

The Common Airborne Instrumentation System Program Management Overview

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ABSTRACT

The Department of Defense, through a Tri-Service Program Office, is developing the Common Airborne Instrumentation System (CAIS) to promote standardization, commonality, and interoperability among aircraft test instrumentation systems. The advent of CAIS will change how the DoD test community conducts business. The CAIS program will allow aircraft test and evaluation facilities to utilize common airborne systems, ground support equipment, and technical knowledge for airborne instrumentation systems.

The CAIS Program Office will conduct requirements analyses, manage system upgrades, and provide full life cycle support for this system. It is initiating several requirements contracts to provide direct ordering opportunities for DoD users to easily procure defined test instrumentation hardware. The program office will provide configuration management, inventory control, maintenance support, system integration, engineering support, and software management. In addition, it will continue to enhance the current system and develop new items to meet future requirements. Where existing equipment provides added benefit, this equipment may be added to the official CAIS family.

KEY WORDS

Airborne Instrumentation, Signal Conditioning, Data Acquisition

INTRODUCTION

The three services have historically developed new airborne instrumentation systems for each new major weapon system they have procured. This has led to a proliferation of instrumentation systems, both across and within the services. Each of the Major Range and Test Facility Base/Aircraft Test and Evaluation (T&E) activities maintains

and supports a wide variety of instrumentation systems for weapon system T&E with limited to non-existent spares and minimal to no commonality. Reutilization of these systems in other programs is minimal, making the cost of ownership high.

Historically, the test ranges each had their own complement of airborne instrumentation systems. A new test requirement always arose due to each new aircraft program, resulting in airframe contractors developing new, tailored instrumentation systems to realize the new capability. This led to many instrumentation systems in the field. The costs associated with keeping personnel trained on each system, finding resources to maintain the systems, and buying spares for the new systems was becoming prohibitive.

The Common Airborne Instrumentation System (CAIS) will change the way tri-services and major aircraft contractors develop and procure instrumentation systems for major weapon system acquisitions. A common/standard airborne instrumentation system is being developed which will meet core data acquisition requirements for weapon systems of the future. This system, the first-generation CAIS, is intended to satisfy core instrumentation requirements into the next century. As the executive manager of the project, the Navy has established a joint project office (JPO) at the Naval Air Warfare Center Aircraft Division and staffed by the three services.

REQUIREMENTS

The major requirements that will be resolved by this project are:

- o Interoperability across aircraft test and evaluation facilities.
- o Standardization of instrumentation preflight and maintenance procedures.
- o Risk reduction to major weapon system acquisition programs.
- o Cost reduction for instrumentation to the services.
- o Elimination of uncontrolled, duplicate efforts and development costs.
- o Maximum reutilization of instrumentation within and across the services.
- o Rapid response to program needs for instrumentation systems .
- o Instrumentation interface provision to the Global Positioning System.

CHARACTERISTICS

There are several prominent key characteristics of the CAIS. The first is commonality. The CAIS will be a suite of standard hardware and software which will be used across service boundaries on all aircraft T&E programs. CAIS will not be airframe- or weapon system-dependant, nor will it be restricted to use by any T&E activity or weapon system manufacturer. The next key characteristic is a single point system life

cycle management organization for all users of CAIS. Included will be procurement, maintenance, upgrades, and system support. The third key characteristic is a modular, expandable open architecture. This provides the capability to expand the system to meet T&E program requirements and to upgrade system components to use new technologies or meet emerging technical requirements. Also, more data acquisition capacity can be added to an existing instrumentation installation without redesigning, removing, and reinstalling a completely new system. These key characteristics will enable the system to satisfy existing and future instrumentation requirements well into the next century by providing a common system that supports a large customer base and open architecture that supports infusion of emerging technology cost effectively.

SYSTEM DESCRIPTION

The CAIS is a time division multiplexed digital data acquisition system consisting of a family of building blocks which will be interconnected via the CAIS bus (Figure 1). The system will be able to handle output data rates from 2 kilobits per second to 50 megabits per second, in word lengths of 12 or 16 bits. The CAIS will be fully programmable with a capacity of at least 8000 input channels. Output data will be IRIG-compatible PCM data stream for telemetry use plus data streams compatible with different recording systems.

