Technology update

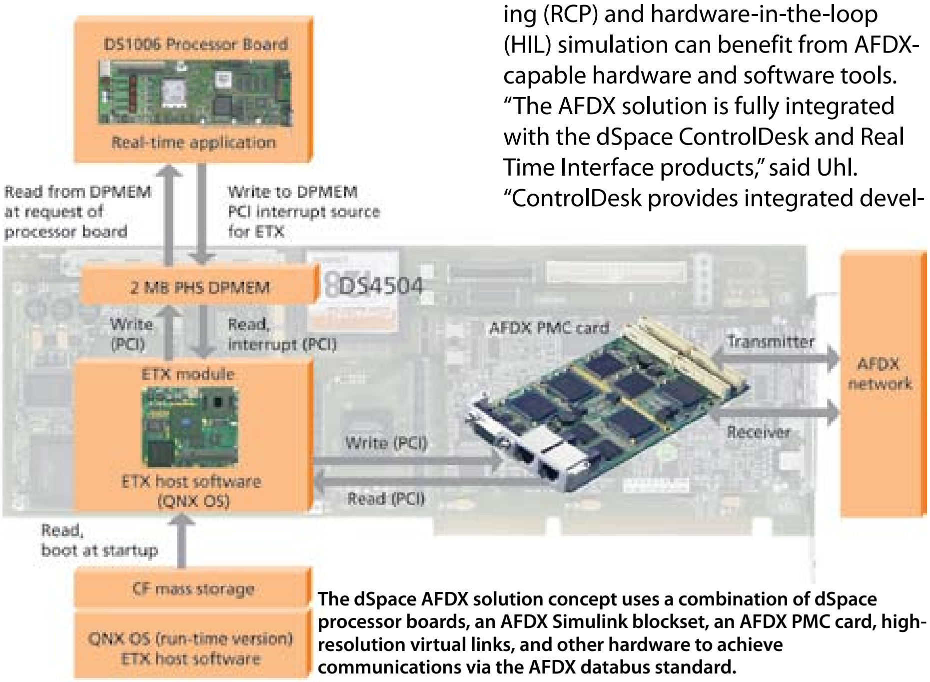
Support for databus standard AFDX

A new compliance standard for data interchange between self-contained aircraft subsystems—such as engines—is now a part of **dSpace**'s databus connection portfolio. The supplier of tools for developing and testing mechatronic control systems now supports multiple network protocols for the aerospace sector.

The Avionics Full-Duplex Switched Ethernet (AFDX) standard—which ensures communication between line replaceable units (LRUs)—joins ARINC 429, MIL-STD-1553, FlexRay, IEEE-1394b, CAN, and others as dSpace-enabled network protocols.

"Adding AFDX support to the product portfolio allows control systems engineers to use proven tools on a broader range of applications," said Bill Uhl, Business Manager for Aerospace and Defense at dSpace in Wixom, MI.

For instance, rapid control prototyping (RCP) and hardware-in-the-loop (HIL) simulation can benefit from AFDX-capable hardware and software tools. "The AFDX solution is fully integrated with the dSpace ControlDesk and Real Time Interface products," said Uhl. "ControlDesk provides integrated development tools, data-acquisition support, graphical user interface management tools, and support of automated validation and verification. Real Time Interface allows users to program the AFDX interface in a high level graphical modeling environment."



The dSpace AFDX solution concept uses a combination of dSpace processor boards, an AFDX Simulink blockset, an AFDX PMC card, high-resolution virtual links, and other hardware to achieve communications via the AFDX databus standard.

Design faults can be detected and corrected early with RCP. And HIL simulations of the controller's environment—sensors, actuators, *etc.*—can be done quickly. But working within a standardized test field can translate to an enhanced development process. "Many manufacturers and suppliers in the aerospace industry have realized that standardized development systems speed up the individual development phases and improve the handoffs," said Susanne Koehl, Product Manager at dSpace in Paderborn, Germany.

Manufacturers of new aircraft are on the AFDX bandwagon. "**Airbus** is deploying copper AFDX on the A380, and **Boeing** will implement AFDX over optical fiber on the 787 Dreamliner," said Uhl.

AFDX is not just for communication between LRUs in aircraft. "It is specified as a deterministic network system that can be used in aeronautical, railway, and military systems. The technology of AFDX is based on standard IEEE 802.3 Ethernet technology," said Koehl. "The benefits of using commercial off-the-shelf Ethernet components include reduced costs, faster system development, and less costly maintenance for the system."

It is possible that AFDX will gain stature over time. "Databus standards emerge as new technologies and requirements evolve with general advances in aircraft and avionics design. Mature, reliable standards—such as ARINC 429 and MIL-STD-1553—may be replaced when aircraft manufacturer requirements for capabilities such as bandwidth, switching, and bus traffic management move beyond what established communication bus standards can offer," said Uhl.

Kami Buchholz

AFDX is rapidly gaining acceptance across the aerospace sector and is expected to become the commercial off-the-shelf networking technology of choice for future manufactured aircraft.

