Technology update

Weight saving the RIU way

Weight saving has always been part of the aerospace industry's mantra for design efficiency leading to operational success. Supporting that aim is a small but significant piece of technology called the remote interface unit (RIU).

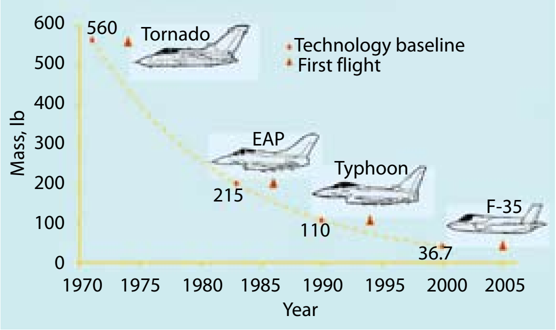
"A few RIUs and their associated databuses can effectively replace the hundreds of meters of multiwire cable looms that would otherwise be needed to connect an aircraft's sensors, actuators, computers, and other systems," said Paul Ainsworth, Distributed Computing Systems Chief Engineer with **Smiths Aerospace** in the UK.

In recent years, aerospace design has moved from federated to integrated architectures in its pursuit of weight savings, reduced cost of ownership, enhanced operating efficiency, and shorter, more cost-effective development programs. All modern architectures are underpinned by fundamental building blocks, and the RIU is an essential component in many.

An RIU is a reprogrammable, generic line replaceable unit (LRU) with the ability to receive data from multiple inputs, *i.e.* aircraft sensors. It can also digitize and process inputs (performing conversions if necessary) and output data onto a digital databus to make it accessible to other aircraft systems and other RIUs. And it can drive aircraft actuators. Basically, the RIU forms a low-cost, reliable system building block that can be used to create simple and modular aerospace architectures.

RIUs are invariably slim, square, and ruggedized to operate in a harsh environment as close as possible to the sensors and effectors with which they interface. They are tested against military and/or civil aviation specifications involving shock, vibration, altitude, humidity, sea fog, sand, dust, "waterproofness," and fluid contamination, as well as industry-standard electromagnetic compatibility standards, including lightning. An RIU is typically capable of interfacing 100 inputs and outputs and has a mass of a little more than 0.6 kg—about the same as a single meter of cable loom.

According to Smiths Aerospace Distributed Computing Systems Chief Engineer Paul Ainsworth, "The RIU design had to contain rugged, reliable, and widely available components. In general, there is little that cannot be multi-sourced or designed around."



A plot of the reduction of weight of military aircraft complete interfacing systems (not cockpit and mission), from the Tornado of the early 1970s to the new F-35.

An example of the RIU's role in taking pounds out of military aircraft is the steady reduction of the weight of their complete interfacing systems (not including mission and cockpit) from the early- to mid-1970s with the advent of the **Panavia** Tornado, through the **British Aerospace** Experimental Aircraft Program (EAP)—essentially a technology demonstrator for the **Eurofighter** Typhoon—and on to the Typhoon itself and now the emergence of the **Lockheed Martin** F-35 Lightning II Joint Strike Fighter.

The figure has plummeted from the 560 lb for the Tornado to a mere 36.7 lb for the F-35. Origins of the RIU as an interfacing technology are rooted in the EAP, said Ainsworth. Making its first flight in the mid-1980s, the aircraft's systems incorporated a utilities systems management system, which comprised four systems management processor units. The utilities management was effectively shared between the four units, which provided the equivalent functionality of about 30 dedicated units on the older Tornado. Prior to the EAP, no project had dealt with such a high quantity and variety of I/O signals, explained Ainsworth.

With the emergence of the Eurofighter Typhoon, RIU technology started to become more widely established and it was fitted to the **Boeing** and **AgustaWestland** variants of the AH-64 Longbow Apache and Boeing 777. RIUs are also known as remote I/Os, aircraft interface units, and remote data concentrators (RDCs).