The CAIS will consist of the following major components:

- o Airborne System Controller. Orchestrates collection and output of data. By storing up to eight different sampling formats, the controller can allow dynamic system reconfiguration during flight to adapt to predefined changing data collection requirements.
- o Airborne Processor. Performs engineering unit conversion and other data manipulations to be put into the data stream or sent to the display subsystem .
- o Data Acquisition Units (DAUs). Allow collection of data from many possible data sources, such as aircraft data buses, global positioning system, and analog and digital instrumentation sensors.
 - Analog-Discrete DAU (ADAU)
 - Avionics DAU (AVDAU)
 - MIL-STD-1553
 - H009 (F-15 avionics bus)
 - Weapons (F-16 weapons bus)

- Global Positioning System DAU (GDAU)
 - Discrete DAU (DDAU)
 - Miniature DAU (MDAU)
- o PCM Combiner. Merges up to 16 asynchronous serial digital data streams.
 - o Cockpit Data Display. Provides up to 16 alpha-numeric displays plus analog outputs.
 - o Instrumentation Support Equipment. The CAIS will also include a complement of laboratory and flight line support equipment to enable system programming, checkout, and maintenance.

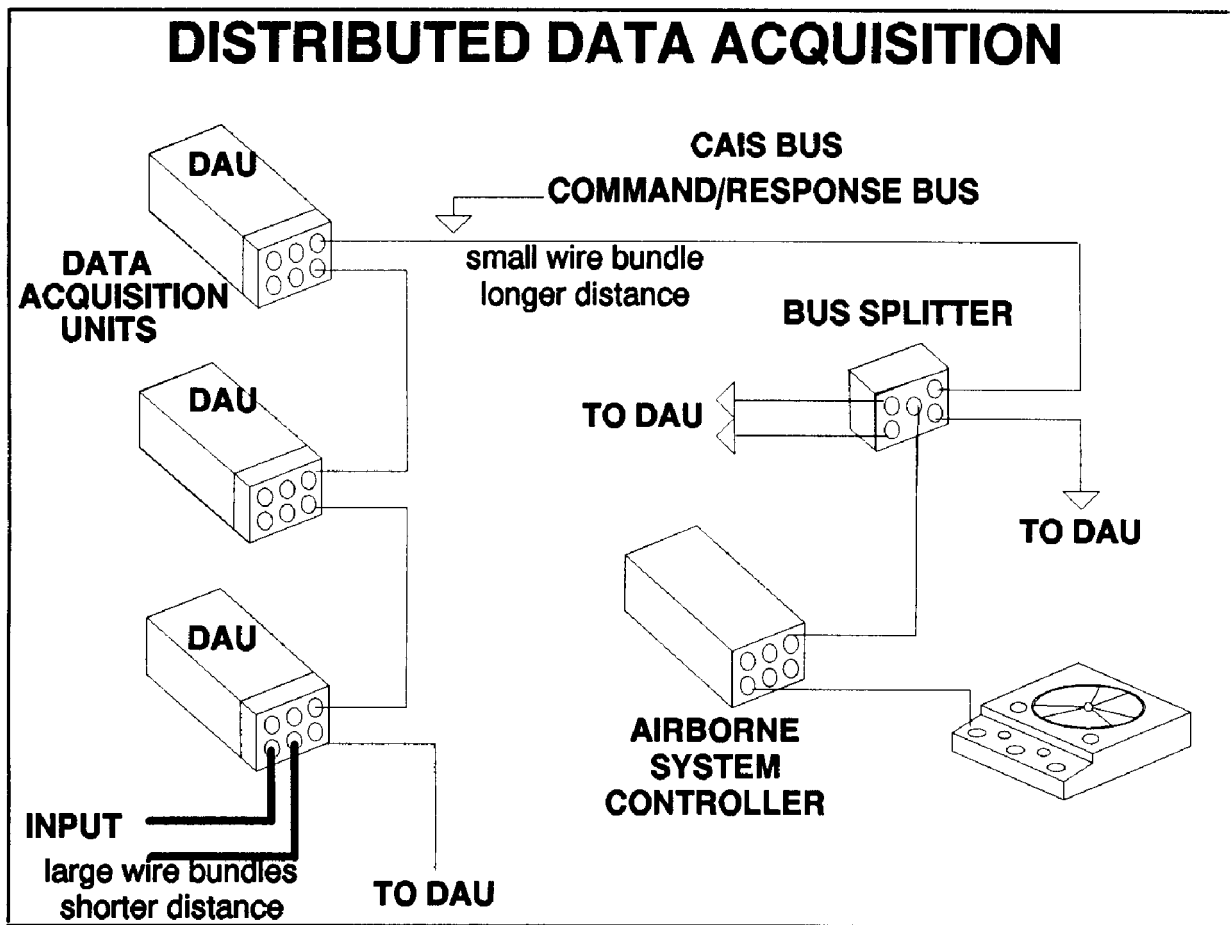


Figure 1. CAIS SYSTEM

PROGRAM MANAGEMENT

The CAIS JPO is located at the Naval Air Warfare Center, Aircraft Division, Patuxent River Naval Air Station, MD. It is staffed with a Navy program manager and Army and Air Force deputy program managers. The program office will be the single point

system life cycle management organization, supporting all DoD users of CAIS. Included will be requirements analysis, upgrades, procurement, maintenance, and system support.

REQUIREMENTS ANALYSIS

During the concept formulation of CAIS, a thorough requirements analysis was conducted. Army, Navy and Air Force T&E organizations, as well as several aircraft manufacturers, contributed to defining minimum system performance specifications. This resulted in development of a system that is capable of meeting approximately 80% of all three services' needs well into the next century. The system is capable of future expansion to keep up with technology advances and changing environments.

To stay cognizant of changing requirements, the JPO is participating in several forums (Figure 2). It sponsors the CAIS Technical Consultant Group, works closely with the DoD Reliance process, and participates on the Range Commanders Council (RCC). In addition, it provides close coordination through its Navy program manager and Air Force and Army deputy program managers, while maintaining presence at several conferences during the year such as the International Telemetry Conference, the Transducer Workshop, and the Society of Flight Test Engineers.

