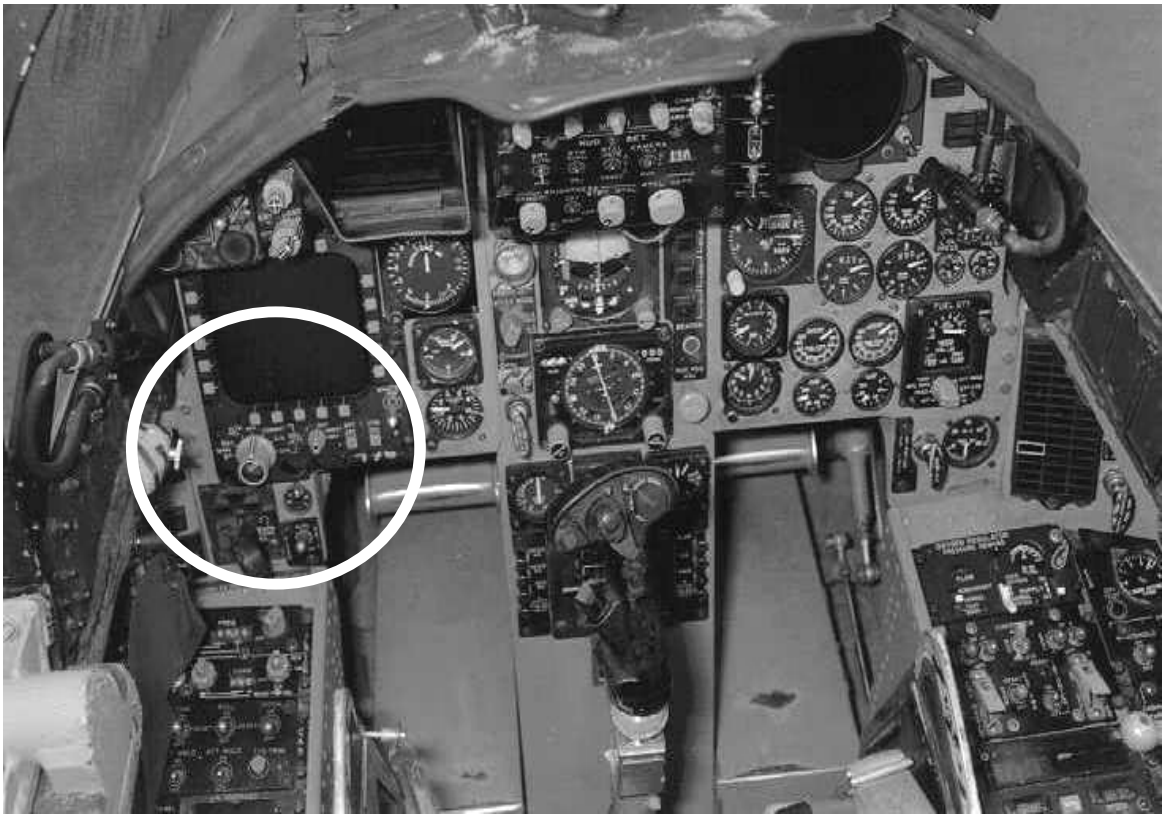
FIGHTER DATA LINK (FDL)



Joint ACAT ID Program (Navy Lead):

Total Number of Systems:	617
Total Program Cost (TY$):	$180M
Average Unit Cost (TY$):	$160K
Low Rate Initial Production:	4QFY98
Full-rate production:	1QFY00

Prime Contractor

Data Link Solutions (Terminal Developer)
Boeing (F-15 Integration)

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

The Fighter Data Link (FDL) integrated into the active Air Force and Air National Guard F-15 fighter aircraft provides situational awareness and sensor cueing in support of the air superiority and air interdiction mission areas. The components of the FDL include a reduced functionality Multifunction Information Distribution System Low Volume Terminal (MIDS-LVT) FDL terminal, a remote power supply, and supporting F-15 cockpit displays and controls. FDL exchanges information via Link 16, a digital data link used by other theater Air Force, Joint, and Coalition forces. Link 16 is robust and has high data throughput and contributes to theater ***dominant battlespace awareness***, the seamless interaction of ***Joint and Coalition forces***, ***precision engagement*** through the exchange of accurate targeting information, survivability, and increased ***lethality*** through the digital exchange of targeting command, coordination, and engagement status messages.

FDL supports the exchange of intra-flight and inter-flight information, including off-board, real-time intelligence into the cockpit. Information exchanged via Link 16 includes flight member position, targets, and ordnance status. Target identification and sorting messages allow all members in a flight and linked command and control agencies to visually observe target selection, assignments, and battlefield damage assessments. Survivability of FDL-equipped F-15 fighters is enhanced through the transmission of location and identification messages as well as emergency and downed aircraft indications.

