NOW IS THE RIGHT TIME FOR SOLID STATE

Al Berard and Chris Nixon
46 Test Wing/TSII Eglin AFB FL

Michael Lockard
Data General Corporation

ABSTRACT

For the last 30 years Magnetic Tape Systems have been the primary means of recording data from airborne instrumentation systems. Increasing data rates and harsh environmental requirements have often exceeded the ability of tape-based systems to keep pace with technology. Throughout this time data recordings have been made mostly with analog longitudinal systems and most recently with digital recording systems that record on commercial DLT, and super VHS tape media. The recordings are played back with the same type of tape device allowing for the data to be processed and/or archived. Since not all data reduction facilities can process the same type of tape media, often tapes are dubbed from one type of tape media format to another, corrupting the translated data. This paper examines operational and data reduction benefits, and life cycle cost of Solid State Recorders as a replacement for existing airborne tape recorders.

KEYWORDS

Solid State Recorders, Digital Linear Tape (DLT), Multi-Application Record/Reproduce System (MARS II), Redundant Array of Independent Disks (RAID)

INTRODUCTION

The 46 TW Instrumentation Division integrated a new Solid State Recorder in two F-15 aircraft in support of AIM-9X flight test. Change was necessitated due to the failure of the existing digital tape recorder in the high vibration environment of the F-15 aircraft. Advances in commercial technology have led to high bit rate airborne digital tape recording systems. Manufacturers have integrated these digital tape recording systems into advanced fighter aircraft, attempting (with some success and some failures) to defy the laws of physics by reinforcing the tape transport utilized to record the data.
Due to the high vibration environment and high dynamic flight profile planned for the AIM-9X test program , the 46 TW Instrumentation Division decided to use a solid state recorder rather than a digital

tape recorder. This paper provides the rationale behind this decision and identifies the immediate benefits realized as a result.

BACKGROUND

The 46 TW Instrumentation Division had FY00 requirements to record in excess of 30 Mbit/sec for a period of two hours. The first of these programs was the AIM-9X requiring greater than 14 Mbit/sec, other programs to follow were F-15 Fighter Data Link, and F-15 Suite IV flight test.

The Instrumentation Division has successfully utilized the Multi-Application Record/Reproduce System (MARS II) from METRUM-DATATAPE Inc. since 1984. Data from the MARS II is recorded on a computer peripheral storage device utilizing a Digital Linear Tape (DLT). The MARS II was limited to an aggregate rate of 12 Mbit/sec. The MARS II E, an upgraded version of the MARSII, was procured because it was capable of recording aggregate rates of up to 40 Mbit/sec.

The failure of the MARS II E to operate in the F-15 flight test environment that led to the 46 TW Instrumentation Division decision to accelerate its FY02 procurement and integration plan. The 46 Test Wing lost flight test data for a number of missions due to vibration induced problems. An immediate solution was required for a form fit replacement unit for the MARS II E capable of meeting both near-term and long-term (FY02 and beyond) requirements. Requirements for a next generation recorder consisted of a Solid State Recorder capable of simultaneously recording 8 MIL-STD-1553 channels, 8 Pulse Code Modulated (PCM) channels with inputs greater than 20 MBS, and two analog channels recording time and audio. The recorder was also to have architecture that allowed for the use of different types of multiplexers, removable storage media, and throughput rates in excess of 540 Mbit/sec. The 46 TW Instrumentation Division adopted the Modular Nonvolatile Solid State Recorder (MONSSTR) from Calculex Inc. as its next generation recording system.

BODY

The progress of digital tape recording technology has been remarkable in the last 20 years. Advances in solid state devices, and improvements in media sciences have made it possible to achieve recording densities never thought possible in the past. However none of these advancements have been made with the intent of operating in the harsh environment of a fighter aircraft. And with a limited number of test flights and decreasing budgets, today’s test programs mandate error free performance of recording systems. The process established by the 46 TW Instrumentation Division to provide an “error free” recording system had to address the following issues:

Aircraft Installation: The existing aircraft instrumentation installations require a single box installation (i.e. form fit replacement of MARS II electronics module) allowing for download of data utilizing PCI/Fiber Channel. The unit installed also utilizes a removable solid state memory canister. Savings can be observed by sharing canisters between various platforms. In addition, the capability to simultaneously record eighteen channels practically eliminated the need to configure channels based on mission requirements.

Data Downloading: Data is downloaded from the aircraft utilizing a PCI/ Fiber Channel Interface into a Redundant Array of Independent Disks (RAID). Data is downloaded in its native format fully compliant with the Recorder Group of the Range Commanders Council (RCC) digital recording standard, IRIG-107.

Data Archiving: Data from the RAID is saved to the archive media in either its native IRIG-107 packetized format or user specific format such as the MARS II.

Data Translating: Since both data and time have been recorded in a digital format, the flight information can be translated into various data products using software decommutation. This means that no special decommutation hardware is required to convert the PCM into a user-defined format ready for additional processing. This translation can be done using the archive media as input, or produced directly while the data is being archived from the solid state device. The stream definition required to interpret the data can be embedded directly in the archive program, or it can be provided as an external file. Another useful feature is that stream lock status can be displayed as the data is being processed. The ability to produce data products directly from the solid state device or the archived media provides significant time savings over the alternative of using a hardware decommutation solution.

Life cycle costs for a Solid State Recorder exceed those of tape systems when comparing past history of tape recording devices. However in the case of the F-15 and the AIM-9X test program this cost is reasonable when the alternative tape system cannot satisfy the customers data requirements. The decision to implement a Solid State recorder has quickly answered several questions. Yes, the cost of a flight test mission is comparable to that of the amount of Solid State memory required. No, it is no longer acceptable to risk missions due to limitations of commercial off the shelf devices. No, it is no longer acceptable to procure systems limited by tape technology. It is a fair assessment that tape technology has matured as much as it is going to given physics of the technology being used. True, tape systems can be modified to withstand certain flight test environments, however development costs and flight tests required can no longer compete with advantages provided by solid state devices. True, use of memory is evolving and becoming more compact and susceptible to temperature constraints, however, specifications of today's Solid State recorders exceed those of tape systems, and they can be conditioned to operate within the military aircraft environment.

CONCLUSION

For the last few years several questions have been raised as to when it would be financially and architecturally feasible to transition from airborne digital tape recording systems to solid state recorder based system. The answer is very simple, NOW is the time for Solid State, acquisition costs are compatible with those of tape systems, error free recordings can be provided to the customers, and tape systems can still be utilized for data archiving and reproduction.

ACKNOWLEDGEMENTS

46TW/TSI, Charles Perry
Macauly Brown Inc., Raul Campa