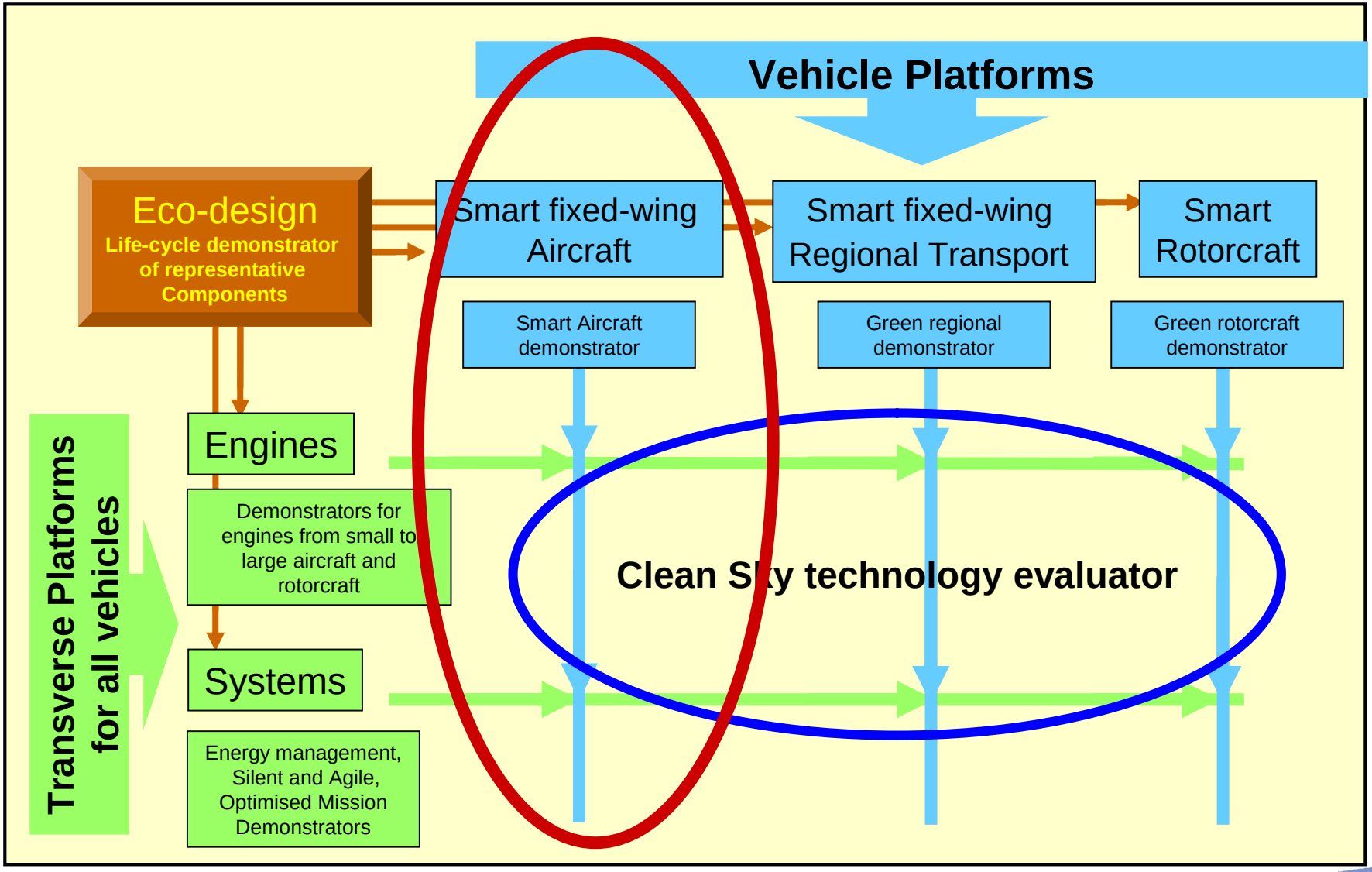
Robert Hinsinger
Airbus SAS

Smart Fixed Wing Aircraft platform

Clean Sky JTI workshop

SFWA : Backgroung & Approach

Technical Organisation



SFWA Rationale and Content

- **Rationale:**

  Create the basis for a step change of large transport aircraft performance and environmental compatibility by:

  - **Rethinking the Wing and Aircraft architectures and components in a fully multidisciplinary approach.**
  - **Validating the best down selected candidates on (a) representative vehicle(s)**

- **Content and Impact:**

  Today, Innovative Technologies, Concepts and Capabilities indicate that they have the potential to demonstrate a step change in critical areas of fuel consumption and noise emission.

  They will be pushed forward in a multi - loop development and down selection process with a final proof on large representative demonstrators.

To this end the SFWA- platform will integrate an *Active Wing* and *Innovative Airframe Concept Technologies*

SFWA Impact

- The Platform will provide the most suitable means of drawing together current research activities at national and European level in a **flagship project** that will pave the way for the next generation of products.

- The platform will have a **leverage effect** on the future R&T investments in the domain of Flight Physics. Outside “Clean Sky” R&T projects will be launched to complement the activities and reinforce the potential impact of the technology on new products.

- Such a Platform will **represent a critical mass of activities that enable the step changes**. Universities, research centres and SME will provide the broad range of skill, knowledge and competence to design, manufacture, simulate, wind tunnel test and flight test the demonstrator.

