RESEARCH APPROACH

Long Term Perspective

First it has to be understood which role small aircraft will play in air transportation in the future, how they will be embedded in future air traffic control and management, and which technologies will be available to guarantee their efficient and safe operations. Therefore SAFAR will start in **WP100 – Future small aircraft transportation system** with a comprehensive analysis of missions for small aircraft, requested functionality, availability of technologies, system concepts and a clear characterisation of society induced aspects such as individual mobility, environmental conditions, noise pollution, and high level safety requirements which leads directly to systems and operations requirements for small aircraft.

Avionics Fundamentals

Based on these requirements the work in SAFAR will now in a second step focus on the avionics fundamentals for small aircraft performing the tasks concept definition – design & prototyping – validation & certification. In **WP200 – Small aircraft future avionics concept** a comprehensive blueprint of future avionics of small aircraft will be drawn taking into account the aspects of all electric aircraft, fly-by-wire flight control system and an innovative sensor, navigation and communication package including a safety assessment of these components.

WP300 – Small aircraft future avionics design & prototyping follows straight forward with design and prototyping of a failure redundant fly-by-wire platform and the corresponding sensor package for navigation and communication. Appropriate control laws will be developed via test flights with a validation aircraft (V-plane) and incorporated in the flight control system on the top of the fly-by-wire platform. On a test rig (iron bird) all components are integrated and their functional behaviour is tested.

In **WP400 – Small aircraft future avionics verification & in-flight tests** the relevant hardware and software is tested on a 6-DOF simulator, than integrated in the V-plane and tested on the ground. Finally in-flight validation of the SAFAR avionics in terms of handling quality, control characteristics and automatic reconfiguration in case of failures will be performed. This closes the work on the avionics technology fundamentals for small aircraft. Long term realisation

In **WP500 – Future small aircraft transportation system implementation** it will be analysed how the SAFAR small aircraft avionics architecture can contribute to the future of air transportation in general. A technology road map will be drawn up to show the long term realisation options for the implementation of a future small air transportation system. Particularly safety relevant issues will be discussed with aviation certification organisations. The SAFAR avionics architecture will be presented to standardisation bodies taking in mind that only if standardised components can be used a cost efficient solution will be in a near reach.

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SAFAR

SMALL AIRCRAFT FUTURE AVIONICS ARCHITECTURE *

SUMMARY

SAFAR will focus on the development of future avionics architectures for small aircraft providing easy and safe control of the aircraft. SAFAR aims at a significant reduction of pilot workload and an increase of safety during all phases of flight and ground operations incl. take-off and landing. In order to achieve this, SAFAR will provide the aircraft with easy handling characteristics and flight envelope protection at any time. The pilot flies the aircraft mainly via stick controller and throttle lever. Switching between flight control and flight guidance modes will be performed by the system in a transparent way for the pilot.

SAFAR shall also provide the capability to take full advantage of the results of SESAR. Advanced ATC and even ATM will be supported in a way of maximum on-board automatism. In long term four dimensional flight vectoring as a result of the on-board ATM/FM will be executed. In mid term, four dimensional flight vectoring is expected to come from ATC via ADS-B. After being checked by the pilot via display, SAFAR will provide the capability for execution of the flight trajectories after confirmation and engagement by the pilot.

The clear objective of SAFAR is to keep the handling of the aircraft for all modes of control, i.e. manual control, control via flight guidance and control via flight management in combination with ATC resp. ATM, as easy as possible.

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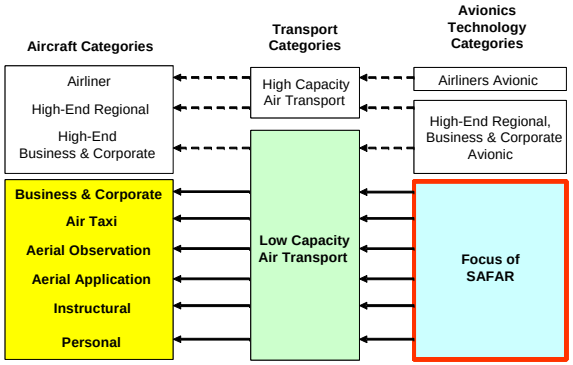
BACKGROUND

Today individual transport is mainly achieved by automotive vehicles. Due to the expected saturation of the road traffic and due to expected longer transport distances in the extended European Union, the increasing demand for individual transport cannot be satisfied by road traffic alone any more. Consequently, the white paper on European transport formulates the goal to establish a proper balance of the individual transport between road, rail and air traffic.

Small aircraft can be a useful mean of personal transportation, particularly for people living in remote regions or requiring fast transportation from A (e.g. a minor secondary aerodrome) to B (e.g. an aerodrome accessible by General Aviation, even of limited capabilities and dimensions, but sufficiently close to a metropolitan area).

