AATIS AND CAIS DATA RECORDING

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ABSTRACT

DOD flight test centers need affordable, small-format, flight-qualified digital instrumentation recording solutions to support existing and future flight testing. The Advanced Airborne Test Instrumentation System (AATIS) is today's primary data acquisition system at the Air Force Flight Test Center (AFFTC). Digital Recorder (DR) 1995 is planned to provide full support for AATIS output capabilities and satisfy initial recording requirements for the Common Airborne Instrumentation System (CAIS). The follow-on to the AATIS, the CAIS is a tri-service development to satisfy future DOD flight test data acquisition requirements. DR 2000 is planned as the future recording solution for CAIS and will be able to fully satisfy the 50 Mbps recording requirement. In the developments of DR 1995 and DR 2000, commonality and interoperability have emerged as significant issues. This paper presents an overview of these recording solutions and examines commonality and interoperability issues.

KEY WORDS

Commonality, Digital Recording, Interoperability, MIL-STD-1553, Pulse Code Modulation (PCM)

INTRODUCTION

Flight testing of complex aerospace vehicles requires the collection and recording of increasing amounts of data. Today's primary data acquisition system for Air Force flight testing is the AATIS, with a sustained data output capability of 8 megabits per second (Mbps). Within the next few years, the tri-service CAIS will begin to replace AATIS. Initial CAIS sustained data output capabilities will be 15 Mbps and the CAIS combiner will increase this capability to 50 Mbps. Recording solutions are needed to support AATIS and CAIS data requirements.

To satisfy AATIS data requirements, instrumentation engineers currently have three alternatives: (1) Analog recorders; (2) Low-end digital recorders; or (3) High-end digital recorders (see Table 1). Analog recorders cannot support the 8 Mbps rate without serious record time and bandwidth restrictions. In addition, a typical 14" analog tape reel costs $200-$250. High-end digital recorders, while capable of exceeding the data rate requirements, are cost-prohibitive for all but the most specialized applications. Low-end digital recorders lack a standard akin to the large format recorder standard, MIL-STD-2179. As a result, there has been a proliferation of numerous low-end digital recorders, many of which are incompatible with each other. Also, many of these low-end digital recorders cannot support the AATIS 8 Mbps requirement.

ANALOG (0-4 Mhz)	LOW-END DIGITAL (0-4 Mbps)	HIGH-END DIGITAL (0-240 Mbps)
•Limited Data Rate	•Lack of recorder standard	•Expensive Hardware
•Expensive Media	•Satisfy AATIS Requirements??	•Too Much Capability
		•Too Large for Fighter A/c

Table 1: RECORDER TECHNOLOGY COMPARISON FOR AATIS REQUIREMENTS

DR 1995 will be an affordable solution for AATIS, bridging the gap between inadequate analog and lowend digital recorders, and expensive, over-capable high-end digital solutions.

As AATIS is gradually phased out in favor of CAIS, DR 2000 will be needed to satisfy the 15-50+ Mbps data requirements. At first glance it might appear that the current high-end digital recorders would be the only alternative capable of handling this volume of data. However, new technologies (e.g., solid state, CD-ROM) are beginning to appear as viable candidates.

For both DR 1995 and DR 2000, commonality and interoperability have emerged as significant issues. After presenting an overview of DR 1995 and DR 2000, the issues of commonality and interoperability will be discussed. The following definitions are offered for those terms:

commonality- The extent to which two or more systems use the same or least interchangeable hardware or software.

interoperability- The measure of a system's ability to exchange data with another system.

DR 1995 OVERVIEW

DR 1995 addresses the need for a standard 8 Mbps digital recording system to satisfy a wide range of instrumentation recording needs and to replace obsolete analog recorders. DR 1995 is composed of an airborne segment and a ground-based segment. The airborne segment is composed of an Airborne Recorder; Data Multiplexer; and Data, Control, and Auxiliary Interfaces and can operate in two configurations, Standalone and Normal (Figures 1 and 2).

