HONEYWELL STS2000 AND AEROSPATIALE ATEC SERIES 6 NEW GENERATION OF AVIONICS TEST SYSTEMS

Mike Linton
Honeywell

Paul Charbonnier
Aerospatiale

ABSTRACT

This paper presents the successful joint development by Honeywell and Aerospatiale of their new generation of avionics test systems. The Honeywell STS2000 and the Aerospatiale ATEC Series 6 are VXI-based ATEs providing all the resources and technologies needed to test the new avionics of the Boeing 777 and the Airbus A330/A340.

1. INTRODUCTION

With the advent of the new avionics of the Boeing 777 and the Airbus A330/A340, Honeywell and Aerospatiale were both faced with developing new Automatic Test Equipment(ATEs). In 1991, Honeywell and Aerospatiale decided to jointly develop new ATEs for the 777 and A330/A340.

2. THE OBJECTIVES

2.1 Test Capabilities for New Generation Avionics

Test requirements for avionics have changed drastically since the introduction of the digital avionics of the Boeing 767, the Airbus A310, and the Douglas MD80.

As digital avionics evolved for the Boeing 747-400, Boeing 737-300/500, Airbus A320/321 and Airbus A330/A340, highly sophisticated test systems have been required in the areas of:

- Digital buses and protocol simulations
- High number of discrete signal simulations
- Analog and digital simulation for Generator Control Units
- AC and DC power disturbance simulators
- Lightning arrester diodes Test Sets
- LVDT, RVDT and high number of sensor simulations
- development, execution and support of very large test programs over 10000 ATLAS statements.

The introduction of the modular avionics of the Boeing 777 led to a major leap of test systems technology in the areas of:

- Aeronautical Radio,Inc(ARINC) 629 and 659 buses
- New dedicated avionics buses and protocols
- Boundary scan test buses (Institute of Electrical and Electronic Engineers(IEEE) 1149.1 and 1149.5)
- Optical I/O.

Therefore, one objective of the joint development team was to provide the capability to test the avionics of past generations, the avionics of the 777 and the A330/A340 and to provide the hooks and/or extensions to cover new requirements that will arise within the next 5 to 10 years.

2.2 Reduced ATE Size

Airline shops and Original Equipment Manufacturer(OEM) service centers have always requested smaller physical sizes (footprints). An objective was set to reduce the footprint by 20% from previous generations of ATEs.

2.3 Improved Reliability

Through the use of new technologies, such as Versa Module Eurocard(VME)bus Extension for Instrumentation(VXI), reliability improvements of 100% were thought to be achievable.

2.4 Reduced Recurring Cost

By making the test systems modular and able to be configured to specific applications, an objective was established to decrease recurring cost by 25%.

2.5 Reduced Non-Recurring Cost

In order to reduce their individual development cost of this new generation of ATE, the two companies defined a common instrumentation core including basic analog sources, digital bus simulators and measurement devices. The development of the core has been shared between the two companies.

In addition, each company is responsible for the development of specific extensions that cover the test requirements of its avionics. These extensions were made available to the other party.

2.6 TPS Development and Maintenance

Through the development/procurement and use of new tools, reductions of 20% in Test Program Set(TPS) development and TPS maintenance were established as objectives.

2.7 TPS Transportability

For years, transportability has been the subject of discussion of many engineers involved in avionics testing and the subject of SCC20 IEEE Committee and ARINC 626, 627 and 608 Committees.
Aerospatiale and Honeywell set the goals of achieving full TPS transportability and TUA compatibility between the STS2000 and the ATEC Series 6. In addition, the ATEC Series 6 will provide 80% TPS transportability with the Aerospatiale ATEC 5000.

2.8 Schedules

In addition to the challenging requirements listed above, the schedule set by management required completion of the ATE development, production of over 40 test systems and development of more than 60 TPSs in less than 2.5 years (June 91 to December 93).

3. THE JOINT DEVELOPMENT TEAM APPROACH

With two companies in distant locations, agreement had to be reached on meeting frequency and location. Early in the project, face-to-face meetings were held often. This helped everyone keep track of changes and, also, helped establish a solid relationship between the companies. Later on, electronic media - FAX, modem, etc. - were used to minimize travel cost.

The companies agreed to share work equally. Therefore, a system of allocating points based on task complexity and content was devised. The companies jointly reviewed the tasks and allocated points to each task. Next, the tasks were divided between the two companies and the point system was used to tabulate each companies' contribution.
The companies had to agree on how to perform the tasks and the format of the outputs from the tasks. The outputs from the tasks would be software and documentation. In order to assure that the outputs would be useable, the companies agreed to establish common methods and standards.

3.1 Common Methods

The companies agreed on a common design approach, design methods, design documentation procedures, Validation and Verification (V&V) procedures and configuration control procedures. A set of common development tools including

UNIX®/VENIX®, MOTIF® and SMART™ were selected.

