COTS TECHNOLOGY FEATURE

Development of an Inflight Work Order Distribution System for the C-17 Globemaster III: A Contractor's Perspective

By George Schreck

The dramatic shifts in military procurement and supply over the past decade, fueled by cost constraints and the desire to incorporate modern technology into long-lived weapons platforms, have propelled significant changes in the way military suppliers conduct their business. The increased emphasis on leanness and speed of response has led both large and small contractors to establish project-specific alliances with aggressive development and deployment timelines.

In this article, we review our experience at Thales Computers as part of a team established by The Boeing Company to help reduce the cost of production flight testing on the C-17 Globemaster III transport aircraft.

Background: The C-17 Globemaster III

The C-17 Globemaster III program has been, and continues to be, one of the most successful in the U.S. Air Force. Since the first C-17 squadron became operational in 1995, the fleet has amassed nearly 500,000 flying hours. The C-17 fleet has been the backbone of supply operations in support of military, peacekeeping, and humanitarian missions in Afghanistan, Kosovo, and Bosnia.

The C-17 Globemaster III is regarded as the most versatile airlift aircraft in history. With a maximum payload of 169,000 pounds, it can deliver equipment and/or troops 2400 nautical miles without refueling. The C-17 is designed to take off and land on runways as short as 3000 feet (914 meters) and as narrow as 90 feet (27.4 meters). The sophisticated digital avionics system, incorporating two full-capability Heads Up Displays (HUDs) and four LCD-type displays, enables the C-17 to fly with a cockpit crew of two and one loadmaster to supervise the cargo.

The Boeing Company's C-17 program received the Collier Trophy in 1995, symbolizing the top aeronautical achievement of 1994. However, the ongoing success of the program is in large part due to continuous improvements implemented since its original manufacture. The single manufacturing plant for the program, in Long Beach, California, recently completed production of the 100th C-17; the latest version features increased fuel capacity, increasing its range by 25 percent. In recognition of its emphasis on continuous improvement and business excellence, the Airlift and Tanker Programs, makers of the C-17, were selected as a recipient of the Malcolm Baldridge National Quality Award in 1999. A total of 180 C-17s have been ordered by the U.S. Air Force through 2008; the United Kingdom Royal Air Force also operates four C-17s.

The problem: costly reflights

Each C-17 is rigorously tested prior to shipment to the Air Force. The test program involves both on-the-ground assessments and production test flights, and is a significant contributor to overall delivered cost. One notable cost driver involved the inability to adequately capture information on transient flight conditions, situations, or problems, to enable subsequent analysis and, if necessary, take remedial action.

The C-17's avionics system is based on nine separate MIL-STD-1553 serial data buses that are distributed throughout the aircraft to shuttle inflight data between many of the line replaceable units (LRUs) on the aircraft. Although it was possible to set up special recording systems to make inflight 1553 data available to engineers upon test flight completion, these often required foreknowledge of likely data needs. In many cases, costly test reflights were required to capture the necessary information.

The solution: Advanced Wireless Open Data System (AWODS)

To reduce the need for production test reflights, Boeing engineers developed the concept of a system designed to capture *all* inflight 1553 data for subsequent analysis. The system, named AWODS, is designed to fulfill two principal missions:

1. To record all 1553 databus information during flight for post-flight engineering analysis
2. To transmit data on specific predetermined events immediately to ground stations

The heart of the AWODS system is the Advanced Open Data Controller (AODC), which is mounted onboard the C-17 during production test flights (the AODC is removed once testing is

©Copyright 2003

complete). The AODC simultaneously records data from all nine onboard 1553 buses during test flights. As the data is being recorded, the AODC also analyzes each piece of data to determine if it meets user-defined triggers for data transmission. The AODC selects data that meets the predefined criteria and sends the data, along with a predefined pre-event and post-event block of information, to Boeing ground stations via satellite.

The AWODS system enables Boeing engineering teams to designate a range of high-priority events prior to test flights for immediate transmission. The "profiles" for each type of event are programmed into the AODC, which transmits only data on those pre-selected events; all other 1553 bus data is captured and recorded by the AODC for subsequent analysis. A typical test flight will generate several megabytes of continuous flight data.

AODC hardware and development

Figure 1 shows a block diagram for the AODC controller, broken down by shop replaceable units (SRUs). The AODC includes:

- System enclosure – 1/2 ATR 5-slot
- Single board computer (SBC) with a PCI mezzanine card (PMC) site
- Two VME PMC carrier cards
- Flash disk memory
- 1553B interface boards
- 429 interface board (handles satellite transmission/receipt)

Once the AWODS concept was approved by Boeing management, the Boeing engineers in charge of the AWODS program began the work of vendor selection. The high priority accorded to AWODS in turn required a short development cycle. "The emphasis was on identifying suppliers who could assume a true partnership role and provide complete support, not only to Boeing, but with the other contractors," said Mark Talbot, Lead Engineer, Avionics Engineering.