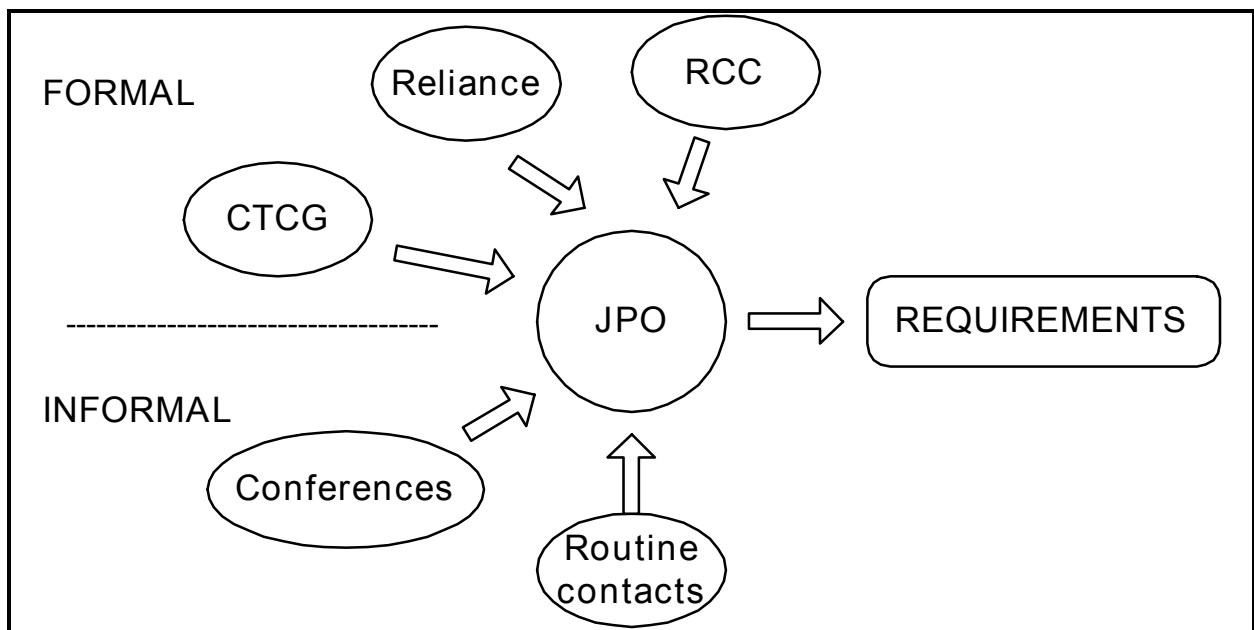


Figure 2. CAIS Requirements

The CAIS Technical Consultant Group is a tri-service group of instrumentation engineers that meets semiannually to discuss airborne instrumentation commonality considerations. This forum identifies system enhancements and criteria for new

developments. Recommendations for new or improved capabilities are forwarded to the CAIS program office.

By participating in and monitoring DoD Reliance efforts, the CAIS JPO stays abreast of instrumentation requirements throughout the entire DoD flight test community. The reliance process identifies broad categories of system requirements, matches them against existing resources, and recommends instrumentation upgrades. The JPO will incorporate these recommendations into their overall development program which will ensure continued standardization and commonality within the DoD community.

The CAIS JPO maintains membership in the Telemetry Group of the RCC. By regularly attending RCC meetings, the CAIS JPO maintains a two way dialog with the individuals writing and updating the telemetry standards used throughout the flight test industry.

In addition, the Navy program manager and Army and Air Force deputy program managers maintain close liaison with their respective services' instrumentation functional organizations. This provides an information flow on any short notice customer requirements.

SYSTEM UPGRADES

The end result of these efforts will be identification of customer requirements necessitating development of new items, modification to existing CAIS components, modifying commercial off-the-shelf (COTS) items, or in some cases relying on an existing COTS item. These developments, modifications, or COTS certification will be managed by the JPO.

When a requirement is identified that can be satisfied through a modification to an existing CAIS component, the JPO engineering staff will initiate action. They will provide program management to develop the engineering design to accomplish the modification. The JPO will coordinate the modification and then maintain configuration control.

