NASA Ames Research Center
Dryden Flight Research Facility

NASA Ames-Dryden Integrated Test Facility

Presented at:

The Control Center Technology Conference

By:

Larry Schilling, NASA
Dave Bolen, CSC

June 18-20, 1991

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Presentation Outline

- Dryden Overview — L. Schilling
- Integrated Test Facility
  - Concept
  - Philosophy
  - Capability
- ITF System Architecture — D. Bolen
  - Hardware
  - Software
- Computer Aided System Testing
- ITF System Video
- Concluding Remarks

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NASA Dryden Integrated Test Facility (ITF)

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ITF – A Facility for the Present . . and Future

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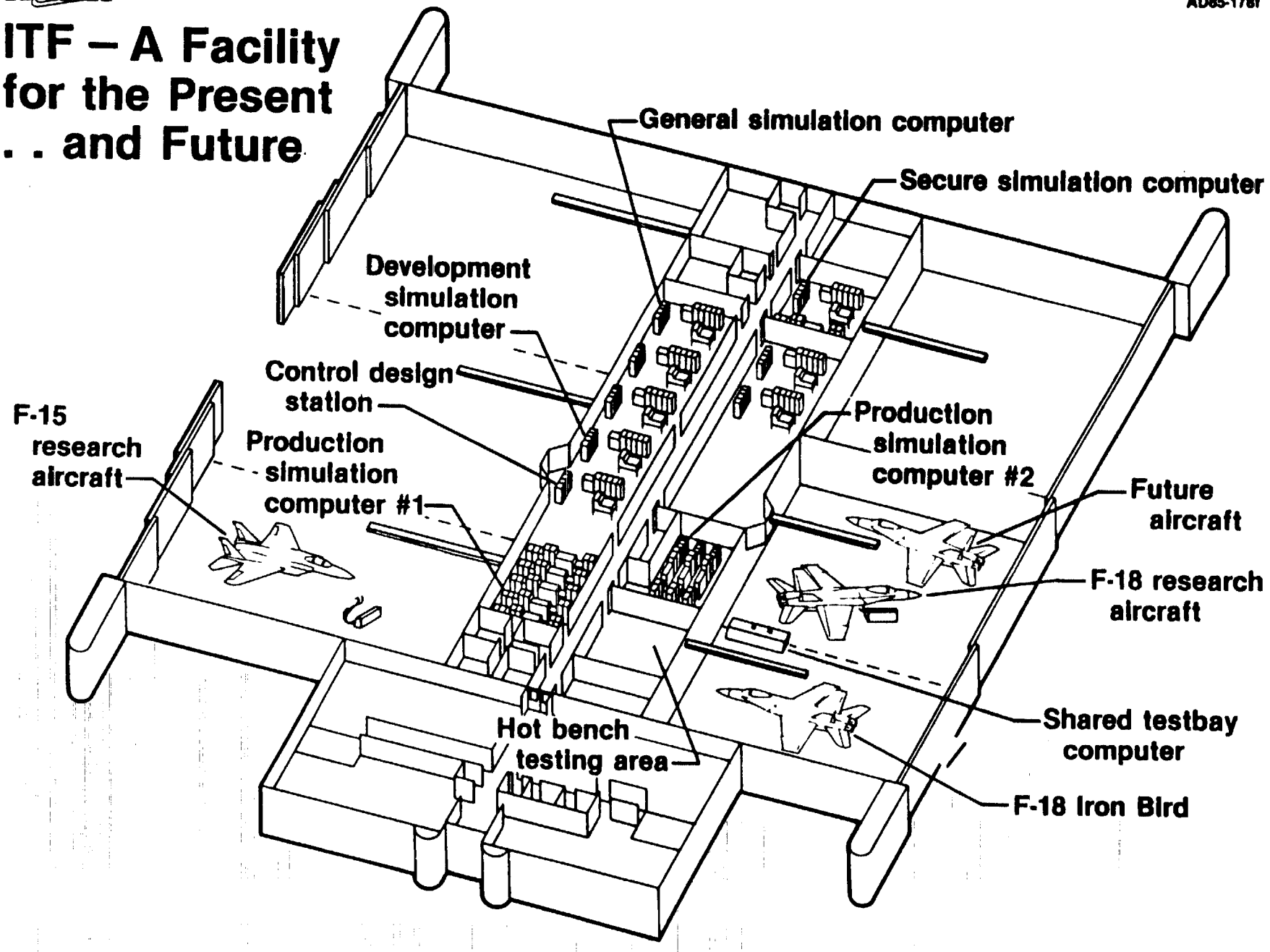