Cool research into hot challenges

"Hot end" engine technology presents particular challenges to aero-engine manufacturers. **Rolls-Royce** is to work with researchers at Germany's **Karlsruhe University** to research cooling in gas turbine combustors and turbines, together with associated technologies to enhance fuel efficiency and environmental performance. The partnership marks the opening of Rolls-Royce's fourth University Technology Center (UTC) in Germany.

The need for engines to operate at ever higher temperatures to achieve required efficiency brings big challenges for cooling systems to prevent powerplant components from melting. The Karlsruhe UTC plans to take a holistic approach to maximize the use of air for cooling. Using less air for cooling and more in the combustion process helps to further reduce engine emissions.

Karlsruhe has built up particular expertise in several areas of cooling technology, including combustion cooling in very hot environments, film cooling, and two-phase flow. It also has a wide range of test rigs and has introduced innovative methods and measurement techniques. Rolls-Royce has two coordinators based in Germany who will manage day-to-day liaison between the company and the university. Karlsruhe will also work with other UTCs in the UK, plus the Osney Laboratory in Oxford, that focus on research into heat transfer, combustion, CFD, aerothermal techniques, and component interactions. They can also provide highly specialized modeling, validation, and testing capabilities.

Research into cooling the "hot end" of gas turbines is to be carried out by Rolls-Royce and Karlsruhe University. Pictured is the Rolls-Royce Trent 1000 for the Boeing 787.

The University has been awarded funding as part of the German Excellence Initiative that seeks to promote top level academic research and make a significant contribution to the long-term strength of science and research in Germany. Karlsruhe is the fourth Rolls-Royce UTC in Germany, joining others based in Cottbus, Darmstadt, and Dresden. Each has a close relationship with **DLR**, Germany's national aerospace research institute.

Stuart Birch

Fuel-cell emergency power system plus a new sidestick controller from Liebherr

Aviation systems supplier **Liebherr-Aerospace** has developed a fuel-cell emergency power system (FCEPS) as an alternative to a ram air turbine (RAT). Because of the way the RAT is designed, the amount of power it generates depends directly on the speed of the aircraft; if the aircraft slows, the system will produce less power. In the final approach phase, the power output drops to zero. The FCEPS is fully integrated in the aircraft fuselage and as a result is not dependent on external airflow or weather conditions and does not produce any aerodynamic drag, according to Liebherr.

The choice of glidepath is not affected, with the FCEPS delivering a constant power output throughout the glide phase, through to land and taxiing. The installation of the system is subject to

Liebherr-Aerospace has developed a fuel-cell emergency power system as an alternative to a ram air turbine, which is dependent on the speed of the aircraft.

The active sidestick controller for helicopter and fixed-wing applications was derived from Liebherr's experience with flight-critical systems.

fewer restrictions than that of the RAT, meaning that aircraft manufacturers can be more flexible in selecting where and how to install it in the airframe.

The system is based on a low-temperature fuel cell that converts hydrogen and oxygen into water, heat, and electric power. Integrated power storage modules enable FCEPS to deliver an uninterrupted power supply, so that electric power is immediately available at startup.

Also new from Liebherr is an active sidestick controller for helicopter and fixed-wing applications. For helicopters, it has been designed to replace the interfaces that control cyclical and collective blade functions plus control surfaces. The new control stick will make the mechanical connections and interfaces of conventional flight-control systems less complex or even entirely obsolete. It will also bring weight advantages.

What the company terms a "pre-development program" has been launched to demonstrate the system's possible use in future helicopter programs. The active sidestick's first in-flight test is scheduled to be conducted on the **DLR**'s (German Aerospace Center) ACT/FHS (Active Control Technology/Flying Helicopter System) test helicopter at the end of 2007. In developing the sidestick, Liebherr has drawn on its extensive experience with flight-critical systems in the area of fly-by-wire flight controls for helicopters and regional jets such as the **Sukhoi** Superjet 100, stated the company.

Stuart Birch

Technology update

Gaining interest in fuel deposits

University of Dayton (UD) researchers have developed a method to show where jet fuel deposits have the greatest potential for clogging engines, providing jet engine designers a head start in designing around problem spots and thus reducing the risks of engine failure due to fuel deposits.

"Jet fuels are used to propel and cool the aircraft," said Steve Zabarnick, University of Dayton Research Institute (UDRI) Fuel Science group leader and a UD mechanical and aerospace engineering professor. "But when the fuel absorbs heat while cooling certain parts, it forms deposits before being combusted for propulsion."

Zabarnick; Jamie Ervin, a UD mechanical and aerospace engineering professor and UDRI modeling and simulation group leader; and doctoral students Zachary West and Nick Kuprowicz developed chemical and engineering models for predicting deposits in fuel nozzles, heat exchangers, narrow valves, and filters. The rate of deposit build-up was measured for a variety of different fuels.


Steve Zabarnick, a mechanical and aerospace engineering professor at the University of Dayton, and doctoral student Zachary West (left) examine fuel valves at the fuel system simulator at Wright-Patterson Air Force Base.