If the customer requirement cannot be satisfied through modifications, the JPO will initiate a system development. Examples of new developments in planning are a wideband DAU and a high-speed data recorder. Normally, the JPO will prepare a system specification, compete a development contract, and provide overall program management. In some cases, the development will be managed at other sites.

Funding for system development and major system modifications may be provided through the Central Test and Evaluation Investment Program (CTEIP). Smaller modifications and those requiring fast reaction times will normally be funded by the primary customer--a system program office or T&E facility.

CAIS FAMILY

The CAIS program is designed to handle most customer requirements. As depicted in Figure 3, CAIS is the core of the instrumentation family, augmented by compliant units to satisfy most customer requirements. Some programs will need to augment their system designs with compatible and non-CAIS units. The program office has established guidelines to incorporate existing systems into the CAIS family. These are listed in Table 1, Classifications for CAIS hardware. For a system to be called "CAIS," it must, at a minimum, be CAIS-compliant. If a CAIS or compliant systems are available, DoD users will be required to use those units.

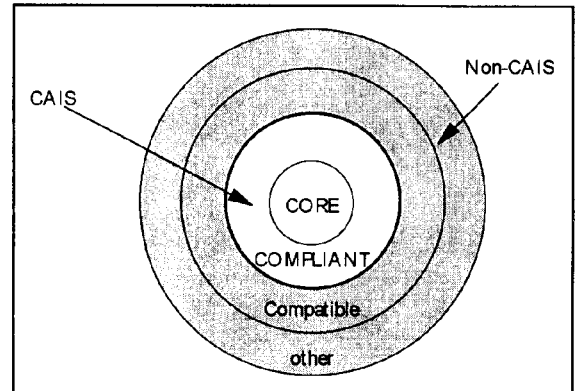


Figure 3 Instrumentation Categories

Table 1. CLASSIFICATIONS FOR CAIS HARDWARE	
CAIS	One of the CAIS family of units designed to CAIS specification and developed by the CAIS JPO.
Compliant	A new or modified device that is developed under sanction of the CAIS JPO and for which the CAIS JPO will provide life cycle support.
Compatible	Any unit designed to interface or function with CAIS components but not sanctioned by the CAIS JPO.
Non-CAIS	Any unit designed to operate within the instrumentation area but not directly interface to a "CAIS" or "CAIS Compliant/Compatible" component.

