

JOVIAL - TRW - MILSTAR Satellite

TRW

MILSTAR Satellite

United States Air Force

Advanced EHF Systems Definition Program

JOVIAL to C++

History: Lockheed Martin was awarded a contract by the US Air Force to begin development of the next generation military communications satellite. TRW, a major sub-contractor for Lockheed Martin, began the System Development and Demonstration (SDD) phase of Advanced EHF (Extremely High Frequency). In order to achieve new higher data rate modes than the low data rate and medium data rate modes of the older generation MILSTAR satellites, the JOVIAL code required modernization to permit operation on newer hardware and simplify maintenance. TRW contracted TSRI to assist in this effort.



Challenge: MILSTAR satellite system was written in J3 JOVIAL, a software language widely used by the Air Force for high performance mission critical embedded applications. TRW decided that the best way to enhance performance and reduce future maintenance costs was to rewrite the JOVIAL legacy software language into modern platform-independent C/C++. This would take advantage of new high performance hardware and new software development environments. Initially, a manual rewrite of the 143,000 lines of MILSTAR JOVIAL code was scheduled to take more than 12 months. To reduce schedule time and technical risk, TRW contracted with TSRI to automatically assess and transform this legacy application. Modernization of JOVIAL into C/C++ is a highly complex problem. Older Jovial systems often ran with a 60-bit word length Cyber hardware, which creates data field alignment problems during transformation. To save space, memory overlays were used to share memory, and data field sizes were defined to bits lengths. JOVIAL has a powerful macro definition mechanism that is inconsistent with those of C/C++. The 1750 hardware used 16-bit big-endian words, which were replaced by 32-bit little endian words on the target hardware. The JOVIAL language itself is a powerful language with highly complex data structure operations, dynamic program structuring, and error handling for real-time hardware interrupts. Transformation of JOVIAL requires assurance that the semantics of operations are perfectly preserved, the state of computation is accurate to the level of bits, and the control flow is correct in the presence of real-time interrupts.

Results: TSRI engineers successfully assessed and transformed the 143,000 lines of JOVIAL code. The project was implemented in three incremental releases, successfully migrating the application's logic from a JOVIAL to a C++ environment. The MILSTAR software upgrade was completed in less than 30 calendar days. Initial acceptance testing, for which the customer had budgeted 8 weeks, was completed in a single day. By its use of automated modernization, TRW was able to begin software performance upgrades one year earlier than the original project schedule. The MILSTAR satellite system carrying the TRW, now Northrop Grumman/TSRI upgrade of its primary control systems, is now waiting upcoming deployment and will soon provide enhanced communication to the United States Armed Forces.