SMART Fixed Wing A/C: Integrated approach

- **Active Wing† concept:**
  - Active Flow Control for Improved Cruise & Low Speed Performance
  - Active Load Control for Reduce Aircraft Mass

- **New configuration**
  - Provisions must be taken on aircraft concept configuration (plan form) to accommodate other systems integration :e.g. New/ Innovative engine configurations (open rotor, GTF, CRTF, ..)

† Wing = Wing plus Engine, Pylon & Nacelle

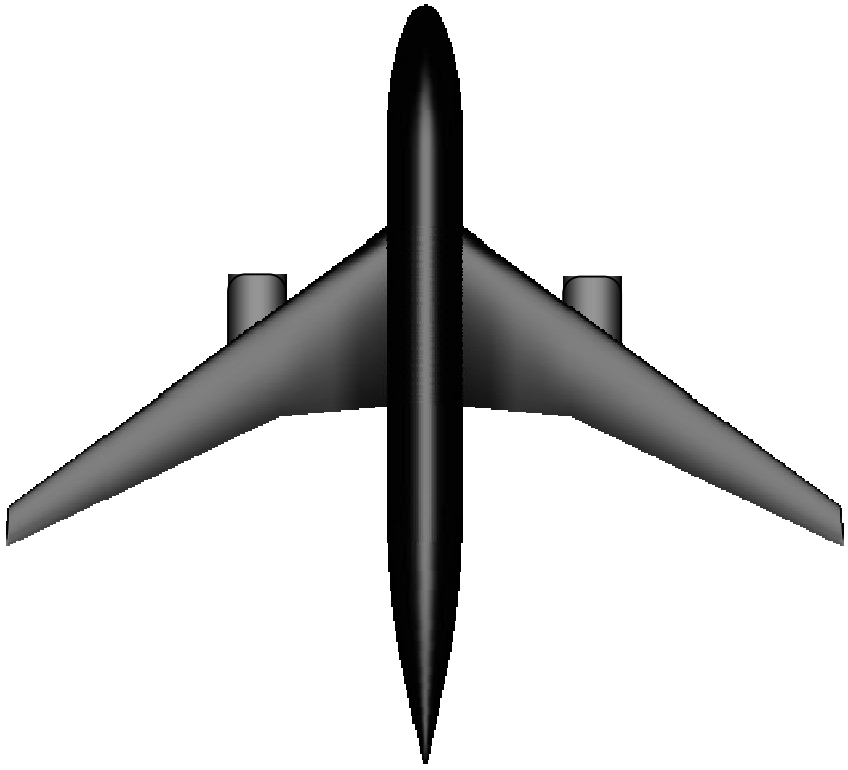
SFWA: Active Wing Concept

ACTIVE WING Concept

- **Scope:** Design, Manufacture and Flight Test of an Integrated SMART WING† containing:-
  - Active Flow Control (ACF) for Improved Cruise & Low Speed Performance
  - Active Load Control (ALF) for Reduce Aircraft Mass
  - plus embedded Structural Health Monitoring
- **Benefits**
  - Reduction in Fuel burn, Structural Mass, Maintenance & System Complexity/Cost.
  - Increase in Ride Comfort and Safety
- **Objectives**
  - Flight demonstrate the benefits of an integrated AFC/ALC Wing
  - Develop the tools to design in the presences of Active Flow & Load Control.
  - Develop a robust sensor-actuator architecture for combined Active Flow & Load Control.
  - Address Certification issues associated with advanced Active Flow & Load Control Systems.
- **Deliverables:**
  - Flight Proven Architecture for an Advanced Active Flow & Load Control Wing.
  - Provide confidence in the AFC/ALC concept.

