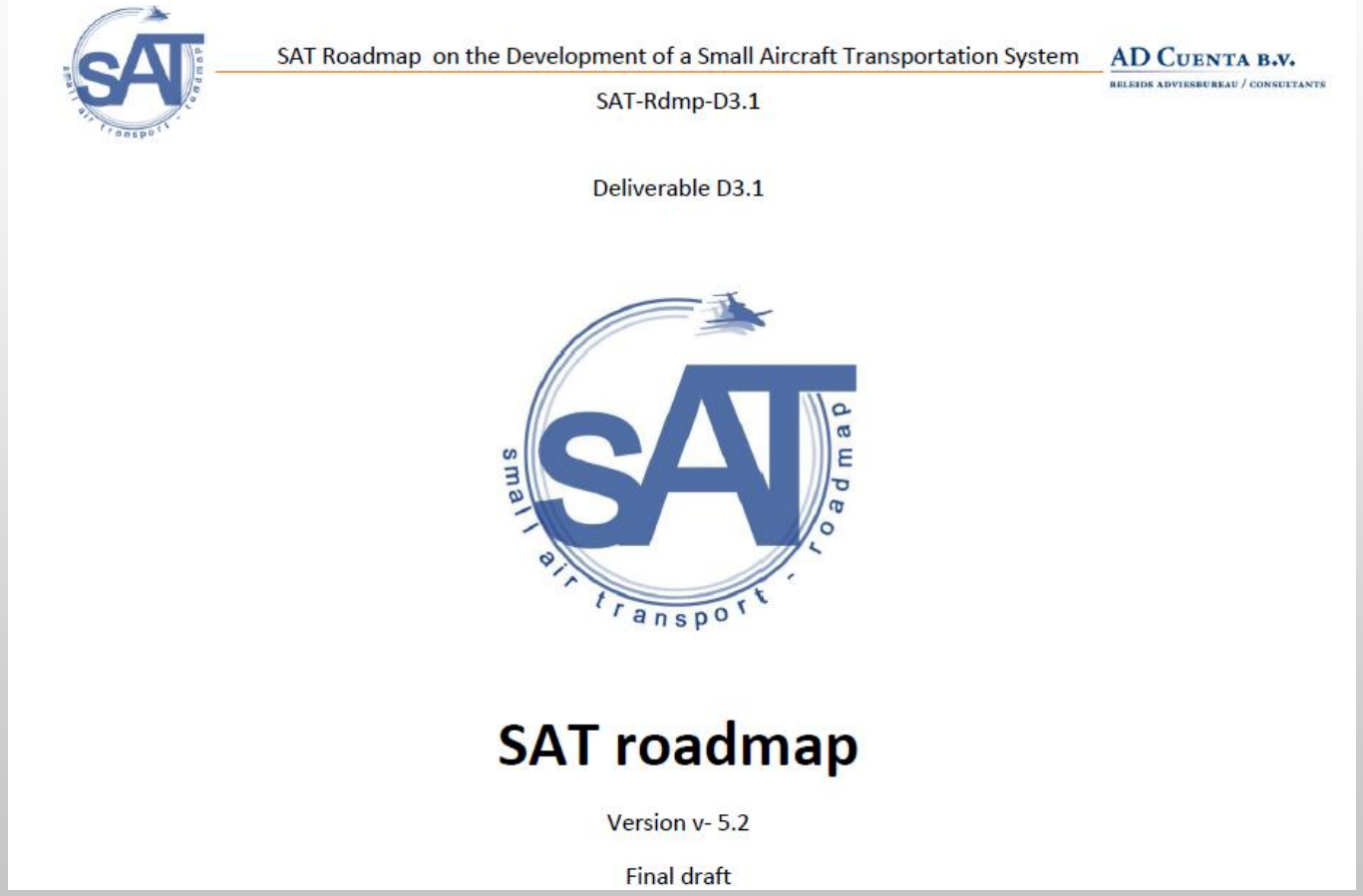
Multi Layer Trim Panel for low Noise Cabin

Innovative Electro Anti-ice /De-ice

Low Cost FbW

20

Thank you



SAT Roadmap on the Development of a Small Aircraft Transportation System

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Deliverable D3.1

SAT roadmap

Version v- 5.2

Final draft