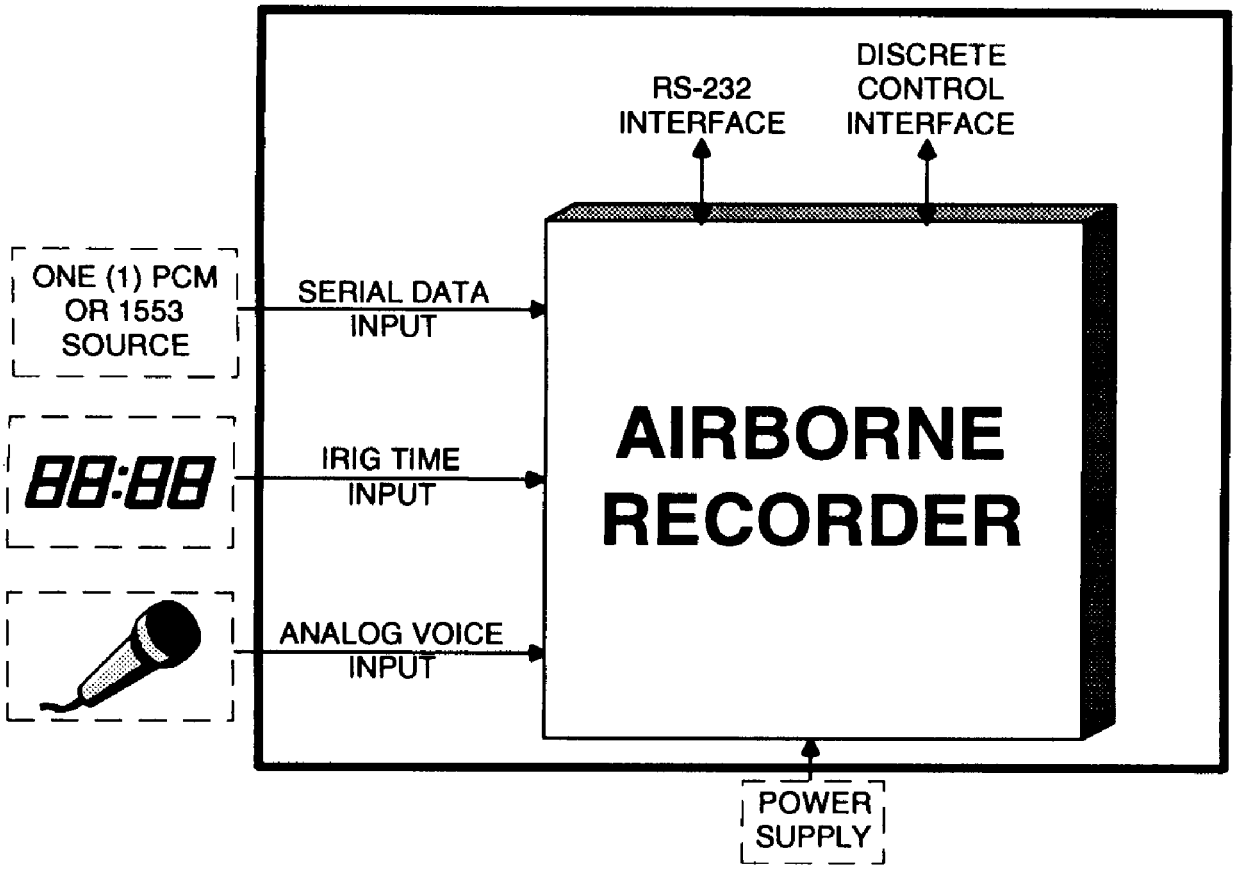

Figure 1: DR 1995 AIRBORNE SEGMENT, STANDALONE CONFIGURATION

Requirements for the airborne segment are:.

