F-22 Avionics Integration On Track

by Robert Barnes
Boeing Vice President and F-22 Program Manager

One of the most challenging milestones for the F-22 program this year is to begin flight-testing the Block 3.0 avionics system on the F-22 before the end of the year. We must meet this milestone before the Defense Acquisition Board will approve low-rate initial production—and we will.

Boeing, tasked with integrating the F-22's highly sophisticated avionics, is working alongside our teammates to ensure Block 3.0 is adequately tested in our Avionics Integration Lab (AIL) and on our 757 Flying Test Bed (FTB) so testing aboard the F-22 can begin on schedule.

We are confident we will meet this critical milestone. In fact, every software delivery Boeing has made to date has been on or ahead of schedule. Both supporters and critics have been closely watching our avionics testing this past year, and we welcome their scrutiny. The F-22's avionics are being tested thoroughly, and have been through more rigorous testing than any previous fighter at a similar stage in its development.

It is important to note that successfully flying the integrated avionics on the FTB more than one year prior to the actual F-22 is unprecedented in military aircraft development programs.

By utilizing our AIL and FTB, we are helping reduce avionics risks and contain development costs by enabling extensive evaluation and troubleshooting before full avionics are ever installed on the F-22. To date, the avionics have undergone more than 15,000 hours of testing in the AIL and 427 hours on the FTB.

The F-22 avionics test concept is progressive in nature, beginning with component-level testing, continuing with subsystems integration and verification at teammate and supplier sites, and finishing with verification of the full avionics system installed in the F-22. Modeling tools and system-performance simulations have been used for integration to maximize the efficiency of other types of testing. These models are based on system design and are being updated during integration to more accurately reflect actual system performance.

Systems are integrated in the AIL, where performance is initially tested. AIL testing includes functional and performance testing of the integrated avionics suite, and includes integration testing of the avionics operating with other on-board systems. Testing in the AIL is accomplished in two types of configurations. One has F-22 hardware and software, with tower-mounted antennas for open-air stimulation. The other also has real hardware and mission software, but also simulated sensors and environment.

Boeing has invested in high-fidelity open-air dedicated targets (airborne and ground) to support this testing. Together these configurations test the system to provide a high confidence of success at the next integration level.

Avionics development transitions into the dynamic open-air environment, first on the Boeing FTB and then on F-22 aircraft. FTB testing takes place in Seattle-area locations, with deployment to Edwards Air Force Base, Calif., operating areas to take advantage of range assets such as simulated threat emitters and military target aircraft.

The F-22 avionics suite is being developed in an incremental block-build fashion in order to break the avionics development effort into manageable segments. This approach reduces program risk by starting with basic functionality and progressing to more complex functionality as the avionics system matures through each successive software block release.

Complex capabilities and functions can be developed and thoroughly tested in separate incremental builds without impacting or being impacted by other functions. This approach allows greater flexibility in the test program.

Boeing has been testing the software blocks in its labs since early 1998. Block 1.1, which provides initial integrated avionics capability, was delivered ahead of schedule to Lockheed Martin in May 1999. Block 1.1 included 80 percent of the final F-22 hardware configuration and more than 900,000 lines of code.

The performance of the sensors and the closed-loop tracking function are crucial to the success of the integrated avionics system. Blocks 2 and 3 will focus on these areas early in the test program. They will also continue the build-up of overall avionics functions.

Block 2, which adds basic missile and electronic warfare functions, provides the initial capability of multi-sensor fusion. Block 2 has been integrated and tested in the AIL and AIL and has begun testing on the FTB. This provides additional early testing on real hardware with real apertures.

Block 3 will add additional radar and electronic warfare modes (more sensor fusion capability) in support of closed-loop tracking. Block 3 is being integrated in the AIL and will be tested aboard the FTB in September before delivery to Lockheed Martin. Block 3.1 will be delivered in June of 2001 and add additional weapons capability.

The F-22 team's low-risk avionics development approach blended with state-of-the-art software development tools and processes has proven successful. Boeing also is leveraging the company's core competence in large-scale systems integration-many of the integration tools and techniques that are being used are the result of lessons learned on the B-2, AWACS, 777 and other large airframe programs.

Thanks to excellent designers and modern software engineering techniques, considerably fewer anomalies have been encountered compared to previous programs. Those anomalies are more easily fixed due to the expertise of our system integrators. Overall, the avionics software packages have been performing exceptionally well. We are confident that performance will continue when we transition to the next stage of testing aboard the F-22.

About the Author

Robert Barnes was named Boeing vice president and F-22 program manager in February 1997. Based in Seattle, Barnes is responsible for Boeing work on the F-22 air superiority fighter. Boeing is teamed with Lockheed Martin to design and build the F-22 for the U.S. Air Force. Since joining Boeing in 1977, Barnes has held a variety of positions in engineering and operations management. Prior to his current assignment, Barnes was F-22 airframe product manager and operations director. In that role, Barnes managed all F-22 structures design and production requirements, including manufacturing, quality assurance, procurement and facilities. Before joining the F-22 program in 1992, Barnes was deputy program manager for the 777 Composite Empennage program beginning in 1989. From 1986 to 1989 he served as manufacturing services manager for the Boeing Composites Fabrication Center in Seattle and division manufacturing engineering manager. Other Boeing assignments include operations manager for the Navy A-6 attack-plane rewing program, manager of engineering and operations computing for the B-2 bomber program, and engineering computing systems manager in the Boeing Commercial Airplane Group. Barnes has extensive management background in composites, tool engineering, N/C programming and production. Born May 27, 1941, he attended the Georgia Institute of Technology and Washington University. His educational background is in mechanical engineering and industrial management.