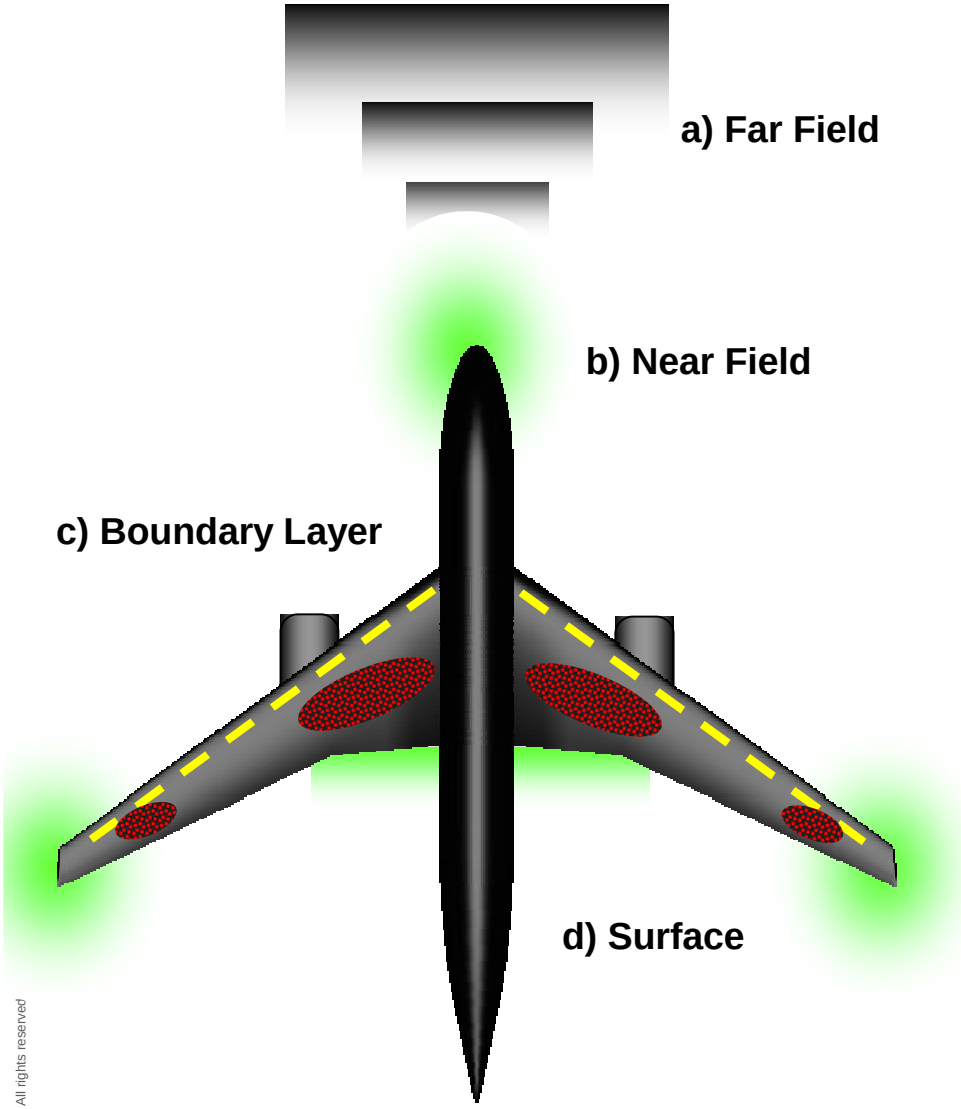
† Wing = Wing plus Engine, Pylon & Nacelle

ACTIVE WING : Basic Characteristics



- **One Network of “Sensors & Actuators” to Actively Manage the Airflow and Loads Across the Whole Flight Regime of the Product.**
  - **Low Drag**
  - **Low Mass**
  - **High Ride Comfort**
  - **Low Complexity**
- **Hierarchy of Flow Sensors.**
- **Massively Distributed Systems (Sensors & Actuators) for fidelity & Fault Tolerance.**
- **Clean Wing & Nacelle**
- **No Movables or Conventional Devices**
- **Note : Should Have a Tail!!!**