General	AATIS- and CAIS-compatible (up to 8 Mbps)
Data Rate	8 Megabits/ second (aggregate), configurable for each input (50k-8Mbps)
Mission Time	2 hours
Inputs - Data, 8 . . .	MIL-STD-1553 and /or PCM, configurable according to mission need
Inputs - Aux., 2 . . .	IRIG Time, Voice

Recording Format . Industry Standard
Recording Media . . Industry Standard
Packaging . . . . . Industry Standard
Error Correction . . . Industry Standard, <lx 10^{-8}
Combiner . . . . . Industry Standard
Interfaces RS-232, IEEE-422
Environmental . . . . Fighter (temperature, altitude, G's, vibration)

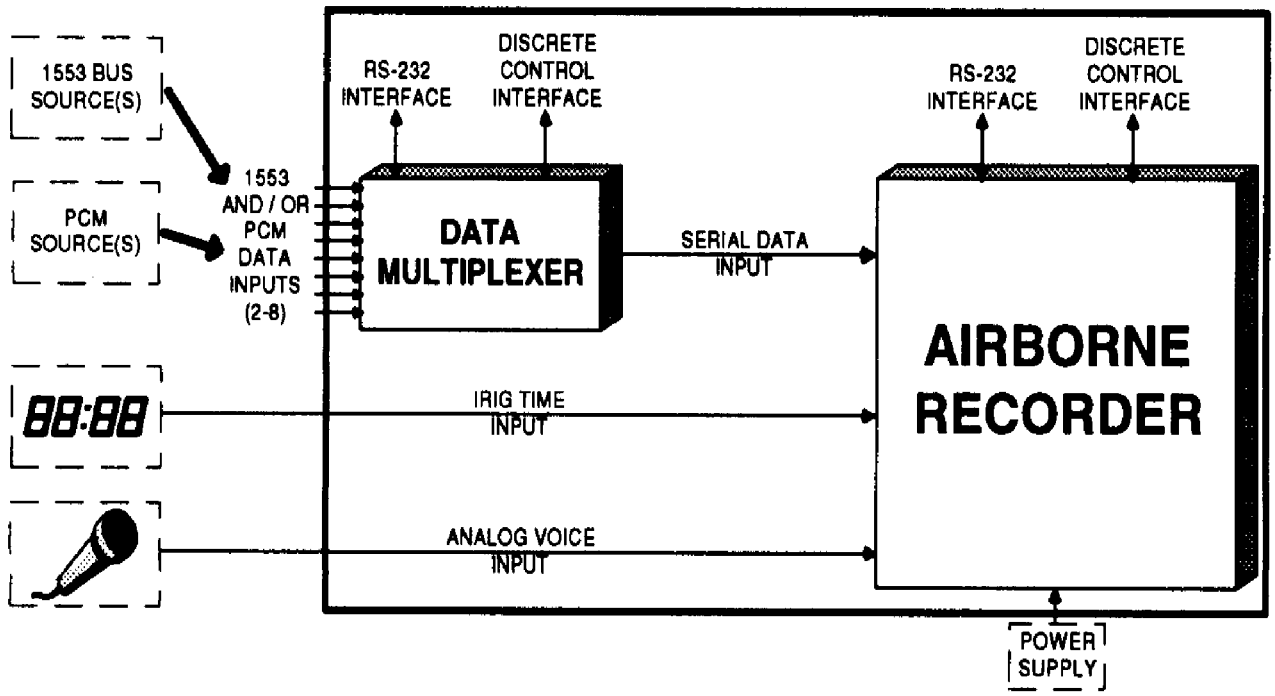

Figure 2: DR 1995 AIRBORNE SEGMENT, NORMAL CONFIGURATION

The ground-based segment of DR 1995 is composed of a lab recorder / reproducer; a data demultiplexer; and associated data, control, and auxiliary interfaces. The Standalone and Normal configurations for this segment are shown in Figures 3 and 4.

Requirements for the ground segment are:

Data Rate . . . . . 100% compatible with Airborne
Search Capability . . . . . High Speed
Outputs - Data, 8 . . . . . 1553 and/or PCM, Configurable
Outputs - Aux., 2 . . . . . IRIG Time, Voice
Recording Format . . . . . Industry Standard, Same as Airborne
Recording Media . . . . . Industry Standard, Same as Airborne
Error Correction . . . . . Industry Standard, <lx 10^{-8}

