DIGITAL AVIONICS

A CORNERSTONE OF AVIATION

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Presented to the NASA Formal Methods Workshop

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INTRODUCTION: Avionics Roles

Digital Avionics - A Cornerstone of Aviation

- Communication
  - HF and VHF
- Satellite
- Data Links
- Navigation
- Ground-based systems
- Inertial and satellite-based systems
- Goal: Autonomous operation!!!
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INTRODUCTION

CURRENT EXAMPLES

CURRENT ISSUES

FUTURE TRENDS

INTERNATIONAL SCENE

SUMMARY
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INTRODUCTION: Avionics Roles

- Fly-by-wire flight controls
  - Historically used for stability & control augmentation
  - Not flight critical

- Emerging as a flight critical system
  - Driven by performance and economic demands
  - F-16, A-320, B-777
TOTAL ON BOARD COMPUTER CAPACITY (OFP)
TRENDS IN AVIONICS ABOARD FIGHTER/ATTACK AIRCRAFT

![Graph showing trends in avionics aboard fighter/attack aircraft over time. The x-axis represents years from 1940 to 1990, and the y-axis represents weight as a percentage of A/C empty weight.]
F-16 AVIONICS SYSTEM ARCHITECTURE

- Engine
- Global Positioning System
- Data Transfer Unit
- Combined Altitude Radar Altimeter
- Central Air Data Computer

- Up-Front Controls
- Crash-Survivable Flight Data Recorder
- Inertial Navigation System

- Hard Points
- Advanced Self-Protection Jammer
- Advanced Interference Blanker Unit
- Advanced IFF System
- Fire Control Radar (APG-68)
- Digital Flight Control Computer

- Stores Mgmt.
- System Central Interface Unit
- Fire Control Computer
- Store Stations
- Chart/Flare Dispenser (ALE-47)
- Advanced Radar Warning Receiver

- Programmable Display Generator
- Head-Up Display Electronic Unit
- Multi-Function Displays
- Head-Up Display

- AMUX (1553)
- BMUX (1553)
- DMUX (1553)
- WMUX (1553)
- Remote Interface Units
F-16 AVIONICS SYSTEM ARCHITECTURE

Engine  Global Positioning System  Data Transfer Unit  Combined Altitude Radar Altimeter  Central Air Data Computer

AMUX (1553)

Up-Front Controls  Crash-Survivable Flight Data Recorder  Inertial Navigation System

Hard Points  Advanced Self-Protection Jammer  Advanced Interference Blanker Unit  Advanced IFF System  Fire Control Radar (APG-68)  Digital Flight Control Computer

BMUX (1553)

Store Stations  Chaff/Flare Dispenser (ALE-47)  Advanced Radar Warning Receiver

DMUX (1553)

Programmable Display Generator  Head-Up Display Electronic Unit

Multi-Function Displays  Head-Up Display

WMUX (1553)

Stores Mgmt. System Central Interface Unit  Fire Control Computer

Remote Interface Units
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CURRENT EXAMPLES: A-320

2 Elevator Aileron Computers 3 Spoiler Elevator Computers 2 Flight Augmentation Computer

Electronic Flight Control System Architecture
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CURRENT EXAMPLES: A-320

**Diagram Description:**
- **Autopilot yaw commands** to **ELAC**
- **ELAC** to **Rudder pedals**
- **FACs** with inputs from **Autopilot yaw commands** and **Rudder trim**
  - **Travel limitation** to **Mech. stop**
  - **Yaw damper** to **G, Y, B**
  - **Rudder trim**
  - **Artificial feel** to **Hydraulic actuators**

**Legend:**
- **M** Motor actuator
- **FAC** Flight augmentation computer

**Hydraulic Systems:**
- **B** Blue system
- **G** Green system
- **Y** Yellow system

**Legend:**
- **Rudder**

**Title:**
- **Yaw Control**
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CURRENT EXAMPLES: A-320

<table>
<thead>
<tr>
<th>M</th>
<th>Motor actuator</th>
<th>Hydraulic</th>
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<tbody>
<tr>
<td>FAC</td>
<td>Flight augmentation computer</td>
<td>B  Blue system</td>
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<tr>
<td></td>
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<td>G  Green system</td>
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<td>Y  Yellow system</td>
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Yaw Control
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CURRENT ISSUES: Hardware

- Modeling of complex systems
  - Proof of fault tolerance, high reliability

- Electromagnetic interference
  - Growing concern due to composite aircraft, increased emission of RF, and smaller electronic element sizes
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FUTURE TRENDS: PAVE PILLAR
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CURRENT ISSUES: Software

- Developing competency in Ada
  - Mandated for DoD, Space Station Freedom, civil transports

- Computer-Aided Software Engineering (CASE) Tools
  - Capabilities for real-time software analysis & design
  - Tool validation
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FUTURE TRENDS: Supporting Technologies

- Flat panel, full color, liquid crystal displays
- Replacing CRTs
- Advanced formats; not electronic steam gauges
- Higher speed data buses
- Artificial intelligence pioneer programs
  - Faultfinder
  - Diverter
  - Pilot's Associate
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INTERNATIONAL SCENE: Japan

- An emerging competitor in the world market

- Historically has been component oriented: displays, microprocessors, etc.

- Lack system design and analysis, & software capabilities
  - FS-X program will help to build a foundation for military & civil avionics

- MITI has established a committee to define an avionics technology development plan
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SUMMARY

- Continually expanding role for avionics
- Flight critical avionics are here
- Strong emphasis on Ada
- Module-based architectures emerging
- Artificial intelligence applications being developed
- Significant competitive threat to U.S. firms from Europe & Japan