ACTIVE WING : Sensor Arrangements

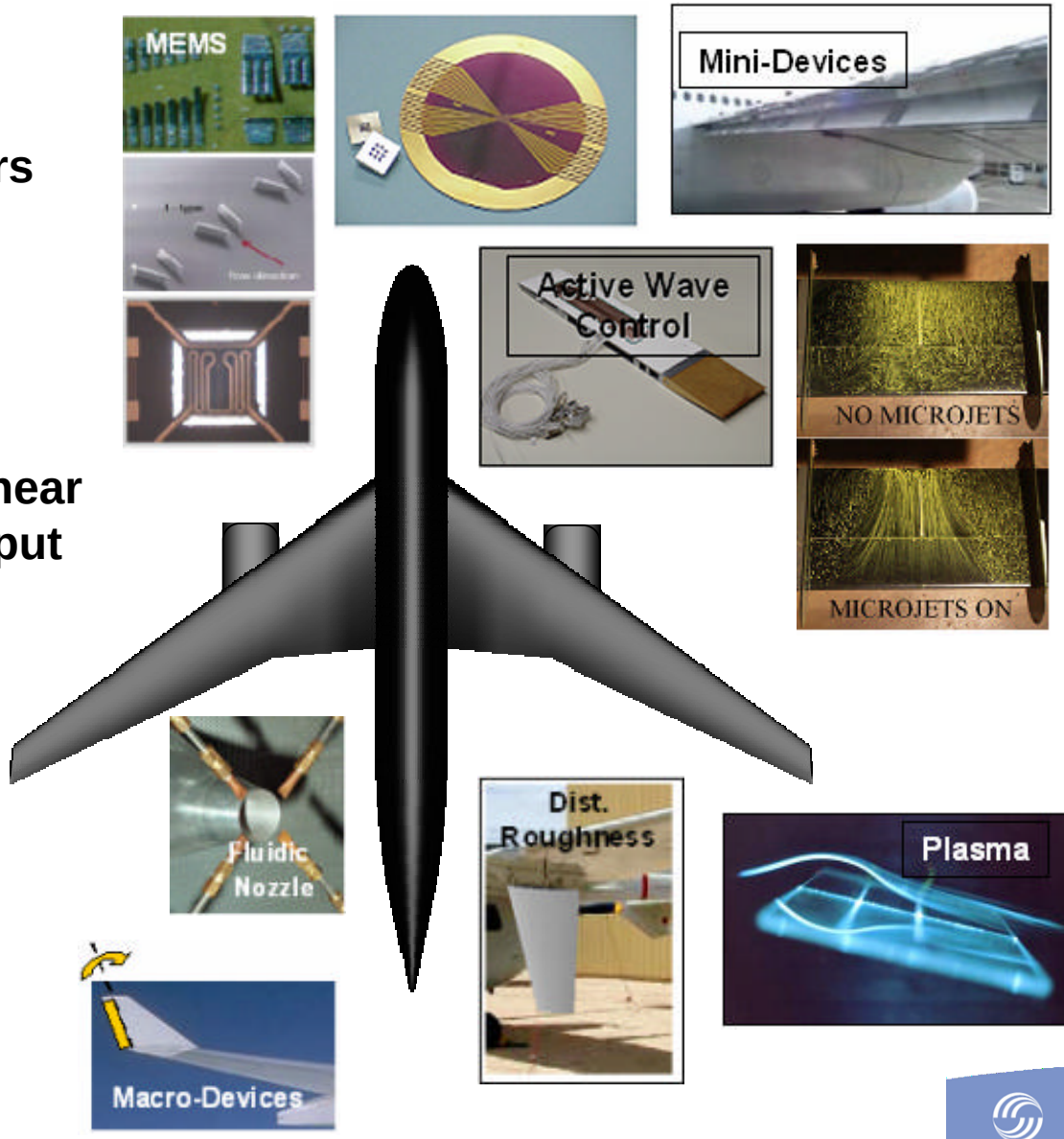


All Connected and Covering All Flight Regimes

- **Hierarchy of Sensors**
- **Different Sensors for Different Applications**
  - **Turbulence, Separation, Loads**
- **Optimal Layout (topology & geometry) for Different Applications is Different**
  - **Cruise or Take-off/Landing**
- **Massive Number of Sensors for coverage and redundancy.**
- **Connectivity and Data Assimilation with Massively Distributed Systems.**
  - **Local, Regional or Global**

ACTIVE WING : Actuators Arrangements

- **Range of Actuators or Effectors**
- **Distribution and Action Dependant Upon Application**
- **Reduced Models of the Non-linear Fluid Reaction of Particular Input**
  - 4 **Multiple-actuators**
- **Deterministic or Emergent Behaviour of Overall System**



SFWA: New Configurations

SFWA “New Configuration“

The spirit of the “New Configuration“ domain:

- Rethinking the aircraft architecture and its components.
- Provide the multidisciplinary capabilities to prepare, operate, exploit and assess selected “New Configuration“ demonstrator on overall aircraft level.

SFWA “New Configuration“

Tentative selection of major objectives

- **Wing configuration**
- **Nose and F/W fuselage configuration**
- **New empennage**
- **Integration of innovative power plants into OAD, noise shielding**
- **Alternative aero-brake system / no thrust reverser brake**

SFWA “New configuration“ Topics and Content

Wing configuration, integration into OAD

Objectives:

- Provide required multidisciplinary tools and development strategies for OAD integration of the Smart Wing and address certification issues

Deliverables:

- Test proven confidence on the potentials and benefits of Smart Wing concept integration.

Benefits:

- Robust information on technologies contributions on reduced fuel burn, reduced noise, cost reduction potentials in design, manufacturing, maintenance and operation.
- Identification of maturity level and prioritization to select technologies for next product.

Nose and F/W fuselage configuration

Objectives:

- Validate the potential for fuel consumption reduction by an improved low drag nose and F/W fuselage layout and a weight reduced structure.

Deliverables:

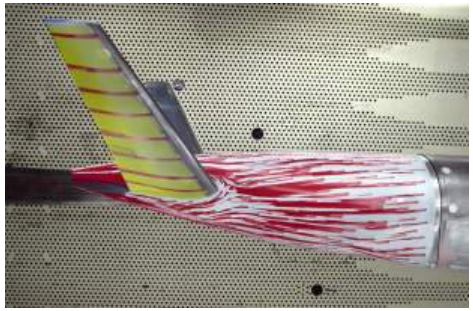
- Demonstrator proven architecture for an innovative nose &F/W fuselage configuration.

Benefits:

- Robust information on reduction potentials of fuel burn and weight. Cost reduction potentials in design, manufacturing, maintenance and operation.

SFWA “New configuration“ Topics and Content

New Empennage



Objectives:

- Identify and demonstrate to OAD alternative empennage solutions
- Assess and validate in real flight condition, static and dynamic aero and loads behaviour and structural concept for down selected solutions within the entire flight envelope.

Deliverables:

- Empennage choice matrix for down selected solutions.
- Priority list to accommodate innovative solutions
- Demonstrator proof of concept with flight worthy aero, structure and system design.

Benefits:

- Robust information on technology contributions to reduced fuel burn noise, weight and system complexity as well as cost reduction potentials in design, manufacturing, maintenance and operation.

SFWA “New configuration“ Topics and Content

Integration of innovative power plants into OAD, noise shielding

Objectives:

- Develop and demonstrate concepts to integrate for innovative power plants (UHBR, open rotor/ Shrouded Fan, Contra Propeller etc.) on OAD level. Set up a choice matrix with new design principles (e.g; noise shielding, empennage buried engine, ..)
- Address certification issues (e.g. engine disc burst protection /blade burst) and requirements (shields and deflectors, system architecture)

Deliverables: (in alignment with “new empennage“)

- Full scale down selected demonstrator empennage with rear fuselage integrated engines
- Innovative design and manufacturing strategy for advanced rear fuselage engine installation concept with optimised reduced empennage / engine drag and system architecture.

Benefits:

- Identification of maturity level and prioritization to select technologies for next product.
- Integration of innovative engines and power systems at highest “green“ level (Fuel burn and noise emission reduction).