Decombiner . . . . . Industry Standard
Interfaces RS-232, IEEE-422, SCSI-2

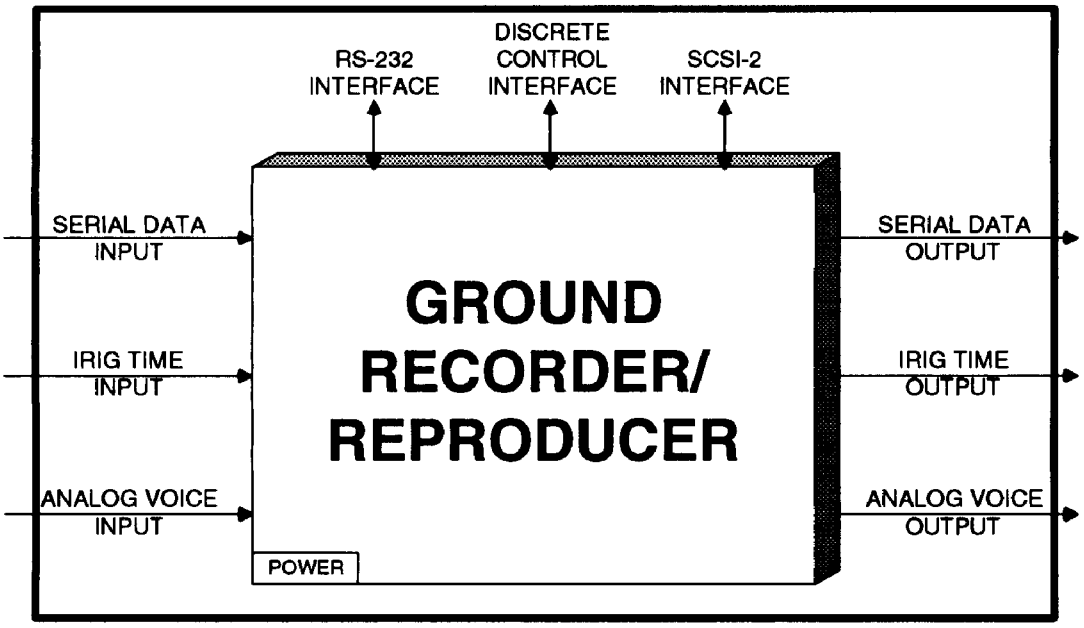

Figure 3: DR 1995, GROUND SEGMENT, STANDALONE CONFIGURATION

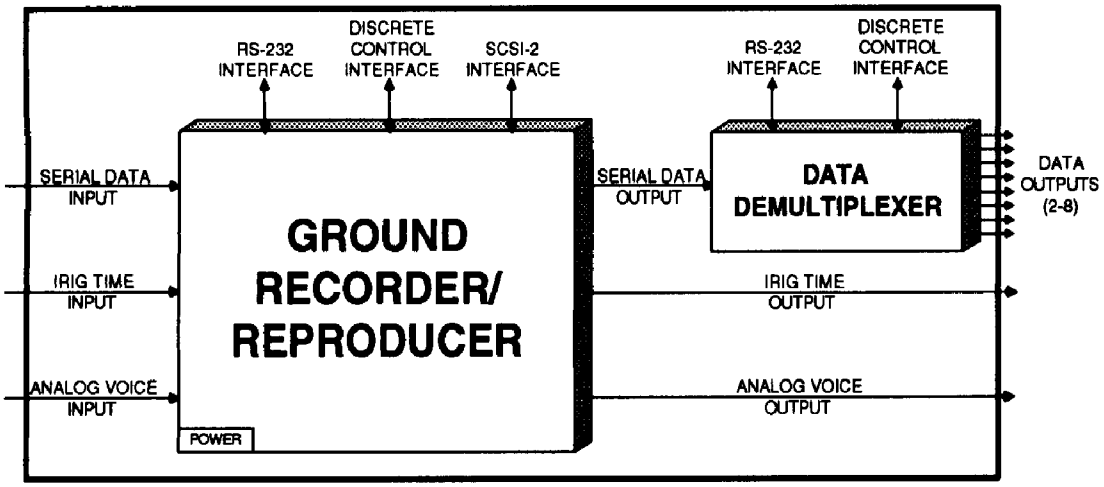

Figure 4 DR 1995 , GROUND SEGMENT, NORMAL CONFIGURATION

DR 2000 OVERVIEW

This effort is envisioned to provide the DOD with a general purpose, solid state high bit-rate recording system with the capability to meet the majority of flight test instrumentation recording needs for the Air Force, Navy and Army, and be interoperable among the Test Ranges. Significant performance envelope parameters include reduced component size and the ability to record flight test data onboard an aircraft at data rates of 50 Mbps and beyond. This recording system will include associated ground support equipment consisting of playback and analysis systems.

