CAIS - PROGRAM OVERVIEW
A USERS PERSPECTIVE

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ABSTRACT

The Common Airborne Instrumentation System (CAIS) is being developed through the Department of Defense Central Test and Evaluation Investment Program (CTEIP) to support the flight test requirements of the military services into the next decade.

CAIS consists of an airborne data acquisition segment and a ground based support segment. The system is designed to accommodate both the small user and the larger, more complex full scale development programs. This paper presents a program overview of CAIS from a users view.

BACKGROUND

The Department of Defense, through the Central Test and Evaluation Investment Program (CTEIP) is developing a comprehensive flight test instrumentation system. This system is known by the acronym CAIS or the Common Airborne Instrumentation System. CAIS, when fully developed, will be utilized by all three services and their airframe contractors to support flight testing.

CAIS, as conceived, will facilitate commonality among the services and across aircraft types. The Common Airborne Instrumentation System is neither airframe dependent or specific nor is its use restricted to any Test and Evaluation (T&E) facility. CAIS is to be interoperable among the various test ranges. The generic interoperability of any flight test instrumentation system is generally governed through the degree of conformance to the Range Commanders Council Telemetry Standards. CAIS interoperability or intersupportability refers to the ability of any T&E

facility which supports CAIS to be capable of providing a full level of support to any CAIS installation regardless of its origin.

Historically the services, mainly through their airframe contractors, have developed data acquisition systems for each new program. While these systems satisfied all the requirements of their particular program, the core of each system was basically the same. The only significant variances were the program unique requirements.

Each of these systems, when eventually transitioned to the government required its own support equipment, spare parts, training and other logistics. Through the use of a common system with an open architecture, the core data acquisition system will be in place with the built-in flexibility to add the program specific features. A standard or common system also offers the advantage that prior training and familiarization is not lost but rather reinforced through the next application. Hardware will be reused from program to program, thus saving the services procurement costs in addition to logistics costs.

HISTORY OF CAIS

The CAIS Joint Program Office (CAISJPO) evolved early in 1989. Even prior to formal staffing, several “user” meetings were held to determine the requirements for such a common system. Participants included users from government and the airframe manufacturing industry. Once a firm requirements foundation was established, the government drafted specifications and a statement of work for the development of CAIS. The procurement process yielded a development contractor, SCI Technology, Inc. of Huntsville, Alabama. CAIS has been under active development since August 1991.

SYSTEM SEGMENTATION

CAIS is comprised of an airborne segment and a ground-based Instrumentation Support Equipment (ISE) segment.

The airborne segment is a family of modular building blocks which are distributed throughout the aircraft and interconnected via a serial communications bus (CAIS bus). The system architecture is modular and open to permit easy and efficient expansion to accommodate new requirements

without the need for the redesign of the existing components.

The majority of the airborne segment consists of Data Acquisition Units (DAU). Other airborne units include: the Airborne System Controller (ASC), Pulse Code Modulation Combiner (PCMC), and bus splitters.

The ISE segment is a collection of support equipment required to operate and maintain the airborne segment. Generally these systems are fashioned from commercial type test equipment molded together with software to perform the functions needed by CAIS.

AIRBORNE SYSTEM CONTROLLER

The Airborne System Controller is the device which orchestrates the operation of the airborne segment. The ASC is electrically and mechanically expandable. It features up to 15 MBPS of sampled data capability and extends its output rate to over 50 MBPS through the use of the Pulse Code Modulation Combiner slice. other controller functions supported through the addition of slices are an Airborne Processor, a MIL-STD-1553 Remote Terminal to permit instrumentation data transfer to an aircraft MIL-STD-1553 system, and the future capability to place data on an aircraft High Speed Data Bus system. An internal time code generator is included within the ASC. The user has the option to synchronize time to modulated IRIG B or nonmodulated IRIG A, B or G code. Time code outputs are available in both modulated and nonmodulated IRIG **A,** B or G code, selectable by the user. Users also have the capability to program time words into the PCM frame.

BUS SPLITTER

Splitter units allow the CAIS bus(es) to be routed in four directions. Each arm emanating from the splitter can support up to 16 DAUs. The bus length from the ASC to the last DAU on a leg can be as great as 150 feet. The bus length restriction is due to the timing necessary to reliably execute a command and reply sequence.

PCX COMBINER

A PCM Combiner which accepts, as input, from 1 up to 16 unsynchronized NRZ-L sources and associated bit rate clocks

is available in two form factors. **A** four input configuration is available as an ASC slice and the complete 16 input configuration is available as a separate unit. The PCMC combines the incoming streams using a data priority technique and formats a resultant IRIG 106 class II tagged data stream.

DATA ACQUISITION

The DAU being developed for CAIS include: Analog-discrete DAU (ADAU), Discrete DAU (DDAU), Global Positioning System DAU (GDAU), Avionics DAU (AVDAU), High Speed Data Bus DAU (HSDBDAU), and a Miniature DAU (MDAU).

The ADAU is designed to accept multi-channel plug-in signal conditioning cards in any of 10 user slots. It has an aggregate sample rate of 417 KSPS. Signal gains up to 2000 are available through a combination of signal conditioner and overhead gain blocks. A to D conversion is performed by a 12 bit device.

Signal conditioning is provided for a wide variety of analog and digital (discrete) signals generally encountered in flight test instrumentation systems. Those conditioners which are inherently analog; for example, analog data filter, have their outputs routed to the external I/O connector in addition to the internal multiplexer. The purpose of this route out is allow the user to cascade several signal conditioning functions if required by the application. Each signal conditioning slot has 24 I/O connections which will allow a maximum of 12 differential channels to be included on any card.

