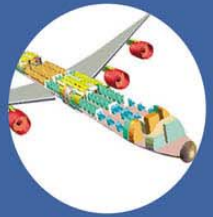


# *Hydraulic System Simulation*

Delphine HERTENS

*Hydraulic System Engineer*

AIRBUS



# VIVACE

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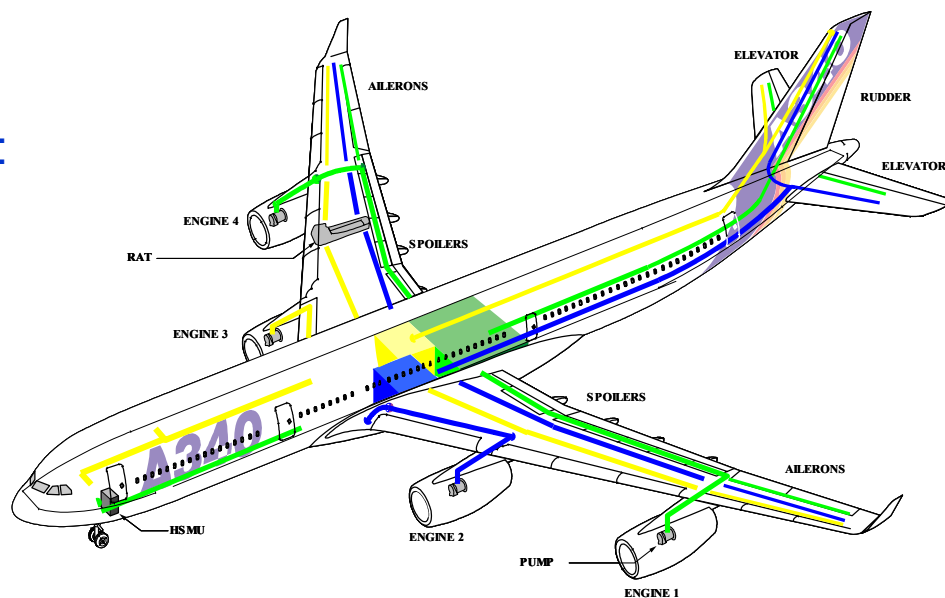
# Hydraulic system overview

•Basic function of Aircraft Hydraulic system: to provide required power to hydraulic consumers which are (mainly):

- Actuators of flight control surfaces (ailerons, elevators, spoilers, flaps...)
- Landing gear systems (extension and retraction, braking, steering...)
- Cargo doors
- Thrust reversers...

•Main components of Hydraulic system:

- Pumps (Engine driven or Electric)
- Valves (ex: Priority valve)
- Filters
- Manifolds
- Indicating devices
- Pipes
- Fittings...





# Hydraulic system task context

- **Objective of the task: improvement of hydraulic system design maturity and reduction of development cost**

- **Axis of work: increase of the level of simulation in hydraulic system design phase**

- **SCENARIO 1:**

- Rationale:*** Allow easier study of a higher number of architectures and allow earlier optimisation of hydraulic system generation

- Mean:*** Providing early in the design phase a predesign model with realistic behaviour of hydraulic system in terms of power available to consumers

- ⇒ Improvement of Flight Cases fidelity

- ⇒ Reduction of work iterations between Flight Control systems and Hydraulics (simulation deliveries and architecture updates)

- **SCENARIO 2:**

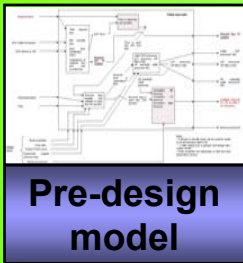
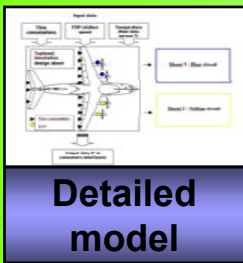
- Rationale:*** Need of a higher fidelity of the hydraulic system detailed model

- Mean:*** Increasing the level of fidelity of hydraulic components, modifying simulation work principles