CAIS units are units specifically designed and developed to the CAIS system specification and managed through the JPO, such as the ASC and AVDAU. These units are the core of the CAIS effort and have JPO certification. These units will bear the CAIS trademark.

Compliant units are those COTS items or new items that are inappropriate for full development by the JPO but satisfy a significant customer need and are sanctioned by the JPO. These units will operate over the CAIS bus and are programmable by the CAIS software, but they do not necessarily include all CAIS standard design features or follow all normal CAIS specifications. The units will be developed competitively by the program office, such as in the case of the MDAU.

Compatible components are part of that 20% bracket that are not currently addressed from a DoD commonality viewpoint. They do not require JPO certification. Although they would not be programmable by the CAIS software, they can be relatively easily interfaced with the CAIS software by the user. These units presumably would be designed by commercial vendors, to match the standard airborne instrumentation interfaces of CAIS. They could also be commercial grade units for use in commercial flight tests.

Non-CAIS units are also in that 20% bracket, but they do not interface with CAIS.

The fundamental objective of CAIS was to develop an 80% solution to the DoD airborne instrumentation requirements. This combination of CAIS, compliant, and compatible units will provide a cost-effective method to reduce operations, maintenance and overall life cycle costs.

COMPLIANT CERTIFICATION

To be considered CAIS-compliant, a COTS item must go through the CAIS JPO certification process. First, the item must be identified in the previously discussed requirements process. For example, the CAIS Technical Consultant Group might recommend adding a particular DAU function. The CAIS JPO would conduct a field study to find what COTS units/functionality exists. After deciding on a unit that best meets requirements, the CAIS JPO would conduct laboratory tests to verify operation over the CAIS bus and identify what CAIS design features the item does or does not have and potentially initiate further modification of the COTS item. The CAIS JPO software support group will then integrate this DAU into the ground support system. At the conclusion of this process, the COTS DAU would be certified as "CAIS Compliant," and the JPO would include it on the official list of compliant units. T&E customers could be assured of its performance when operated in conjunction with the core CAIS.

COMPATIBLE SYSTEM DEVELOPMENT

Items in this category do not require any official CAIS JPO involvement. For example, if a customer has a requirement to build a one-of-a-kind DAU to function with CAIS, he may do so without going through the compliant process discussed above. In addition, the user is responsible for programming this unit.

LIFE CYCLE SUPPORT

When the CAIS is fielded, the JPO will provide full life cycle support (Figure 4). In addition to identification of requirements and development of new or modified units to these require satisfy ments, the program office will provide logistics, program control, engineering support, software management, intermediate-level (I-level) maintenance, and coordinate depot-level (D-level) support.