SFWA “New configuration“ Topics and Content

Alternative brake system / no thrust reverser brake

Objectives:

- Demonstrate new aero brakes concepts with L/G and with same or better efficiency for alternative solutions in replacement of thrust reversers at lower cost, lower weight and lower system complexity solution.

Deliverables:

- Full scale on A/C alternative brake system demonstrator combining the e.g. innovative L/G functionality and dedicated smart wing “aero brake“ capabilities.

Benefits:

- Reduced mass and fuel burn, reduced system complexity, cut of noise from thrust reverser landing and reduced maintenance cost (in particular engines).

SFWA: Demonstrator

SMART Fixed Wing A/C – Demonstrator Objectives

- **Active wing**
  - To deliver mature “ready to use” technologies and methods to apply the most efficient active flow and loads control to future a/c. This objective passes trough the design, development, flight test and technology assessment of integrated active loads/flow control architectures

- **New configuration**
  - Plug on the active wing concept other major innovative components into one or tow new overall configurations

SMART Fixed Wing A/C – Demonstrator Characteristics

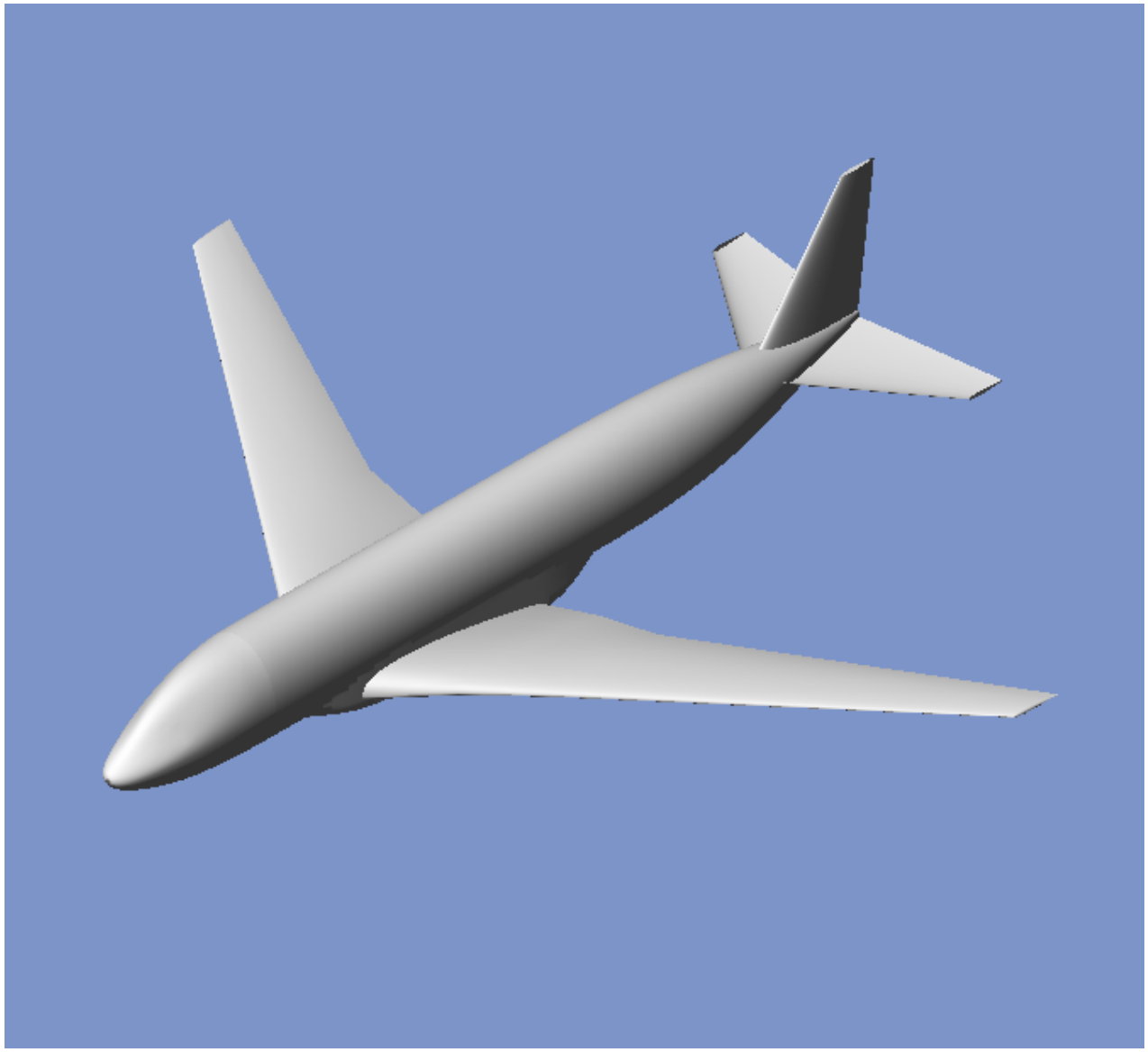
Active wing/New configurations

- **Large** : Sufficient in overall size to reach the necessary flight Re numbers.
- **Fast** : Cruise speeds into the transonic regime, typically in to a cruise region of M0.8-0.85
- **Modular** : We should have a fuselage section with suitable interfaces (structural & system) to allow replacement of wings and empennage.
- **Sustainable** : Should not be a one off, but some thing that will be a long term facility, allowing us to experiment cheaply with new technologies in flow, load and flight mechanics.
- **Ownership** : In line with sustainability probably needs to be operated by a separate group, located some where in a safe but remote location.