Now and the Future
Military and Civil Aircraft

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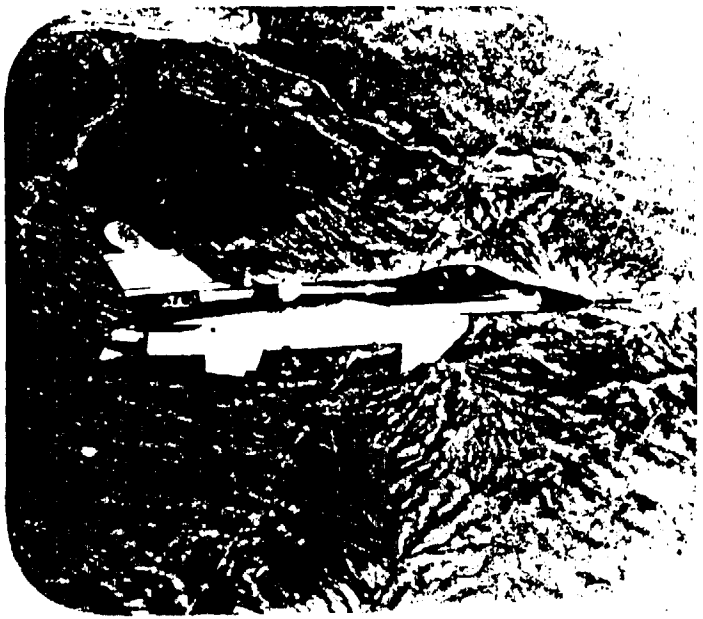
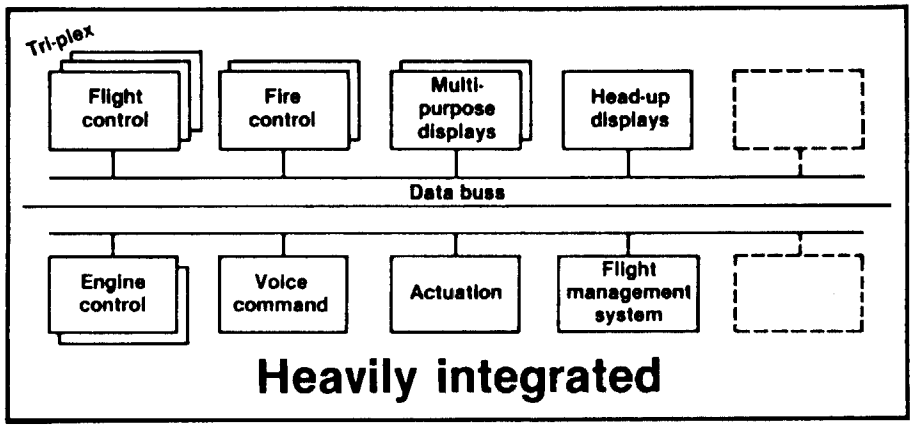


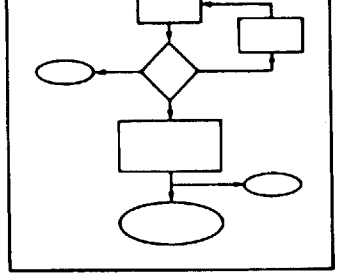
Aircraft systems



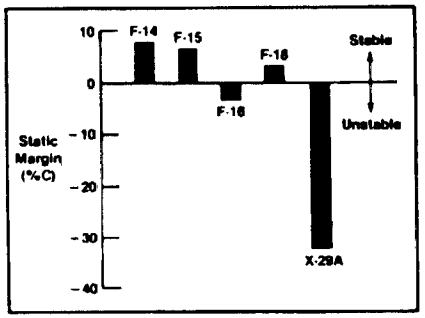
Heavily integrated

Facility requirements

- Test entire aircraft
- Assess system interactions
- "See" into avionics systems
- Handle software intensive systems



