Flying with the Iron Bird

- Test bench for new actuator concepts at DLR
- Multiprocessor environment with DS1005 PPC Boards
- Realistic simulation of flight maneuvers

Statistically, you are far more likely to win the lottery jackpot than you are to experience a plane crash due to a system failure. This high level of safety is partly due to the comprehensive tests that flight systems have to pass while still on the ground – long before the prototype aircraft takes off for the first time. The German Aerospace Center (DLR) is currently designing a test facility that uses dSPACE equipment and will provide enormous flexibility in developing the flight systems of the future.

More Hydraulic Pressure – New Actuators

Standards require that the safety-relevant systems in commercial aircraft, such as the hydraulic systems for driving elevators, rudder, and ailerons, have double and triple redundancy.

▲ *The iron bird at the German Aerospace Center (DLR) allows a wide range of flight situations to be simulated. The control surfaces are on the right, the cockpit at bottom left.*

In hydraulics, for example, there are usually three independent systems. This redundant system architecture ensures maximum safety, as total failure of all systems is extremely improbable. However, minimizing weight is a major priority for aircraft designers, so the current trend is to increase the pressure in the hydraulic systems from the usual 3000 psi to 5000 psi or more, as greater hydraulic pressure allows the use of smaller and lighter actuators.

The "More Electrical Aircraft"

Another trend is towards replacing hydraulic actuators by electrical or electrohydrostatic actuators (EHAs), in other words, actuators with their own integrated hydraulic supply. The new Airbus A380 is an example. This latest generation of actuators, combined with a reduction of the central hydraulic system, cuts weight and therefore saves kerosene. The idea is called the "more electrical aircraft", and the aim is to reduce the diversity of power systems (hydraulics, pneumatics, electrics) to just one – the electrical system. The result would be a reduction in system complexity and weight.

To prepare for these new actuator concepts, we are designing a test facility with dSPACE equipment that will be able to cope with all foreseeable developments and allow us to test a broad range of actuators in widely varying configurations.

Our Most Important Tool: The Iron Bird

Commercial aircrafts typically fly at speeds of 800–900 km/h and at altitudes of 8–12 kilometers. Reproducing these conditions on the ground is extremely difficult, and to implement authentic system tests, we need a special test facility known as the "iron bird". Each iron bird is a framework of steel tubing roughly shaped like an aircraft, with practically all system-relevant components installed on it. Numerous situations that could conceivably occur in flight can be reproduced

realistically on an iron bird. For example, aerodynamic loads can be simulated by means of load cylinders on the iron bird's control surfaces.

Realistic Flight Simulations on the Ground

The iron bird will be used to develop and test new flight control concepts and systems. It is designed to let us run through the majority of all conceivable flight situations and simulate a large number of faults in the hydraulics, electrics, flight control system, and actuators. The faults that are simulated include pressure changes in the hydraulics and component failures. The iron bird will support the following testing activities for flight control systems:

- Reproducing aircraft hydraulic systems with pressures of up to 5000 psi
- Testing the latest generations of actuator systems, in varying configurations
- Integrating load cylinders for realistic simulation of real flight conditions
- Developing and testing new kinds of actuator systems
- Integrated cockpit simulation for implementing closed-loop tests

Simulation Environment with dSPACE Hardware

The simulation environment includes three DS1005 PPC Boards and various I/O boards from dSPACE. Each of the DS1005 boards has its own task to perform, such as calculations for the real-time simulation of flight maneuvers, the hydraulic system, horizontal stabilizers, or autopilot functions such as automatic landings. The boards are easy to configure for their tasks using MATLAB®/Simulink®, and the control can also be changed quickly by modifying the Simulink model. Because the simulation environment is modular in design, additional DS1005 boards and I/O boards can be added, or the existing ones replaced, with little effort. This allows us to produce a multiprocessor environment that is tailor-made for a new range of tasks. The dSPACE components give us the flexibility we need to adapt the test facility to new actuator concepts and aircraft types, with a minimum of effort.

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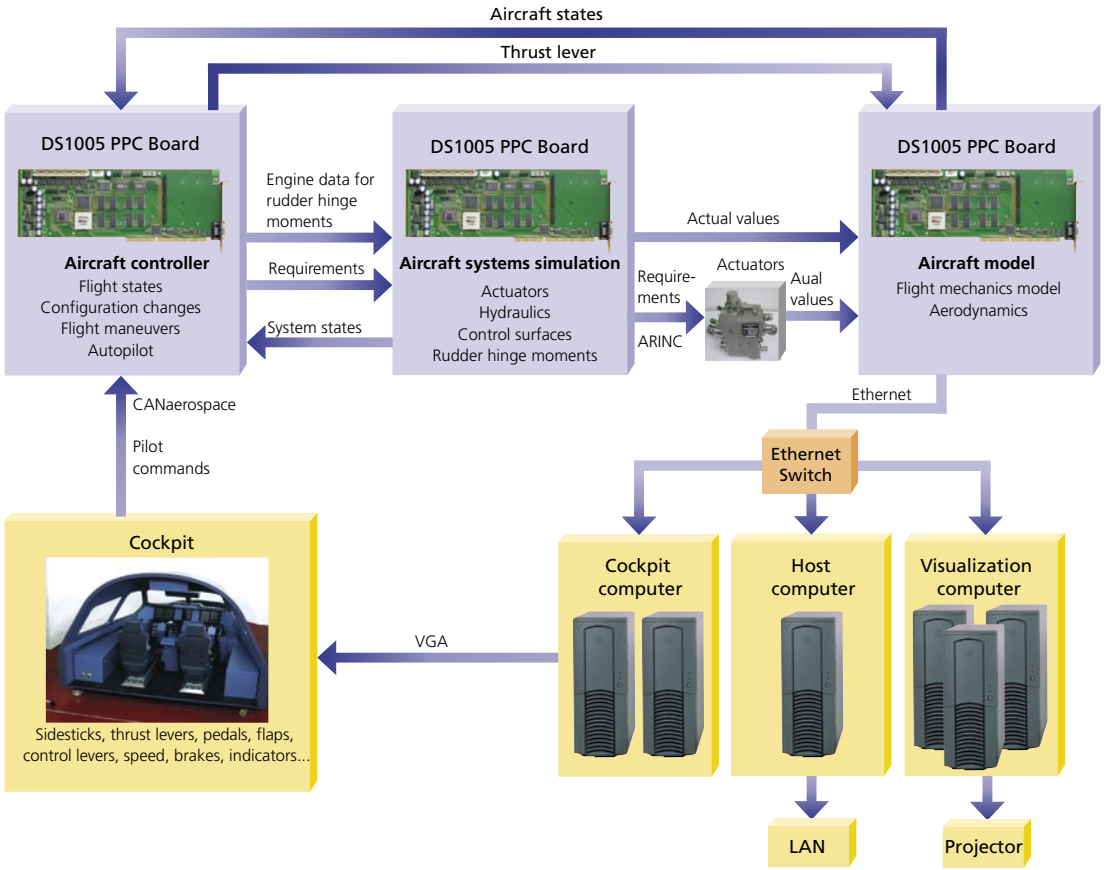

The multiprocessor environment consists of three DS1005 PPC Boards and performs calculations for the real-time simulation of flight maneuvers, hydraulic system, horizontal stabilizers, autopilot functions, automatic landing, and so on.