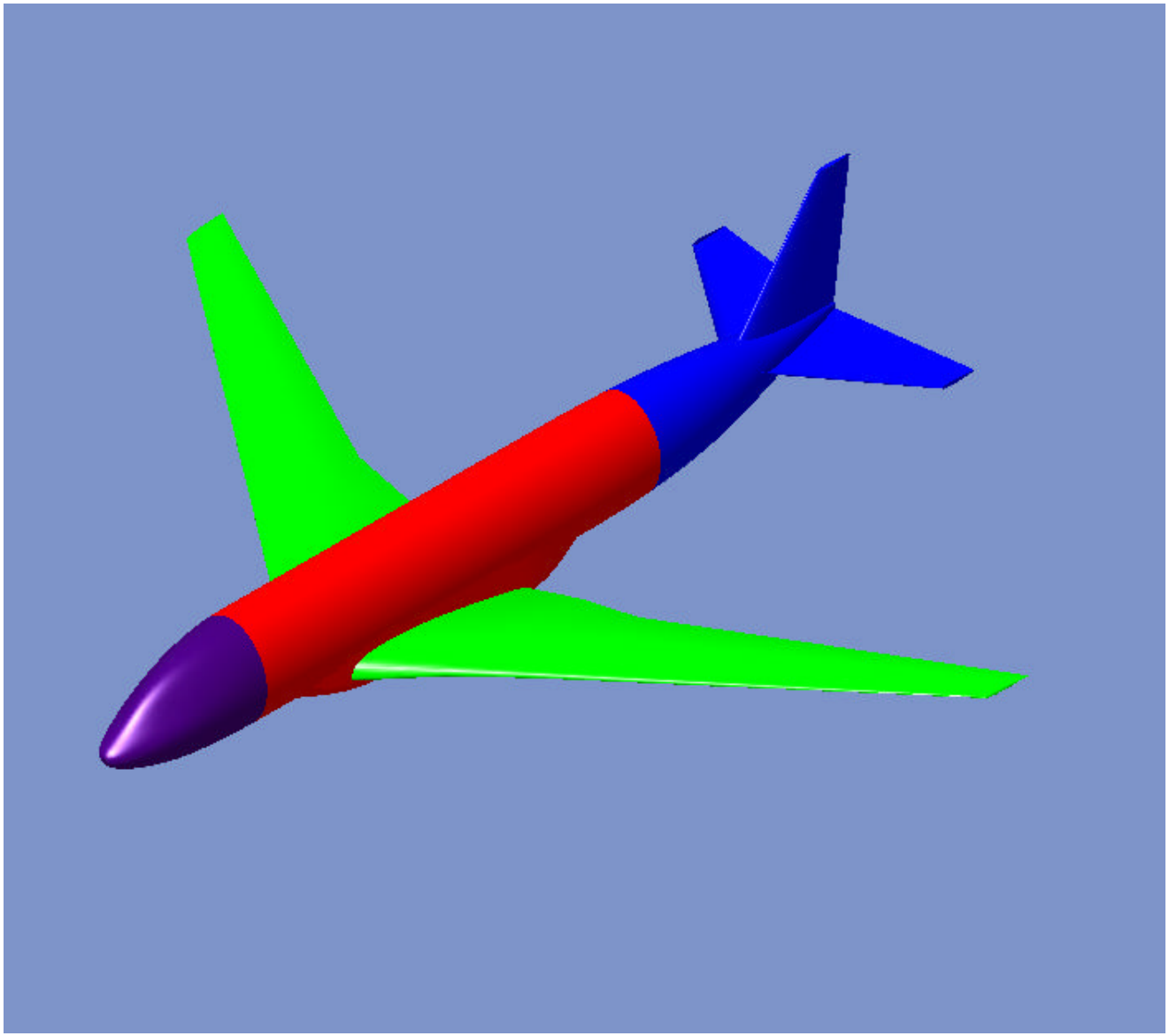
Existing aircraft: A340 (loads control), A320 (Flow control)……