3.2 Standards

By selecting system software standards, system software and system software tools would be transferrable. UNIX/VENIX and ANSI C were selected as system software standards.
By selecting test application standards, test programs written by Honeywell for their STS2000 would be transferrable to the Aerospatiale ATEC Series 6 without modification. SMART and ATLAS 626 were selected as test application software standards.

The standards selected for the switching system and instrumentation were:

- ARINC 608A
- IEEE 488
- VXI
- Multisystem eXtension Interface(MXI)
- Standard Commands for Programmable Instruments(SCPI).

ARINC 608A provided a switching system definition and a patch panel pin assignment that, when used by both companies, assured Test Unit Adaptor(TUA) compatibility.

VXI, IEEE 488, MXI and SCPI defined electrical interfaces and data transfer formats that provided hardware freedom of choice, system modularity and low cost development.

3.3 Concurrent Engineering & Incremental System Building

In order to meet the schedule, it was necessary to develop in parallel:

- The prototype ATEs
- The ATE user's documentation
- The ATEs for production
- The Test Programs.

The detailed hardware specifications and the instruments supplier's documentation were used as input to the:

- ATE design team
- Users documentation team
- Purchasing team.

The prototype ATE specifications were developed by the ATE design team and issued to the User documentation teams and the TPS developers. The ATE design team used the prototype ATE design specifications as a baseline for the production ATEs.

The product definition documentation written by the design team was used to build the prototype ATEs and the production ATEs. Errors in the documentation that were uncovered during build were returned to the design team to be corrected.

It was decided to build the prototype ATE by increments. Full V&V procedures were applied to each of the increments. As a result, the hardware and software were put under maintenance configuration control prior to incremental V&V. By incremental building, problems had to be resolved much earlier in the program than if the hardware and software had been released for a system level integration.

The production ATEs were used to debug the test programs as soon as the programs were released. Obviously such a development plan is risky and required strong configuration control and formal design/V&V procedures.

4. THE PRODUCT DESCRIPTION

4.1 ATE Architecture

One of the keys to meeting all the objectives was the use of VXI instruments. VXI instruments provide more functions in less size, higher reliability and better performance than previous instrument technologies. The ATE architecture is highly modular and based on VXI technology (see Figure 1).

The Test Control Computer (TCC) can be either:

- A workstation running SMART under UNIX
- A desktop PC running SMART under VENIX
- a VXI embedded PC running SMART under VENIX.

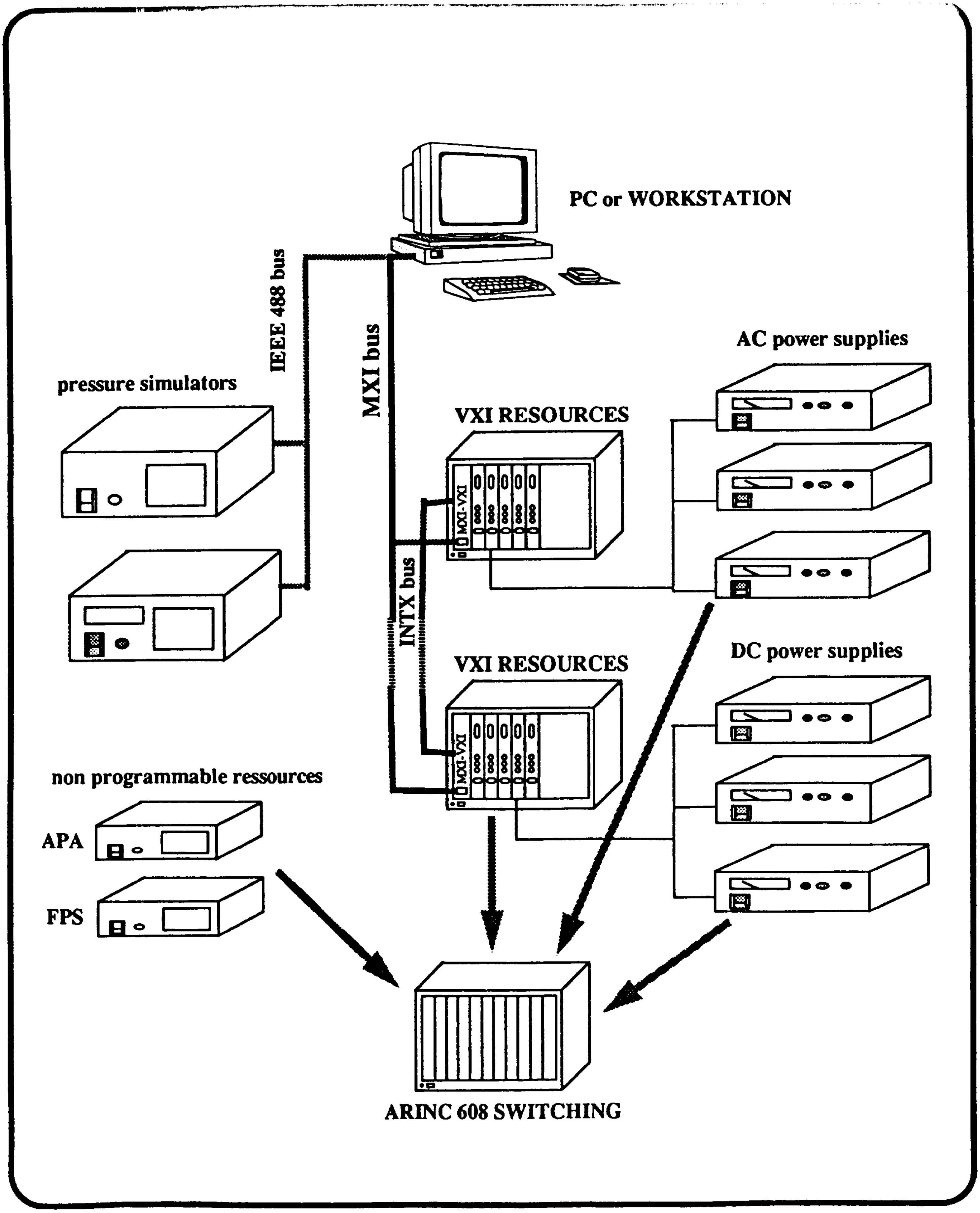
PC or WORKSTATION
IEEE 488 bus
MXI bus
pressure simulators
VXI RESOURCES
AC power supplies
MXI-VXI
INTX bus
VXI RESOURCES
DC power supplies
MXI-VXI
non programmable ressources
APA
FPS
ARINC 608 SWITCHING