Link 16 is a tactical data link designed to pass surveillance information between Command and Control (C2) platforms, surveillance platforms, fighter aircraft and other manned weapons systems. It also includes the capability for C2 platforms to commit weapons systems against targets; however, the weapons system must locate the target with its own targeting system prior to engaging the threat. FDL, as currently implemented into the F-15 air superiority fighter, is designed to satisfy the U.S. Air Force requirement for a communications data link to provide situational awareness, particularly of threats and targets. The FDL terminal, associated Link 16 network designs, and F-15 integration observed during testing, provided cueing information so that the F-15 aircrew could perform targeting with the F-15's onboard radar. The FDL and the current implementation does not support target engagement using remote sensor data transmitted through FDL—that is, weapons engagement quality data was not sent via Link 16 from off-board sensor platforms and processed by the fighter computer to deliver a targeting solution to release ordnance. It is anticipated that if this were a requirement, the Link 16 network, the on-board F-15 FDL integration and possibly the throughput capacity of the FDL may require redesign along with development of new Link 16 messages to support the specific weapon targeting solution and update requirements.

BACKGROUND INFORMATION

The F-15 FDL is being developed to satisfy Air Force F-15 data link requirements under the umbrella of the Navy-led MIDS-LVT program. The FDL shares approximately 60 to 70 percent hardware and software commonality with the MIDS-LVT terminal. By design, FDL has less capability than MIDS-LVT: this is a trade-off for lower terminal cost and improved reliability. FDL is modular, and those additional capabilities, digital voice communications channels, internal Tactical Air Navigation (TACAN), and higher power transmitter output, can be inserted into the terminal if required.

The initial host platform for the FDL was the F-15C/D air superiority fighter. During late FY97, the F-15E air interdiction fighter was added and the FDL design was modified to create a "common configuration" terminal that could be installed in either fighter aircraft. In FY98, the Air National Guard selected FDL to satisfy their F-15A/B fighter data link requirements.

TEST & EVALUATION ACTIVITY

FY99 FDL testing included completion of Developmental Testing, Multi-Service Operational Test, combined Developmental Test/Operational Test flight test, participation in two major exercises, Initial Operational Test and Evaluation, and operational tester over-the-shoulder observations of three F-15E FDL developmental test flight missions. The developmental testing included bench regression testing of updated FDL software that corrected deficiencies documented during FY98 flight testing.

During FY99, an accelerated reliability stress test was completed at the Eglin AFB environmental test facility. The accelerated reliability test consisted of three FDL terminals in a controlled environment using simulated F-15 mission profiles that were stressed to provide an acceleration factor. Using data gathered during these tests, a terminal reliability prediction was developed by the Reliability Analysis Center, Rome, NY. Stressed conditions included increased time slot duty factor (i.e., terminal transmitting time), temperature cycling rate, and operating temperature. The terminals were evaluated for 3,129 operating hours during which they were exposed to 3,348 thermal cycles.

The F-15C FDL Link 16 joint Service interoperability Multi-Service Operational Test was conducted in conjunction with a two-week deployment of two FDL equipped F-15C fighter aircraft to the All Service Combat Identification Evaluation Team (ASCIET) 1999 exercise in Ft. Stewart, GA and surrounding airspace. Other Link 16 capable systems participating in the ASCIET 99 Link 16 network with the FDL included the E-3 Airborne Warning and Control System (AWACS), E-2C Hawkeye, an AEGIS guided missile destroyer USS Cook (DDG-75), Marine Tactical Air Operations Center, PATRIOT, Forward Area Air Defense Command and Control. FDL-equipped F-15s flew 24 missions during the ASCIET Multi-Service Operational Test.

Six combined Developmental Test/Operational Test flight missions were conducted using F-15C/D aircraft and common configuration FDL terminals during 2/3QFY99. Two missions used off-board Link 16 data from E-3 AWACS aircraft and the land-based Control and Reporting Center. The FDL terminals were operated for a total of 63 flight hours.

F-15C FDL IOT&E was conducted from August 5-17, 1999, and consisted of six missions employing two to four FDL equipped F-15 air superiority fighter aircraft. All missions were conducted at the Eglin AFB over-water ranges. The scenarios were air superiority with a mix of adversary aircraft. These adversaries included F-15 and F-16 aircraft. All IOT&E missions were supported by E-3 AWACS or the Control and Reporting Center.

To assist in the Operational Testing at Eglin AFB, the Air National Guard (ANG) deployed two F-15A fighters, aircrew from three states, and a data collection team from the ANG/Air Force Reserve Test Center at Tucson, AZ. ANG's participation during dedicated Operational Testing resulted in a 40 percent increase in data available for analyses.

Additional operational effectiveness and suitability data was collected from ANG F-15A FDL equipped flight missions, other test and training missions using FDL equipped F-15C fighters, and the deployment of FDL equipped F-15C and F-15E fighters to Nellis AFB, NV, for the Joint Expeditionary Forces Exercise 1999. In total, FDL was evaluated during 79 flight sorties resulting in 116 hours of operation using seven different F-15 fighter aircraft.