or Unmanned Vehicle (modularity) could be potential candidates

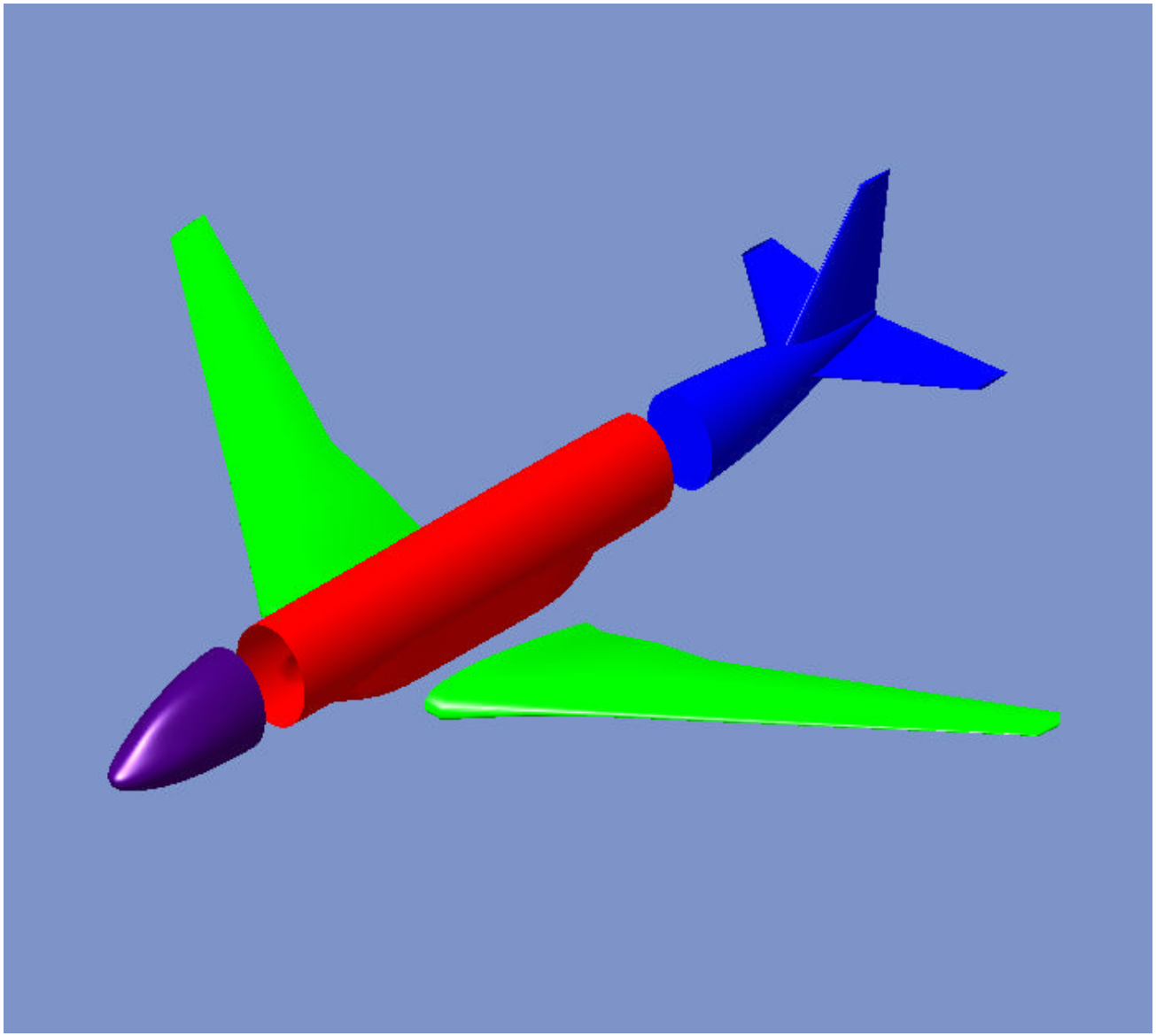
Modular Demonstrator : Basic Demonstrator Concept



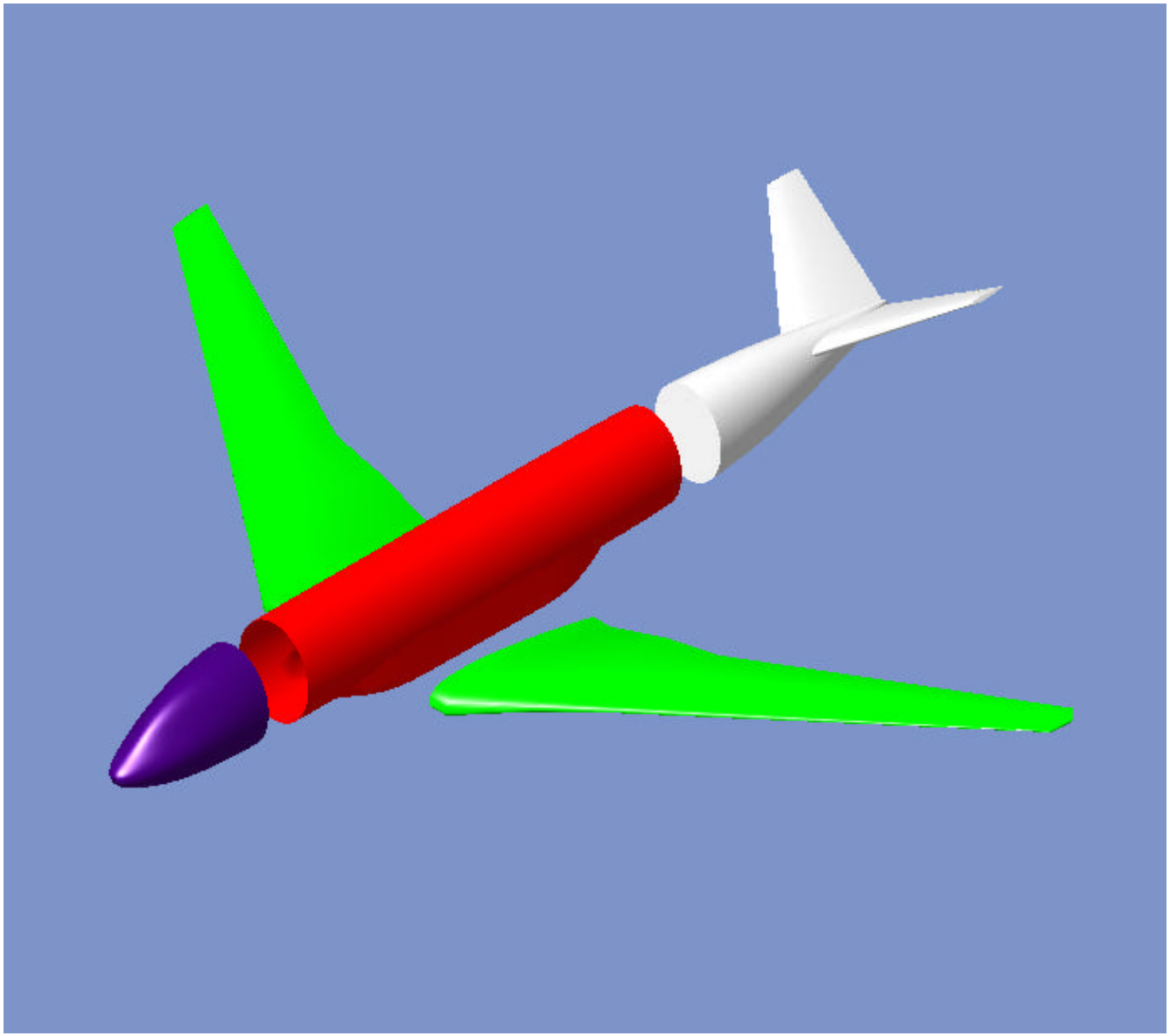
Modular Demonstrator : Modular Components