Digital/software intensive



Life critical

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Capability Concept

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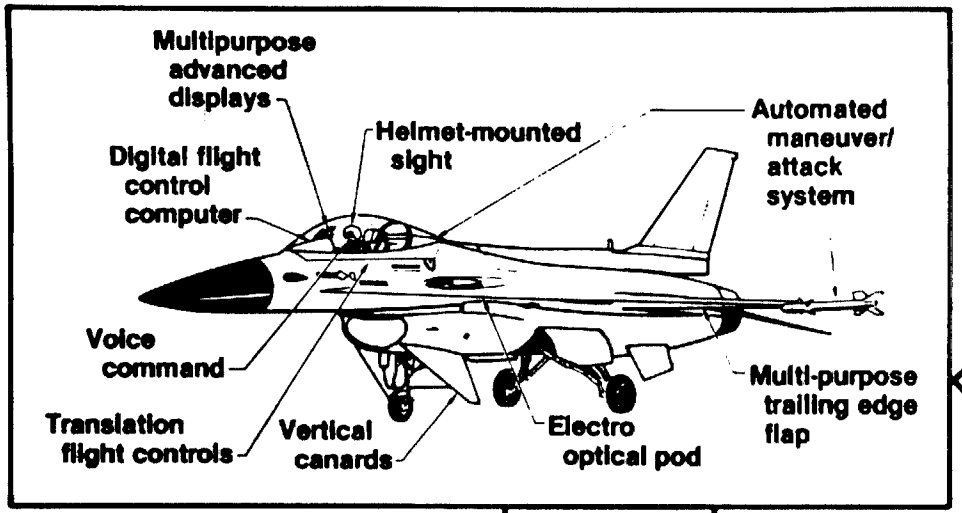
Fully Integrated Testing of the Aircraft Performed Within the Facility



ITF

Aircraft systems integration

- Software V & V
- EMI
- System diagnosis
- Avionics compatibility

Aircraft simulation models

- Closed-loop stability
- Handling qualities
- Dynamics

Feedback Parameters

- Control surfaces
- Pilot inputs
- Avionics commands

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The ITF Philosophy

- Routinely interface actual flight vehicles.
- Make the aircraft undergoing test think it's flying.
  - Test the vehicle as a whole
  - Provide power, cooling, hydraulics
  - Tie dynamic simulation with vehicle
- Record everything.
  - Anomalies are difficult to repeat
- Make the user productive.
  - Automate testing
  - Provide quick turn-around
  - Common look and feel across projects
- Conduct tests safely
  - Personnel and equipment
- Develop ITF systems independent of building construction
  - Use a target project (F-18 HARV) to focus developments
  - Combine developers and users on one team
  - Provide generic capability for multiple projects

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Major ITF Capabilities

Remotely piloted vehicle control

Computer-aided system testing

Piloted simulation

Ground vibration test

"Airplane-in-the-loop" test

Hardware-in-the-loop and hot-bench tests

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Architecture Details

- ITF System Architecture — D. Bolen
  - Hardware
  - Software
- Computer Aided System Testing
- ITF Video
- Concluding Remarks