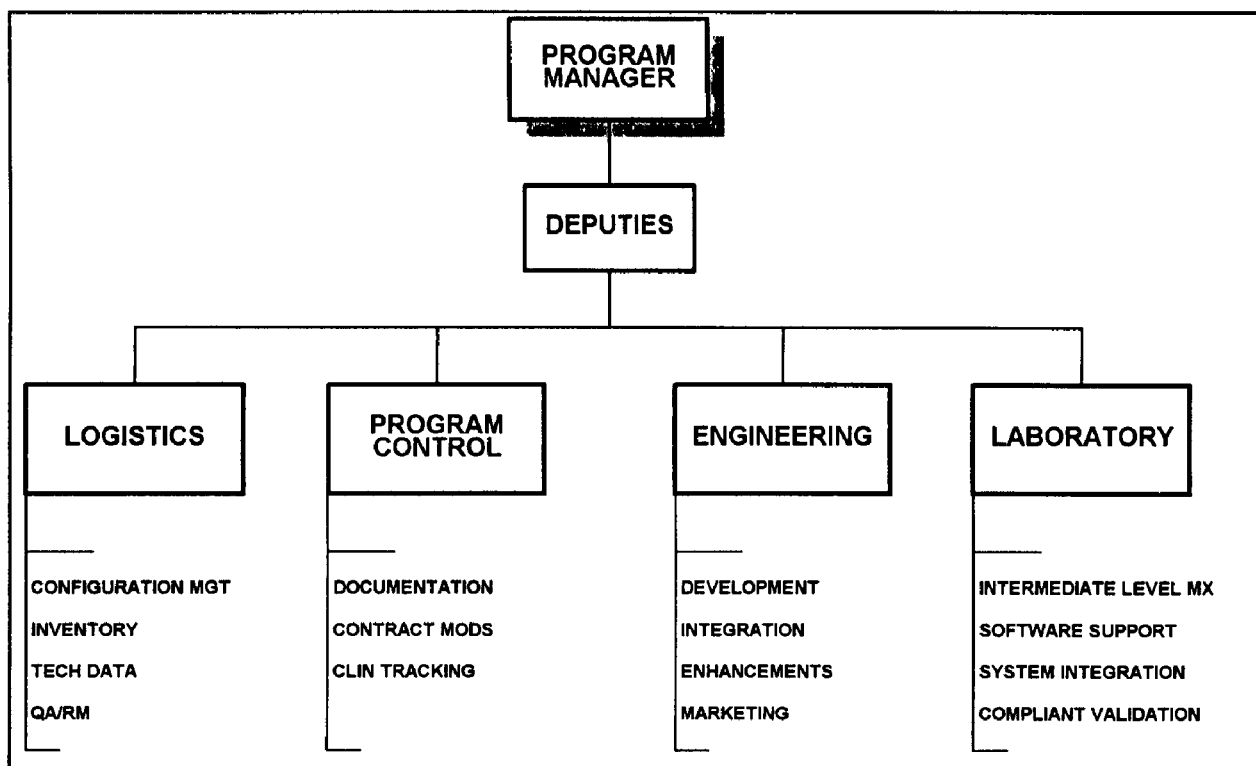


Figure 4. Functional CAIS JPO Organization

Currently, the JPO is in the process of establishing contracts to enable DoD customers to readily procure CAIS components. Requirements contracts will be in place for all CAIS units. Customers will be able to purchase products through the program office, and they will receive full procurement support.

In the area of logistics support, the JPO will maintain full configuration management. This includes managing all drawings and technical documentation. In addition, the goal of the office is to maintain a sufficient inventory of line replaceable units (LRU) and shop replaceable units for customer support and maintenance execution and monitor the overall quality/reliability effort.

The JPO will maintain a core of expert engineers to support the requirements and development functions. In addition, this team will provide oversight to maintenance activities, provide system integration support for DoD customers, and be available for field support.

Following system development, particularly the preflight unit, the JPO will maintain all software support. It will maintain configuration control and modify/enhance software to support hardware modifications or new CAIS LRUs.

The CAIS maintenance concept is based on the three-level concept. For organizational-level (O-level) maintenance, field units will trace system failures down to the LRU unit level and remove and replace these units on the aircraft. The CAIS JPO will maintain I-level maintenance capability to repair these malfunctioning items. In addition, the JPO plans to maintain sufficient LRU inventory to resupply customers with critical schedule requirements. For LRUs not repairable at the I-level, the JPO will coordinate and provide access to D-level support at a contractor or Government facility. The contractual effort for this maintenance will be supported by the program office. Both I-level and D-level will be funded by the customer, on a charge-per-order basis.

PROGRAM SUMMARY

The CAIS JPO was created as a tri-service program to provide a flexible and expandable instrumentation system for DoD. The program developed a standard modular complement of hardware and software which will be used on existing and future aircraft test programs. The system will be modular, allowing for expansion to meet the requirements of projects having broad data acquisition requirements. Economies of scale will result from usage by all services and weapon system manufacturers and by a reduction of the many varieties of instrumentation systems used and maintained by the services.

By utilizing a common system, major weapon system programs can rely on full life cycle support from the single CAIS JPO for their airborne flight test instrumentation systems. Personnel training is limited to one system, and spare equipment is required for one system type. Interoperability between ranges will be greatly increased due to

the existence of ground support, emergency spares, and technical expertise already in place at the national and specialty test sites.