The **Airbus** A380 has four RDCs as part of its landing gear extension retraction systems. "Each unit is able to recognize its location within the landing gear system and configure itself to service the particular local set of inputs and outputs," said Ainsworth. The technology is also being used to validate and enable emerging system architectures for future aircraft platforms as part of European Framework and UK research and technology programs.

An important element of RIU capability can bring major benefit to an aircraft: "It can continuously monitor and report on its own health and the health of associated wiring, sensors, and effectors," said Ainsworth. Because the units are reprogrammable they can make a major contribution to cutting non-recurring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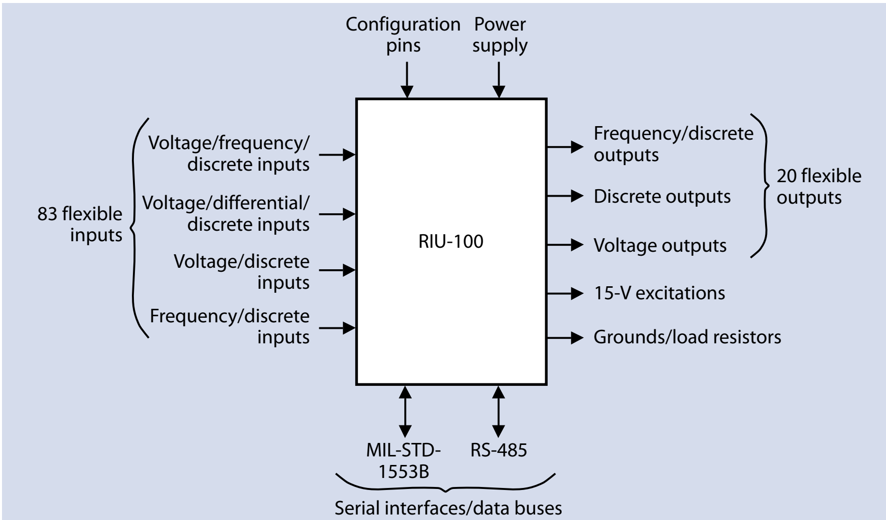
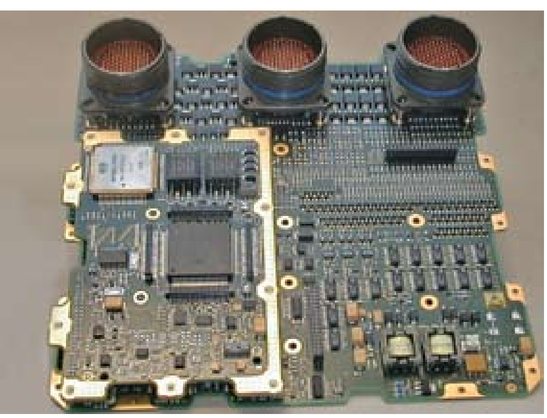


What it's all about: RIU-100 system diagram.



What it looks like: an RIU-200 circuit board.

development costs and minimize system development time scales on aircraft programs. Costs are also kept low thanks to extensive design reuse.

"When designing our current generation of RIUs in the late 1990s, we did not want to create something that would be hard to maintain," said Ainsworth. "Also, the design had to contain rugged, reliable, and widely available components. In general, there is little that cannot be multi-sourced or designed around."

Smiths has established a product-focused RIU Core Team based at its Cheltenham, UK, facility but with overseas support offices. The team includes software, hardware, and aircraft systems engineers, plus manufacturing specialists and business development personnel. The team uses an in-house designed PC-based RIU configuration tool. Built around a common (file server located) database of generic design solutions, it is used to capture the interface and data-processing requirements for a specific aircraft application.

The tool is then used to guide engineers through what Ainsworth describes as a well-defined, semi-automatic process, resulting in the automatic generation of the data tables that configure a set of RIUs to deliver required functionality. "The generation of configuration data in this way provides an efficient, cost-effective approach to a large part of the software design and allows design changes to be made quickly and effectively," he said.