Three F-15E FDL initial Developmental Test missions were observed by DOT&E, in addition to the three FDL-equipped F-15E fighters deployed to the Joint Expeditionary Forces Experiment 1999. The objective of this observation was to assess the degree of risk for the integration of FDL into the F-15E air interdiction fighter aircraft.

TEST & EVALUATION ASSESSMENT

FDL completed OT and was assessed as operationally effective and suitable. FY99 FDL Developmental Test concluded with one critical and 34 non-critical open deficiencies carried into OT. A number of the open non-critical deficiencies pertained to the incomplete Built-In Test (BIT) design. With the exception of the impact on completion of BIT evaluation during OT, none of the other open deficiencies had an impact on completion of OT. The critical deficiency and six of the non-critical deficiencies were verified closed by the FDL Failure Review Board shortly after IOT&E.

The Multi-Service Operational Test, conducted during FDL participation in ASCIET 99, concluded that FDL was interoperable with all of the participating Service Link-16 elements. The FDL position location message was correctly displayed at all the participating units and air tracks were received by the F-15s through FDL from all of the network surveillance systems.

Initial Operational Test and Evaluation, augmented by additional data collected from other FDL flights, indicated that FDL, integrated into the F-15C/D fighter, was operationally effective and suitable.
FDL provided F-15 fighters with increased situation awareness resulting in increased air engagements (3.8 to 1) and survivability (improved by 30 percent). The automatic exchange of position, engagement, weapons, and fuel status between F-15 flight members by FDL resulted in decreased communication workloads, allowing more time to concentrate on other tasks. Network entry times were under two minutes on average, within both the threshold and objective requirements. The FDL displayed 99.5 percent of all air and position track data transmitted to it.

The FDL flight hours were inadequate to demonstrate the 1,000 hour FDL reliability requirement; however, the test was adequate to demonstrate that the FDL Mean Time Between Critical Failure is 58 hours—a 340 percent improvement over the F-15C Class 2 JTIDS terminal IOT&E results. The Mean-Time-To-Repair was 11 minutes; well within the 30-minute threshold and 20-minute objective requirement. The evaluation of BIT was unresolved due to immature software. Operational availability: .98 met both threshold and objective requirements. Training for both aircrew and maintenance personnel was satisfactory. Maintenance publications were not available.

FDL operated in basic navigation modes during initial F-15E FDL Developmental Test missions and indicated potential for improving air interdiction mission effectiveness during the Joint Expeditionary Forces Experiment 1999 deployment. Compatibility of the FDL with the F-15E's primary navigation system, the Global Positioning System, is a critical requirement, and initial bench and flight testing indicate that additional integration is needed. However, the developer and AFOTEC agree that completion of FDL integration into the F-15E poses a low to moderate risk to entry into F-15E Fighter Data Link IOT&E during 2QFY00.

CONCLUSIONS, RECOMMENDATIONS, LESSONS LEARNED

Implementation of Link-16 messages into host platforms varies by developer, resulting in interoperability problems in the field. An ongoing Multi-Service Operational Test, conducted in concert

with major exercises and contingencies, can identify Link-16 network design, management, and message implementation issues between Service, Joint, and Coalition host systems.

Contractors need to develop test stations that adequately and faithfully represent the host platform interfaces and employ these stations to conduct checks of terminals before they are shipped. A number of FDL test events have been delayed because factory screening of terminals and components did not emulate the operation of the terminal as integrated into the host platform. This was especially costly for those common MIDS components developed overseas. When conducting early involvement and assessments, the tester should ascertain the maturity and level of investment the contractor has in test stations.

The F-15E FDL integration is aimed at improving air interdiction mission effectiveness. The FDL integration into the F-15E has more risk since, unlike the F-15C/D, the Class 2 JTIDS was never integrated into that platform and the F-15E has a number of unique characteristics. For example, the air interdiction mission relies heavily on precise navigation provided by the Global Positioning System. Integration of the F-15 E's navigation system with the FDL is critical. Early tests have proven encouraging and DOT&E will continue to closely monitor the development and integration leading to full evaluation during 2QFY00 OT.

ANG's contribution during OT resulted in a 40 percent increase in data available for analyses. Through their participation, ANG received early operational experience with FDL, which will prove invaluable in fielding of FDL. The lesson learned is to not overlook the potential contribution of all available test participants and to include them in core planning early in the test design phase.

The FDL contains a number of hardware and associated firmware components that have varying levels of commonality with MIDS-LVT, and many of these components are developed and produced by MIDS partner nation industries in Europe. Logistics supportability for spares and repair turnaround planning must account for delays in shipment of components due to customs and distances. Finally, the production contract for MIDS will be bid by a new consortium of U.S. and European manufacturers. This presents risk to the production representativeness of FDL terminals now under test. Robust regression testing under DOT&E oversight will be required before fielding terminals.