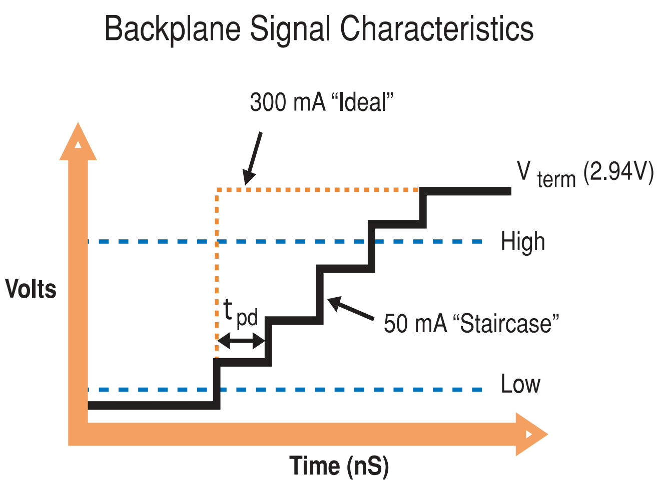

Figure 1

Thales Computers was selected to provide the SBC and PMC carriers for the AODC. Other principal vendors included Miltron Systems Inc. (AODC system enclosure), Condor Engineering Inc. (1553 and 429 interface modules), and Targa Systems Division of L-3 Engineering Corporation (Flash disk).

"Thales Computers was initially considered by Boeing because of our long track record in providing harsh-environment products for military applications. But what set us apart was a willingness to work interactively with Boeing and with the other AWODS vendors, to help Boeing shorten their timeline and produce a prototype quickly," said Joe Eicher, Engineering Manager at Thales.

Working interactively included frequent site visits to Boeing's facility by Eicher and Customer Support Engineer Bill Carter, to discuss both hardware and timeline requirements. Thales also supplied loaner boards to Boeing and the other vendors to enable work on the various AODC subsystems (especially the enclosures) to proceed on concurrent, rather than sequential, tracks. "The willingness to provide both ample manpower and hardware early in the project was critical to meeting our development timeline goals," Talbot said.

The SBC provided by Thales is a ruggedized conduction-cooled version of the high-end VMPC6d SBC, which employs dual Motorola PowerPC 7410 (G4) chips running at 400 MHz, augmented by the AltiVec vector processing unit (see Figure 2). For the AODC, the VMPC6d is equipped with 256 Mbytes SDRAM arranged in a massively shared memory architecture that facilitates real-time memory access with extremely low latency.

Figure 2

Current status

The initial order for the VMPC6d SBC and PMC Carriers was sufficient to build four prototype AODC units. Thales Computers completed shipments on this order in the fourth quarter of 2002. In December 2002, the prototype units began a software shakeout phase. Deployment on C-17 production test flights is expected to begin early in 2003. If the AWODS concept proves successful during the initial phase, it may be expanded to the entire C-17 program and possibly to other platforms as well.

©Copyright 2003

The AWODS program has been instructive and rewarding for Thales Computers. It has demonstrated the value of providing full, comprehensive support at the front end of a program to help the client meet aggressive timelines. We have also learned the importance of being able to work well with other vendors involved in a new program. This enables tasks that might have been tackled sequentially in the past to be handled in a concurrent fashion, further shortening development cycles.

Perhaps most important, the AWODS experience has emphasized that it is no longer sufficient in the current world to provide just superior high-quality products. The client must feel empowered to draw on the extended resources of the entire supplier company. This is especially critical in programs involving multiple vendors. "We went shopping for parts, and ended up with partners," Talbot said.

George Schreck, *Thales Vice President of Engineering, has extensive hardware, software, and project management experience. He has held various managerial positions in the engineering and marketing departments of Concurrent Computers, Sky Computers, and Plessey Microsystems. He has strengthened concurrent design practices and schedule reliability and has shortened development cycles. George has a BS in physics with a minor in chemistry.*

For more information, George can be contacted at:
Thales Computers
1203 New Hope Road, Raleigh, NC 27610
Tel: 800-848-2330
E-mail: gschreck@thalescomputers.com
Web site: www.thalescomputers.com
Boeing's Web site: www.boeing.com

©Copyright 2003