Current ways to reduce or eliminate fuel deposits include restricting the fuel's temperature, using systems that remove oxygen from jet fuel, or using fuel additives, some of which have been developed by UDRI researchers according to Zabarnick. However, so far nothing has been perfect. Restricting the fuel's temperature seriously limits the plane's efficiency, fuel additives can be costly, and the oxygen removal systems have not been perfected yet, say the researchers.

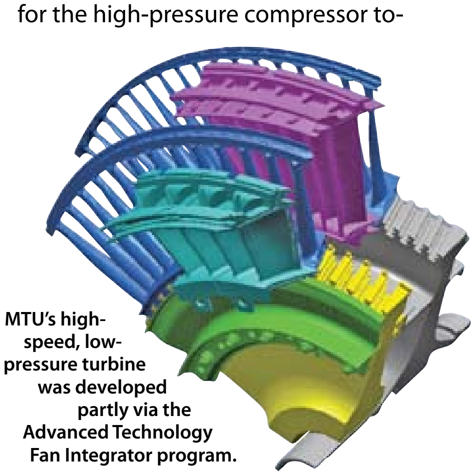
By being able to predict where fuel deposits may congregate, and then designing the engine to prevent them, the researchers believe that millions of dollars could be saved because of less downtime for aircraft, reduced maintenance costs, and increased fuel efficiency.

Nationally, UD ranks 13th in federally funded engineering research and 14th in U.S. **Department of Defense** research contracts and grants. The researchers performed much of their work at nearby Wright-Patterson Air Force Base.

Jean L. Broge

MTU and P&W combine on the GTF

The future belongs to the geared turbofan, believes German company **MTU Aero Engines**, which, together with **Pratt & Whitney**, is working on the system for applications to short- and medium-haul aircraft. MTU's responsibility is for the high-pressure compressor together with what it describes as "an innovative low-pressure turbine." The technology will form part of an engine demonstrator based on the PW6000 turbofan—which powers the **Airbus** A318—designed to be quieter, more economical, and cleaner than conventional engines.


MTU's high-speed, low-pressure turbine was developed partly via the Advanced Technology Fan Integrator program.

The system (trademarked by P&W as GTF) uses a reduction gear that decouples two of the engine's modules that typically are interconnected by a common shaft: the low-pressure turbine and the fan. According to MTU, decoupling the two from each other permits the large-diameter fan to run slower and the turbine much faster, allowing both to run to best effect, with the fan rotating at one-third the speed of the turbine. The operationally optimized components improve the engine's efficiency and reduce its noise levels.

Weight is also lower, thanks to the normal number of parts and stage counts being reduced by around 50%. MTU claims fuel burn is cut by some 12%, perceived noise level by 50%, and maintenance costs by 40%, with the new design also promising to reduce CO_2 emissions by more than 12% and NOx by up to 55%.

The GTF demonstrator is scheduled to make its first run later this year and to fly in 2008. The new technology was developed mainly via two programs: the Advanced Technology Fan Integrator (ATFI) and the Component Validator for Environmentally Friendly Aero Engine (Clean). ATFI was a joint project involving MTU and **Pratt & Whitney Canada** with the target of reducing fuel consumption by 10% and lowering noise levels. It has been successfully concluded and involved MTU's high-speed, low-pressure turbine plus its transonic high-pressure compressor. The demonstrator successfully completed all module and core engine tests, and the seven-stage compressor met expectations with a comfortable margin.

Stuart Birch

UPTEMP for electronics packaging

A research initiative to develop high-temperature electronics packaging solutions for aerospace engine and other applications has been launched by the **UK Department of Trade and Industry** (DTI). The program is addressing the growing need to install electronic power and control systems in high-temperature environments to improve accuracy of critical measurements and to reduce the cost of cabling from remote and hostile applications.

UPTEMP is a research project to develop high-temperature electronics packaging solutions for aerospace engines.

Called UPTEMP, the project involves **Oxford University**'s Materials Department, which is funded by the **Engineering and Physical Sciences Research Council**, together with a consortium of end-users that includes **Sondex Wireline**, **Vibro-Meter UK**, materials suppliers **Thermastrate** and **Gwent Electronic Materials**, and **Micro Circuit Engineering**, which specializes in the design and manufacture of multi-chip modules. It is part of **GE-Aviation**, formerly **Smiths Aerospace**.

The requirement for such systems centers on what the DTI terms the "traditional limit" of 125°C for high-temperature exposure of electronic systems. Operating temperatures above 200°C, which are typical of these types of applications (including gas turbine aero engines), in combination with high pressures, vibration, and potentially corrosive environments, means that different semiconductors, passive components, circuit boards, and assembly processes will be needed to fulfill the target performance specifications.

The project's target is to demonstrate electronic packaging/assembly materials and processes for long-term operation at temperatures up to 250°C on a representative circuit used in aero-engine and other applications. The project program includes reliability analysis of the materials and processes, according to DTI. This involves investment directly into new and emerging technologies and has been designed to help businesses work collaboratively with each other, or with academic partners, to develop technologies that will underpin products and services of the future.

Stuart Birch