ITF System Architecture

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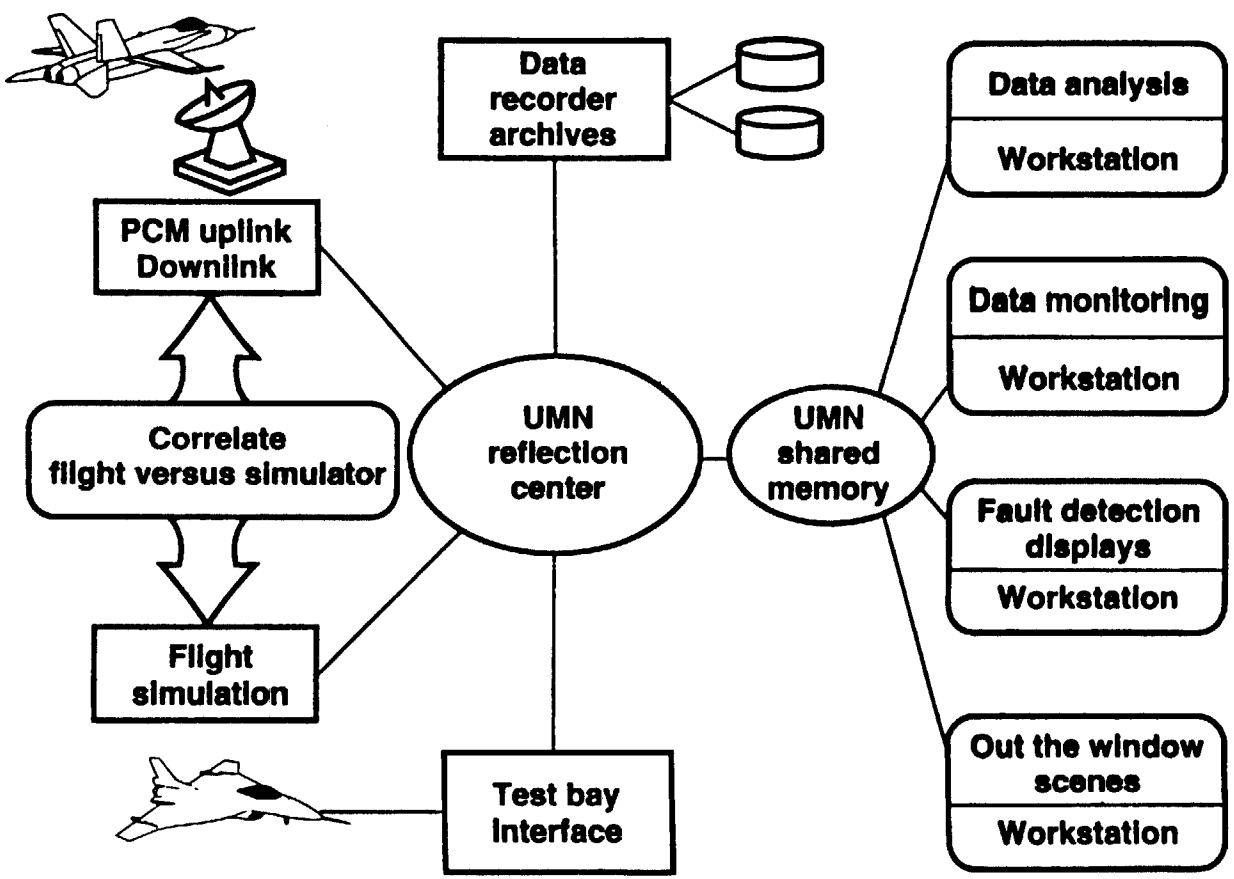

Key elements

- Simulation processor
- Test bay computer
- Data recording computer
- Workstation connectivity
- Universal Memory Network
- Realtime correlation of aircraft response to simulation