Smiths Aerospace sees RIUs continuing to be used as building blocks within modern architectures for both manned vehicles and UAVs. RIUs have been selected for part of the vehicle management systems of several UAV development programs.

The company has placed particular significance on the evolution of the RIU design tool set, called RIU Analysis and Configuration Engine—now under development. Ainsworth said this would represent a qualified tool set that would enable users to create, amend, and partially automatically generate RIU configuration tables independently, allowing them to easily configure aircraft system architectures "from a pre-defined and pre-tested superset of functionality."

Stuart Birch

Multiple UAV tracking

As the UAV role in aerospace design, manufacture, and operation continues to expand, **QinetiQ**, the UK-based research organization, has achieved what it claims as a world first in the technology. It has completed a flight demonstration of a system capable of controlling and autonomously organizing multiple UAVs. "The successful flight trial was conducted to support the concept of using a package of self-organizing UAVs under the control of an operator flying in a fast jet," stated a company announcement.

It may look like a BAC 1-11, but thanks to researchers at QinetiQ, it thinks like a UAV.

The demonstration was undertaken as part of a **UK Ministry of Defence**-funded program using a **BAC** 1-11 aircraft that has been converted into a surrogate UAV. In addition to controlling the BAC 1-11 "remotely," an operator directed a package of simulated UAVs at a strategic level and carried out a simulated ground attack from a moving target.

The system developed by QinetiQ has been designed to reduce very significantly the human workload in operating multiple UAVs, with an autonomy computer using agent-based reasoning software in the 1-11 responsible for the self-organizing of the UAV package at a tactical level, plus the operation of communication systems, sensors, and weapons.

Although a flight crew was in the aircraft for safety monitoring and for control during takeoff and landing, throughout the flight trial sequence the aircraft flew and operated as if it were unmanned and was directed from a command station designed for use in a fast jet. The flight took place in uncontrolled airspace.

Comprehensive preparation for the flight trial involved testing of the whole UAV system in a simulation environment, enabling flight crew and trials team to rehearse the first real sortie using both software and hardware installed in the 1-11.

Andrew Sleigh, QinetiQ's Group Managing Director, Defense and Technology Sector, said that the successful in-flight demonstration was a significant step in proving that complex autonomous decision-making technologies were ready for the move from simulation to real flight conditions. "Ultimately, this work could lead to a single human operator controlling teams of highly autonomous unmanned vehicles to carry out complex missions, while reducing risk to manned aircraft," he said.

The next step in the program will involve QinetiQ's Tornado Integrated Avionics Research Aircraft equipped with a UAV command and control interface. This step will allow further flight trials during which the package of real and simulated aircraft, including the 1-11, will be commanded by the fast jet crew while in flight. The Tornado flights are scheduled to begin shortly.

The direction of multiple autonomous UAVs is not a wholly military scenario. In the civil sector, the capability may bring benefits to UAV use in coast guard rescue, disaster relief, and environmental monitoring applications.

Stuart Birch

Technology update

High-technology Taranis UAV project takes off

In a significant expansion of Europe's UAV technology presence, a project is getting under way to develop a "world-class" technology demonstrator funded jointly by government and industry. Under the name Taranis (the Celtic god of thunder), the project, which will apply fully integrated autonomous systems and low-observable features, is being led on the industry side by **BAE Systems**—which has significant UAV development experience—in association with other companies of expertise, including **QinetiQ**, **Rolls-Royce**, and **Smiths Aerospace**. They will work together with **UK Ministry of Defence** scientists and military staff. The four-year, $240-million Taranis project will demonstrate emerging technologies and systems and is part of the UK government's SUAVE (strategic UAV experimental) program.