The DDAU conditions up to 128 discrete input lines.

Designed to operate in conjunction with tactical Global Positioning System receivers, the GDAU extracts user specified data and time. The GDAU has the capability to provide a time code signal for use by the ASC, AVDAU and the HSDBDAU.

The AVDAU supports both selected and 100 percent acquisition of avionics data from MIL-STD-1553, H009 and F16 Weapons buses. This unit is both electrically and mechanically expandable to handle up to eight MIL-STD-1553 buses. The base unit contains two bus monitors and the bus type is user selectable; however, the add-on slices are only available as

MIL-STD-1553 bus monitors. The AVDAU will accept either IRIG A, B or G nonmodulated as its time code input.

The High Speed Data Bus Dau supports selected and 100 percent acquisition of data from a JIAWG J88-N2 fiber optic bus system. This unit also accepts IRIG A, B or G nonmodulated time code.

The most recent addition to the CAIS family is the Miniature DAU. This DAU is a microminiature version of the ADAU. This add-on development will be used to support installations where a limited number of measurands are to be acquired in an area which has a severe size restriction, such as in a wing tip. The signal conditioning complement is similar to the ADAU in types. The MDAU is not being specifically developed for CAIS, but rather an existing unit is being configured to fully function with the CAIS bus system and be integrated into the CAIS support equipment.

SYSTEM CONFIGURATIONS

Through proper system design and selection of CAIS components, users will have the ability to satisfy the requirements of most flight test programs. The wide variety of data acquisition units and signal conditioners can be interconnected with the ASC to fulfill the larger system needs. The ASC has the capability to support up to 180 DAU on three separate CAIS bus systems. Sampled data is returned to the ASC which formats the PCM output. By using the PCM Combiner, a system can be configured which will produce a “single” output consisting of the CAIS sampled data as well as the 100% avionics data and any other combined sources. Outputs are available as a primary IRIG 106 serial PCM stream, a clocked byte serial stream supporting rotary head recorders, and a variety of reduced rate output PCM streams for recording and telemetry uses.

In addition to operation as remote units connected to an ASC, each DAU has the capability of being configured to generate its own PCM output. The ADAU possesses even more flexibility. By adding a CAIS controller card in one of the signal conditioner slots the ADAU can operate independent or become a controller for up to 60 other DAUs. There are system limitations when the ADAU functions in this mode. Because of memory size and the addressing scheme used, the ADAU is capable of generating an unwound PCM format of up to 1024 words; that is, it functions as a sequencer. The

maximum ADAU bit rate will be 5 MBPS when functioning stand alone and 2.5 MBPS when serving as a controller. Other DAU stand alone rates are; DDAU, 1 MBPS; GDAU, 1 MBPS; AVDAU, 5 MBPS (selected) 16 MBPS (100% mode); HSDBDAU, 20 MBPS (selected).

INSTRUMENTATION SUPPORT EQUIPMENT

CAIS will be supported with a suite of ground-based Instrumentation Support Equipment (ISE). These systems range from a multi-user, multi-tasking Laboratory Support System to a shoe box sized Hand Held Decom. The CAIS ISE will be able to fully support all the airborne hardware items. Included among its support functions are automatic format generation, loading of formats into the airborne units, quick look decommutation, semiautomatic check-out of an installed system and exercise and analysis of BIT. The ISE is also capable of performing acceptance testing of hardware items and serves as a tool for troubleshooting and fault isolation.

DEVELOPMENT SCHEDULE

Figure 1 presents an overview of the CAIS full scale development schedule. Hardware being produced include an engineering model and several sets of flight demonstration units. The flight demonstration units will be fully qualified and used by the services to perform a series of CAIS flight tests prior to actual fielding of the system.

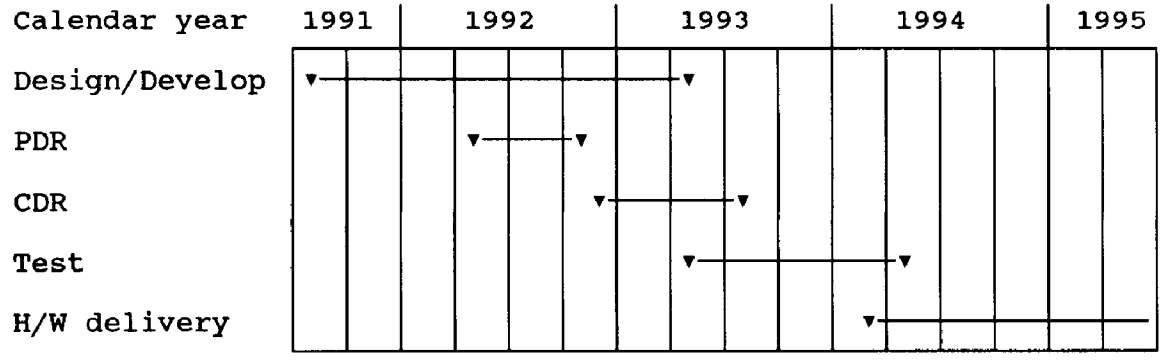

Figure 1. CAIS Development Schedule

Following successful completion nf the development phase of the program, contract options will be exercised for additional developmental units. These units, as were the

flight demonstration units, will be fully qualified production units.

By the conclusion of the development program a complete set of documentation including drawings, manuals, specifications, and software documentation in accordance with DOD-STD-2167A are to be delivered to the government. The government will use this documentation to provide life cycle support for CAIS and to competitively reprocure identical units to satisfy the flight test needs of the services in the coming years.

REFERENCES

Faulstich, Raymond J. “Common Airborne Instrumentation System”, 1991 International Telemetering Conference (ITC) Proceedings, Volume XXVII.