FIGURE 1

The system buses are IEEE 488(for resources like pressure generators or power supplies) and VXI/MXI. For the VXI/MXI buses, the slot 0 controller can be either an embedded PC, an IEEE 488 controller or an MXI slot 0 controller.

The combination of the MXI bus and the embedded PC provide:

- Full use of VXI synchronization capabilities across chassis,
- Return of instrument interrupts to the TCC for either signal monitoring of error handling
- High speed for memory/memory huge data transfer.

The switching system is ARINC 608A compliant and can be either an off the shelf integrated solution or a dedicated solution made up of VXI modules.

4.2 Test Resources

A bank of test resources provides the following capabilities:

- AC power supplies for POR and PMG simulation including power disturbance simulation
- DC power supplies including power disturbance simulation
- AC/DC precision generators
- Arbitrary waveform generators
- Synchro/resolver simulators
- A measurement system including multimeter, counter, digital scope, angular position
- Resistance simulator
- Load simulation
- Test buses as IEEE 1149.1 and 1149.5
- Avionics buses such as ARINC 429, 629, 659, 717, 719, 708
- RS232, 422 simulators
- Dedicated digital buses and protocols
- High and low level pressure generators for air data, cabin pressure and Electronic Engine Control (EEC) test
- Radio frequency test set
- Optical test set.

The Honeywell/Aerospatiale common core system includes:

- Power supplies
- Arbitrary waveform simulator
- Synchro/resolver simulation
- The measurement system
- ARINC 429
- Pressure generators for air data and cabin pressure.
- ARINC 608A Interface.

The team worked closely with VXI instrument manufacturers to make resources available that met the test requirements. Through this cooperation, the team and the VXI manufacturers were able to enhance available instruments, develop new instruments and quickly fix problems found during prototype systems' integration.
The team developed some VXI instruments that were critical to the new ATEs' development. Development was made easier using VXI since mechanical and electrical interfaces were available off the shelf. Some of the VXI resources developed were:

- ARINC 659 simulators
- ARINC 717, 719, 708, RS232, RS422, general purpose serial bus simulators and dedicated bus simulators
- AC/DC high power, high resolution general purpose simulator.

The VXI instrument software drivers were developed using the SMART ATE modeling tools. For each of the instruments the team developed:

- A software driver
- A self-test
- User documentation
- A functional validation test suite

The software drivers(called SMART models) were developed using SMART ATE modeling tools and were coded using the dedicated resource description language and device model language of the SMART software.

The instrument self-tests were written in ATLAS 626.

The user documentation provides installation and maintenance data and an ATLAS programming manual.

The validation test suites were written in ATLAS 626 and provides formal checks of the test requirements, the instrument performance and the SMART model functions.

4.3 Test Programs

The TPS were coded using ARINC 626-2 ATLAS Language. They were developed using the SMART tools including the:

- editor
- compiler, resource allocation processor
- linker
- TUA description processor
- test executive.

The TUAs conform to the ARINC 608A standard.

5. DELIVERIES

The first ATEs have been delivered to Honeywell and Aerospatiale internal users. They are being used for avionics development, avionics production and TPS development. The first deliveries to Airlines are scheduled in October this year and are on-schedule.

6. CONCLUSIONS

As evidence of the success of this project, the prototype ATEs were ready on schedule with only a small number of problems. The first production ATEs were operating within a very short time after the prototype's full validation.

Through participation, Honeywell and Aerospatiale have met their objectives and have positioned themselves well for future cooperative efforts. Future projects will be much easier due to the common methods and the relationship established during this effort.