- ⇒ Maturity improvement

- ⇒ Reduction of hardware tests: ground tests (Iron Bird) and flight tests

# Scenarios

	Need	Hydraulic system model	Use	Type	Output for Hydraulic system
<b>SCENARIO 1</b>	<p>Predesign of other systems / Hydraulic system</p>	<ul style="list-style-type: none"> <li>• Tool: SCADE</li> </ul>  <p>Pre-design model</p>	<ul style="list-style-type: none"> <li>• Integration in Flight Control simulation platforms (Laws and Handling Quality)</li> <li>• Base for more complete models (for simulators)</li> </ul>	<ul style="list-style-type: none"> <li>• Real time</li> </ul>	<ul style="list-style-type: none"> <li>• Flight control tests cases</li> <li>• Earlier optimisation of hydraulic generation</li> </ul>
		Architecture principles ↓			
<b>SCENARIO 2</b>	<p>Design of Hydraulic system</p>	<ul style="list-style-type: none"> <li>• Tool: SABER</li> </ul>  <p>Detailed model</p>	<ul style="list-style-type: none"> <li>• Stand-alone simulation</li> <li>• Coupled simulation with Flight Control simulation platform "OCASIME"</li> </ul>	<ul style="list-style-type: none"> <li>• Non real time</li> </ul>	<ul style="list-style-type: none"> <li>• Hydraulic system performances status</li> </ul>



# Work accomplished

From the beginning of VIVACE project the following work has been done:

- State-of-the art and business use case for hydraulics:

- The state-of-the art for simulation in Flight Controls and Hydraulics domain activities has been set,
- A description of identified technologies (tools) used / to be used for hydraulic system simulation has been done

- Predesign model:

- The predesign model requirements have been established (including: tool selection, structure of the model definition, interfaces requirements, coherence with Airbus modelling procedures)
- The predesign model has been done and validated in stand-alone

- Detailed model:

- The detailed model requirements have been established



# Hydraulic system pre-design model

- Model of A400M hydraulic system (composed of 2 circuits: “blue” and “yellow”)
- Principal functions of the model:
  - Computation of the total required flow
  - Computation of each pump contribution
  - Computation of flow in each line
  - Calculation of the pressure drops in the lines
  - Calculation of the pressure at the ports of each hydraulic consumer
- Mains characteristics and advantages of the pre-design model:
  - Manifolds, filters, priority valves pressure drop modelled
  - Priority valves and low pressure switches logics modelled
  - Pumps (engine driven) model using static curves (pressure / flow)
  - Choice between two types of fluids (high or low density)
  - Choice of the fluid temperature
  - Compatibility with several actuators' models
  - Possible integration into AMO HYD model (complete hydraulic system model for simulators, built following Airbus general modelling rules)

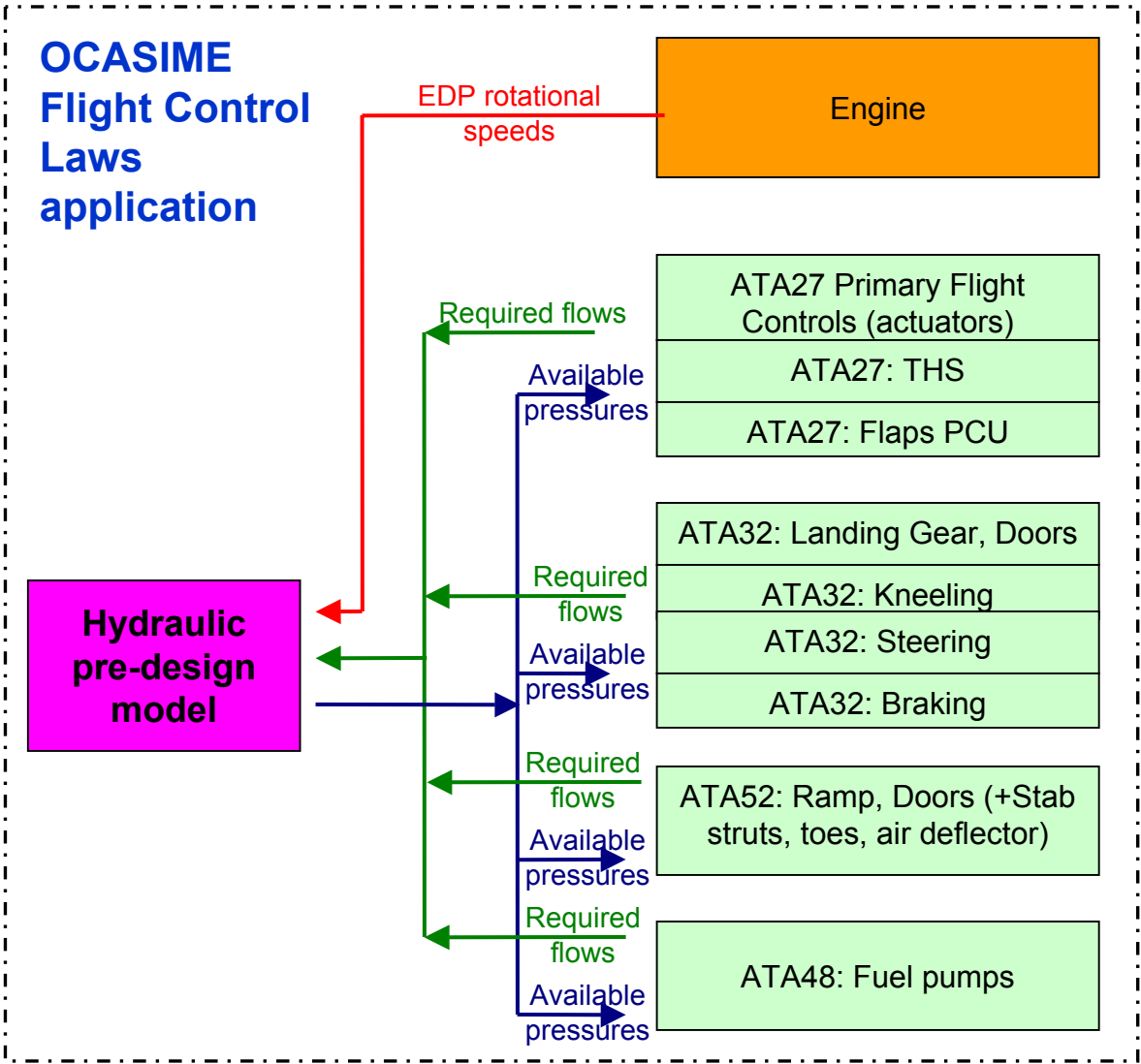
# Hydraulic system pre-design model integration and interfaces