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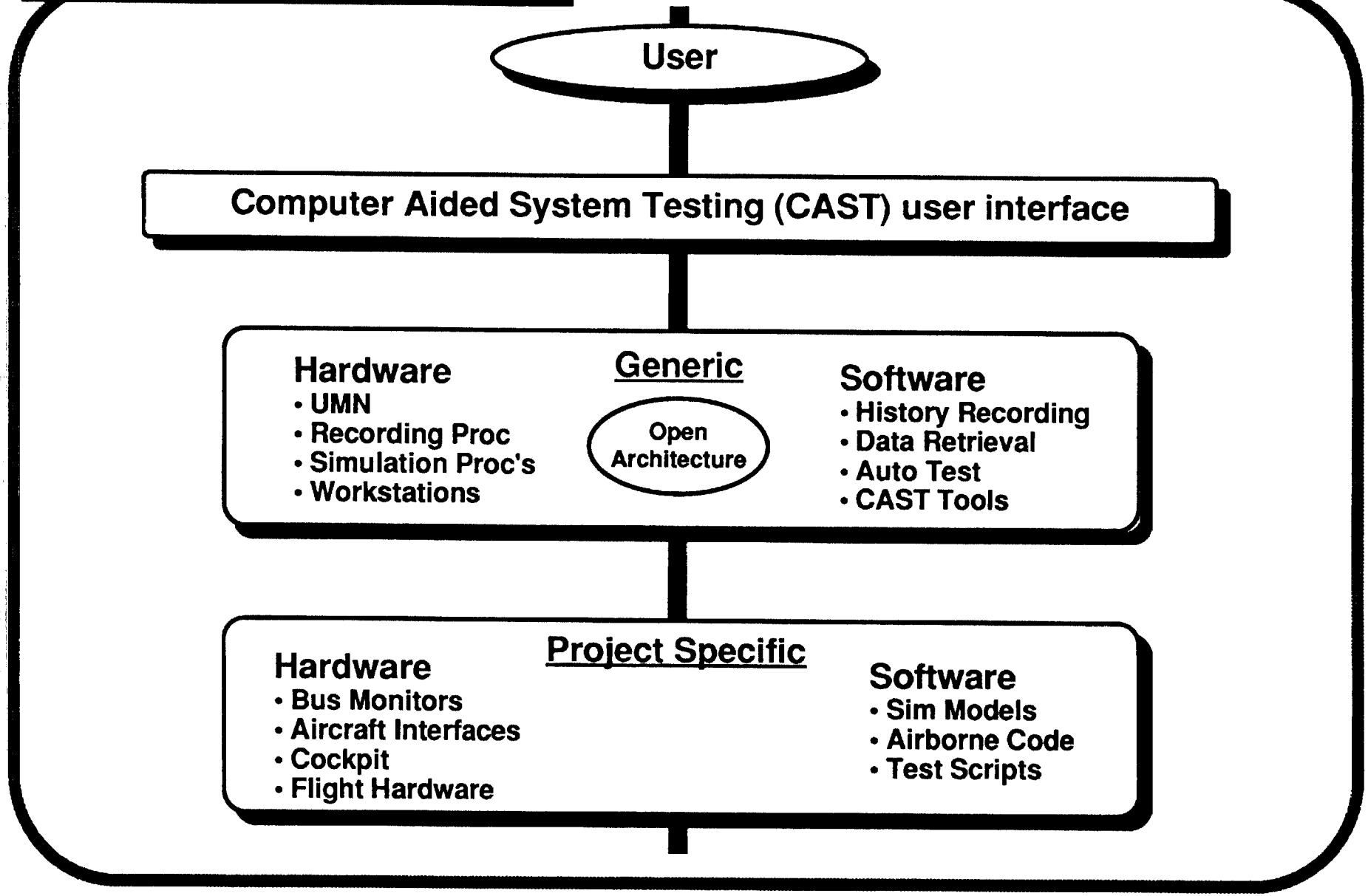
ITF System Components



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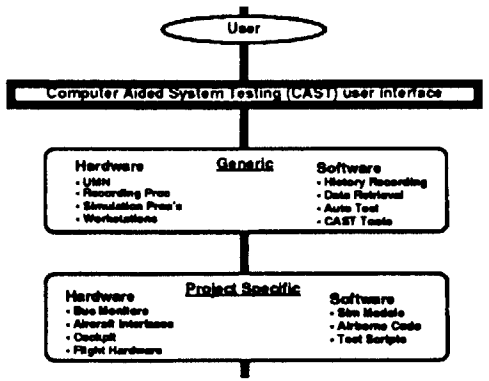
Computer Aided System Testing

What is CAST?

"An integrated toolset to increase the efficiency of software validation and verification."



- Development effort came after Government & Industry reviews
  - JSC Software Production Facility. Real-time Display System (RTDS) now in use at Dryden.
  - KSC Launch Processing System & GOAL.
  - GD open loop testing techniques (F-111, F-16, A-12).
  - RI closed & open loop testing of X-31.
- Chose OPEN Systems architecture
  - C, Unix, X-Windows
  - High performance workstations
  - Generic to support multiple projects

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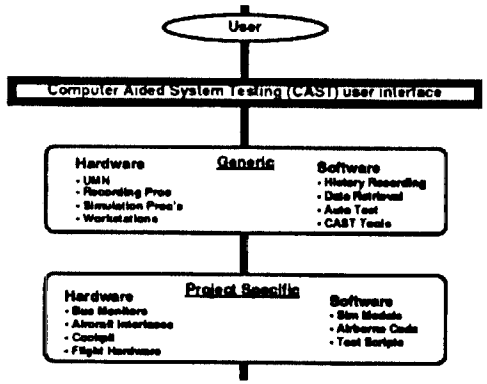
The CAST Package

- Eight interactive core applications.
  - XCapture
  - XLRC
  - XAnalysis
  - XGetLRC
  - XPlot
  - Xmonitor
  - XAIDS
  - XArchive



- Based on X-Windows and Dryden's GUI toolkit.