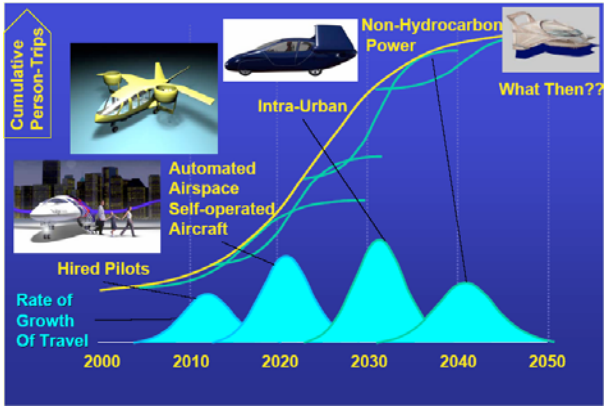
A significant growth potential for the Low Capacity Air Transportation market is expected arising from future highly efficient, highly reliable LCAT aircraft which should achieve point-to-point on-demand traffic at speeds three to four times faster than highway (road) speeds and approximately two times faster than using scheduled air transport traffic between major airport hubs.



SAFAR future avionics architecture will be an avionic platform allowing the realisation of such highly efficient small aircraft at even improved handling qualities and safety. In total, the high aircraft efficiency will lead to more affordable aircraft in terms of life cycle cost.

OBJECTIVES

The long-term, ultimate goal of the consortium is to introduce new and innovative technologies into the small aircraft aviation segment; everything from avionics, navigation up to aircraft manufacturing. This will be a completely new transportation system for small aircraft which will make it more available to everyone and should provide safe, “green” and affordable air transportation even under denser air traffic and more complex ATC in the future.



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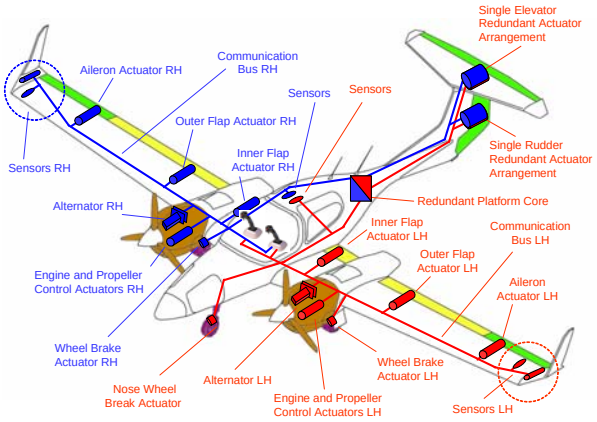
Within the SAFAR project first steps will be done in this direction with design, development and validation of an avionics architecture for future small aircraft (safe, cost efficient, extendable and scalable) which will point the way ahead for advanced low capacity air transportation (LCAT) systems.

Fly-By-Wire

Baseline of the SAFAR architecture will be an advanced safety critical, fault tolerant fly-by-wire platform applicable to LCAT aircraft. The platform will comprise computing resources, a human machine interface, a mainly satellite based fault tolerant attitude/navigation system and a safety critical electric power supply with all-electric actuators. In order to keep the handling characteristics of the aircraft as easy as possible and to avoid any pilot training cases, the fly-by-wire platform must maintain the same handling characteristics and flight protection features even in cases of platform failures. Significant functional degradations in the handling characteristics such as degradation to “direct law” are not acceptable. This requires an all time / full performance / full authority fly-by-wire platform without any mechanical backup.



All Electric

The fly-by-wire platform will be developed as a fail-operational and fail-passive all electric platform incl. all electric actuation. Therefore, new absolute safety critical electric power generation / distribution incl. strategies providing safe E-power and storage in cases of emergency descent due to total engine loss (no ram air turbine will be used) incl. mechanisms for continuous accurate diagnostics of energy storage will be investigated

Navigation

Reliable and accurate position and attitude information is a fundamental requirement to enable autonomous control. For the SAFAR project a primarily GNSS based solution is identified as a promising solution to create a cost efficient and failure tolerant position and attitude sensor.

ATM Integration

Future operation in environments of much increased traffic densities will need advances in ATM capabilities and operational practices. It will be mandatory that the present practice of tactical instructions by Air Traffic controllers using very busy radio channels is to be replaced by a strategic trajectory based ATM system. The recommendations of SESAR will be considered here.

More Safe, More Green

The objectives of making A/C more affordable, reliable and more green, will be supported both directly and indirectly by SAFAR. It will allow advanced A/C design relying fully on active control, monitor and diagnostics functions. This will allow A/C designers to utilise mechanical safety margins optimally and thus to design more flexible and lighter structures. Also, natural dynamic stability will not be a constraint for A/C design any more.

Certification Issues

The fly-by-wire platform developed in this project will be the first to be certified according to CS23. Therefore a certification guideline for fly-by-wire / all electric small aircraft will be established in close cooperation with EASA and national CAAs. Up to now CS23 relevant for A/C considered here is not adapted for fly-by-wire control. So, clear criteria about the application of design assurance levels (DAL) as they are given in CS25 do not exist in CS23 and will be proposed.

PERSPECTIVE BEYOND

Beyond the current research it is the intention of the SAFAR consortium to provide a generic, enhanced and proofed avionics architecture to the aeronautics community with a high degree of reuse of generic hardware and software components which will allow in the future to implement advanced functionalities to small aircraft such as automatic takeoff and landing or automatic go-home and auto-land functionalities in case of emergency.