The system is intended to be modular and allow expansion to meet the varied requirements of DOD flight test programs.

DR 2000 will be based upon previous data recording systems and the growth of airborne technology during the next few years. An important system constraint is the ability to multiplex and record high data rates (50 Mbps and beyond). These high data rates will impact system size and recording media. Some key concerns relating to system development is the requirement for a system (Airborne and Ground Support) that is modular and compact in design with the capability to meet the majority of flight test needs for the Air Force, Navy and Army.

DR 2000 will preclude the need for differing types of data recording systems in the DOD flight test community. This system will efficiently support programs with both high and low data rate requirements and consist of a standard modular complement of hardware and software which will be used on existing and future aircraft and other test programs. The payoffs include a growth in capacity (data rate), reduced component size and reduced cost due to the elimination of multi-service developments. Should DR 2000 not become reality, the DOD would not be able to effectively record at the data rates required for existing and future flight test programs. Incomplete and inadequate testing will result. Also, the interoperabiltiy limitations that exist between different test facilities would not be solved.

STANDARDIZATION (INTEROPERABILITY AND COMMONALITY) ISSUES

Instrumentation requirements to provide airborne support for test and evaluation missions are now being satisfied on a one-of-a-kind basis. Each aircraft is modified to the extent required for the specific test. When other requirements materialize, the aircraft is taken down and modified again. This procedure is expensive, inefficient, and requires an inordinate amount of aircraft downtime. Aircraft modification also causes long delay between receipt of the test program's instrumentation requirement and Initial Operating Capability (IOC) of the instrumented aircraft. Design, procurement, and installation time of the required instrumentation can take as long as 18 months for a large program.

Each test center has its own suite of instrumentation subsystems which best satisfy their specific mission. Thus, an aircraft modified at one test center cannot deploy to another test center without taking support personnel and spare equipment: i.e., there is no interoperability among test centers.

The DOD flight test community needs a complement of instrumentation which they can plan and formulate their test designs. An availability of standard components which can be installed in an aircraft upon its initial assignment would reduce total downtime for modifications and eliminate the delay caused by the procurement of long-lead time components.

A need exists for a standard instrumentation subsystem that would satisfy future requirements and increase the DOD's flight test capability. In order to achieve standardization and interoperability, a Standard Airborne Instrumentation (SAI) working group has been formed which includes members from the various Test Centers. This group will oversee the acquisition of standardized equipment and capabilities. This includes standardization of data acquisition systems, auxiliary equipment, and unique capabilities. As mentioned earlier, the Test Centers are utilizing the AATIS. An important part of the SAI effort is the development of the CAIS. As CAIS components become available for flight test use, we will be well into the development and execution of interoperability and interconnectivity among DOD Test Centers. Having a standardized modular data acquisition system (CAIS) will allow the Test Centers to meet customer specific instrumentation requirements in a timely and cost-effective manner.

Instrumentation auxiliary equipment requires continual modernization to meet the increasing complexity of aircraft and their associated systems and to provide a reliable and more efficient mission support capability. Modernization will provide the capability to design, fabricate, calibrate, and maintain these airborne components. Computer-aided ground support equipment will provide the capability to perform design tasks in a reasonable time and speed up preflight checkout time with increased reliability, faster turn-around-time, and reduced cost.

CONCLUSION

The acquisitions of DR 1995 and DR 2000 will fill a niche between the inadequate analog systems that DOD test centers use today and the high-end test center-unique digital solutions that are being proliferated due to the lack of small-format standardization. A major emphasis in both acquisitions is to provide standard recording solutions for tri-service use. Increasing equipment commonality and interoperability between test centers is vital in the era of scarce DOD resources.