- Controls project specific applications via UMN toolkit.
  - Overall test control
  - Sim data recording and monitoring
  - 1553 data recording and monitoring

- Common look and feel across the facility.

- Designed with automation in mind.

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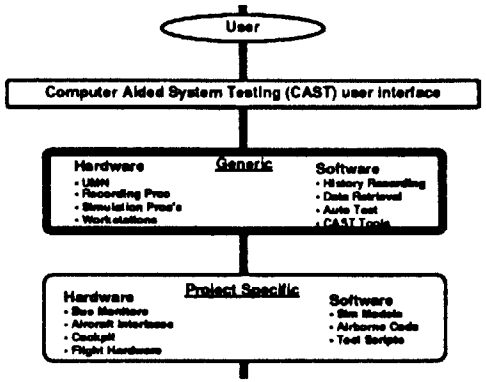
Generic Elements

Software

- **Local Recording Capability**
  - Multiple asynchronous data streams
  - All Time Tagged data (IRIG-B - microsecond resolution)
  - Rates up to 570K words/sec
- **Standardized Data Retrieval**
  - Time History Output Files
  - Merging, Skewing, Derived Data
- **Automated Test Programs**
  - Scripts, Autotest Functions
- **Computer Aided System Testing (CAST) Tools**
  - Control, Display, Monitoring, Analysis and Retrieval software



Hardware

- **Universal Memory Network**
  - Shared Memory for Dissimilar Computers
  - Low Latency Transfers
  - High Bandwidth (40MB/sec)
  - No Host Protocol or Overhead
- **Dedicated Recording Processor**
  - Three 850 MByte Drives
  - IRIG-B Time Source
- **Open Systems Architecture**
  - Sun, Encore, Silicon Graphics, IBM, Concurrent

Overview of Test Operations

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Pretest

Script generation

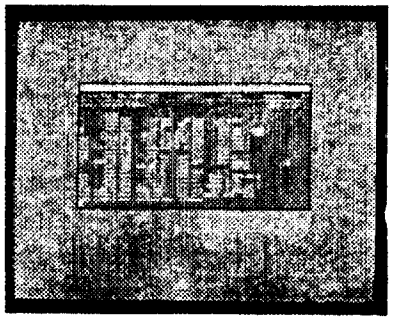
- An automated way of performing a test on the simulation processor

```
ERT
IC
H=15000.
AMCH=.5
IC;H=15000;AMCH=.5
LS
4=1
SI
PITCH=1;ROLL=0;YAW=0
PDOUBLET=1;RDOUBLET=1;YDOUBLET=1
PSQUARE=1;RSQUARE=1;YSQUARE=1
PT1=1.;RT1=1.;YT1=1.
PT2=2.;RT2=2.;YT2=2.
PT3=3.;RT3=3.;YT3=3.
PA1=1.;RA1=1;YA1=25.
PA2=1.;RA2=1;YA2=25.
TST
RUNTST=1
TSW1ID(76)=10
IDSVAL(76)=0
IDSVAL(332)=1
TSTIDS(76)=1
TSTIDS(332)=1
TSTIDS(42)=1;IDSVAL(42)=1
TSTIDS(1)=1;IDSVAL(1)=1;IDSVAL(1)=0
CON;N
DUMP
ALL;DUMP
OP
REFRESH
RST
```