Although—not surprisingly—few details of the vehicle have been released, it will be about the size of a BAE Systems Hawk (**U.S. Navy** designation, Goshawk; Canadian Forces, CT-155) advanced jet trainer/light attack aircraft. Depending on series, the Hawk has a wingspan of 9.4 m to just under 10 m and fuselage length (not including pitot tube) of 10.78 to 11.4 m. Taranis will use high-level reasoning software as part of its autonomous capability.

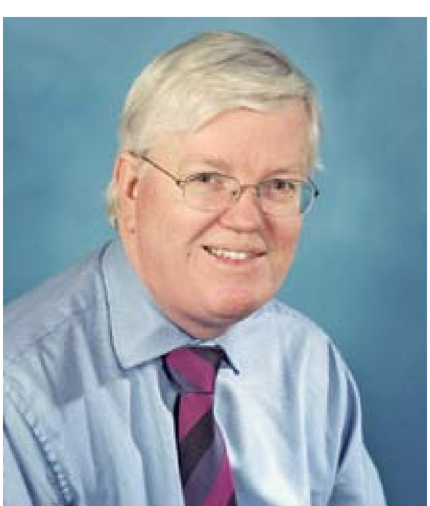
Ground testing is slated for 2009, with first flight the following year. According to Mark Kane, BAE Systems' Managing Director, Autonomous Systems and Future Capability (Air), "Taranis will make use of at least 10 years' research and development into low observables, systems integration, control infrastructure, and full autonomy."

At QinetiQ, Graeme Ferrero, Managing Director, Defense Technology, described Taranis as being a prime opportunity to build on the company's previous research in autonomous and low-observable systems and to apply it in a practical UAV environment.

Rolls-Royce's role in the Taranis project will be to focus on next-generation propulsion installation, while Smiths Aerospace will apply its expertise in vehicle systems. Other suppliers will be involved in the project, including BAE Systems Australia, which specializes in flight control computing.

Stuart Birch

Taranis is a new UK government and industry project to develop a "world class" autonomous UAV technology demonstrator.



QinetiQ's Graeme Ferrero, sees the Taranis UAV project as an opportunity to build on the company's research into autonomous and low observable systems.

Technology update

B-1 spreads its wings

Boeing has successfully demonstrated the use of a **Lockheed Martin**-manufactured electro-optical/IR targeting pod on a B-1 bomber, increasing the aircraft's ability to minimize ground threats and halt an enemy's advancement.

Configured with a Sniper XR pod, the B-1 crew completed more than 40 test conditions in approximately eight hours in January over the Mojave Desert in California. The demonstration is said to have validated the B-1 crew's ability to positively identify moving and stationary targets in a variety of real-world conditions.

Mounted on an external pylon below the cockpit, the targeting pod allowed the flight crews to track moving vehicles day and night, in both crowded and clear conditions. The sensor detected large and small vehicles at different ranges and angles and maintained its track even when the target vehicle passed other vehicles.

"Included in the flight tests were tanker rendezvous and refueling, which further emphasized the aircraft's ability to loiter for extended periods," said Greg Burton, B-1/B-2 Program Director at Boeing. "The test team—comprised of **U.S. Air Force**, Boeing, and Lockheed Martin personnel—put the pod through a rigorous series of tests, which featured an 'engine running' crew change to enable broader aircrew participation in the demonstration flight."

Boeing's B-1 team recently demonstrated the use of a B-1, such as the one pictured here, to positively identify moving and stationary targets in a variety of real-world conditions.

Images and data from the sensor were displayed in the weapons systems operator stations in the rear seat of the aircraft and at the pilot/co-pilot station. During the demonstration flight, the pod also transmitted video images to the control room, enabling the monitoring team to actively participate in the test events.

"Successful demonstration of this targeting pod paves the way for a fielded capability that the operators have been requesting," said Burton. "It shows that with sustained modernization, the B-1 will remain a major component of U.S. air strike capability for the next 25 years," concluded Burton.

Jean L. Broge