**OCASIME**

**OCASIME:**

- desk top simulator workshop dedicated to one system analysis (system specification phase)
- includes piloting function and virtual cockpit

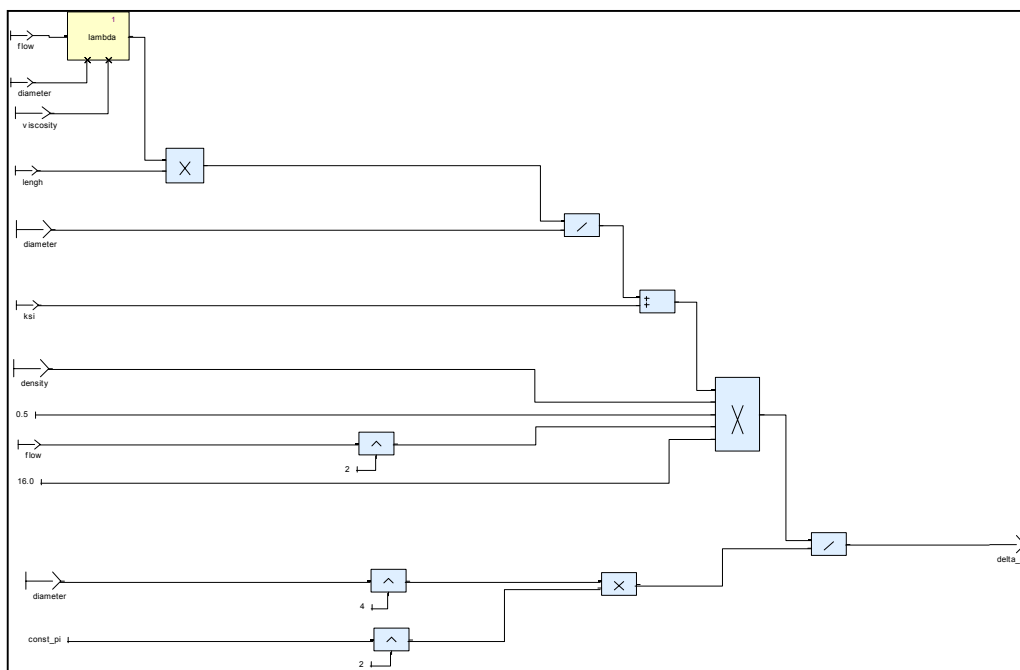




# Hydraulic pre-design model: modelling

- Comparison with Excel model for calculation of difference of pressure available to consumers:  $\Delta < 0.5\%$

- Example of SCADE sheet: (formal language)





# Way forward

The following activities are planned for the next months:

- Predesign model:

- Integration of the predesign model in Flight Control Laws platform
- Validation of the integrated model
- Evaluation and assessment of the benefits of the predesign model in aircraft development process
- Work until end of 2005

- Detailed model:

- Development of the improved detailed model
- Work from 2006