Real time

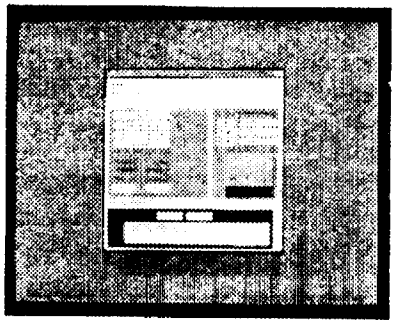
Simulator activation

- Starts simulator
- Runs script
- Performs test



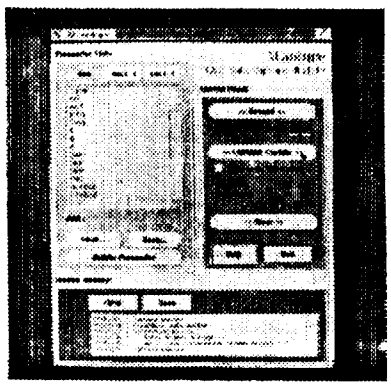
XLRC activation

- Controls high capacity history recording



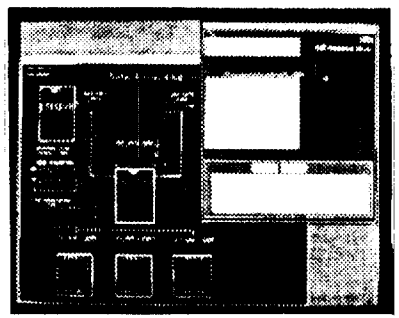
XCapture

- Simpler data recording utility



XMonitoring

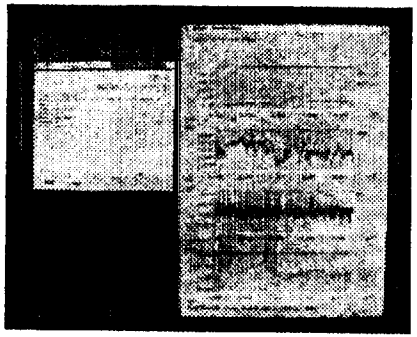
- Data monitoring



Posttest

XPlot

- Provides time history and frequency response plots



XLRC Description

CAST Local Recording Capability Utility

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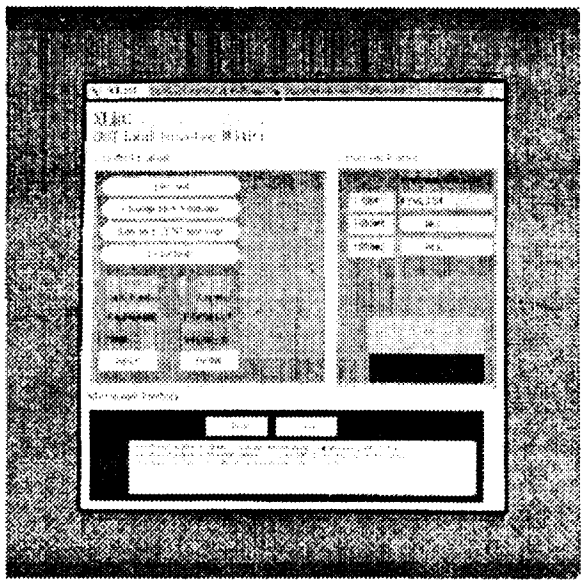

- Provides controls for the high capacity history recording process
- X-window interface from a workstation
- Builds history files
- Records all data time tagged

XMon Description
CAST Data Monitoring Utility

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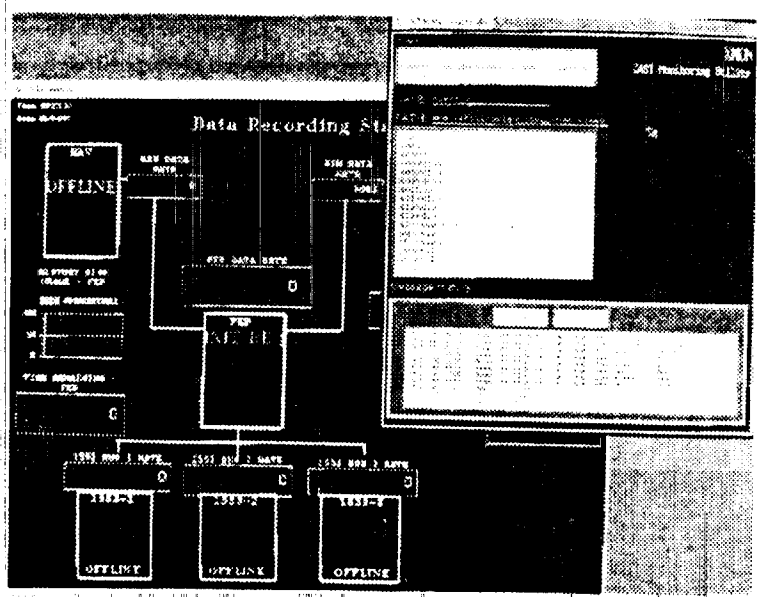