Modular Demonstrator : Exploded view

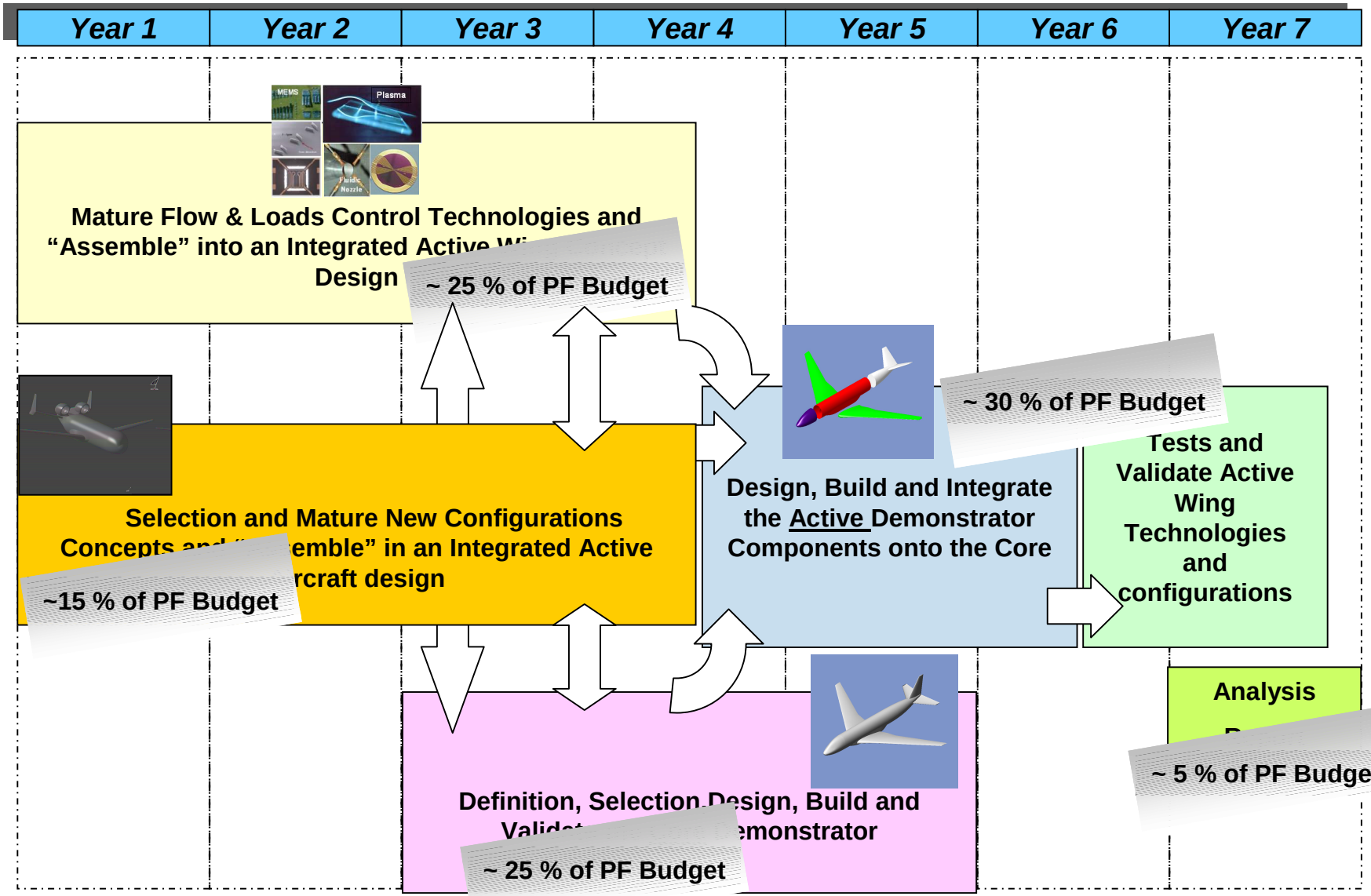


Modular Demonstrator : Alternative Tail



SFWA: Platform structure & Top Level Planning :

Overall Programme Concept and Cost Share



About 5% more budget have to be dedicated to the platform management