- Provides user definable and select-able display outputs
- X-window interface from a workstation
- Integrated with DataViews™ to provide a multitude of graph and plot types
- Provides realtime displays from the memory network current value tables
  - SIM and 1553 bus data
- Display change in less than 1 second

XPlot Description
CAST Data Plotting Utility

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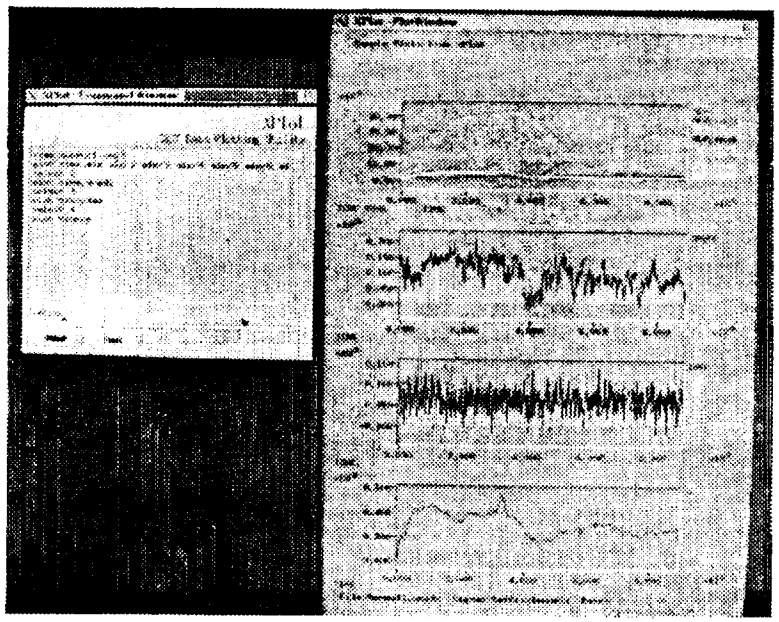

- Utility for plotting XY data
- Provide time history and frequency response plots
- X-window interface from a workstation
- Accepts standard GETDATA (Dryden common) file formats (UNC3, CMP3, ASC1)
- Generates research report compatible output

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Other CAST Tools

XCAPTURE

- Limited realtime data capture on a workstation

XAIDS

- Aircraft Interrogation & Display System
- User-definable displays

XANALYSIS

- Runs analysis applications on data collected

XGETLRC

- Retrieves history data
- Thins data as required
- Generates multiple output formats (ASCII, Binary, etc.)

XARCHIVE

- Archives network files (compressed, encrypted, etc..)

Auto Test Programs

- Automate all CAST tools

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ITF System Video

- 5 Minute video of how the CAST tools are used in the ITF.
  - sim cockpit and scripts
  - aircraft in test
  - CAST tools in use
- This test took 1 hour versus 1 day without the ITF System.
- Parallel test functions are shown serially on the video.

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Concluding Remarks

- Systems built around an OPEN architecture.
  (Vendor independence, modularity, portability, connectivity)
- Provides a common "look and feel" to the user.
- Provides the ability to interface to DISSIMILAR systems in REAL-TIME.
- Portable to other facilities.
  - Dryden flight control rooms
  - National Aerospace Plane contractors chose Dryden approach as their standard for data collection and reduction.
- Expandable to FUTURE flight research programs.
  - Interface of generic system requires ~ 1/2 workyear.

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Concluding Remarks
(cont)

"Highly interactive systems => measured productivity improvements"

- Measured productivity improvements:

	BEFORE	NOW
X-29 Frequency Response Tests	8 hours	2 hours
X-29 End to End System Test	8 Weeks	3 Weeks
F-18 SIM Check Cases	2 1/2 Days	4 Hours

- Our estimate: Overall test time reduced by a factor of 3

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