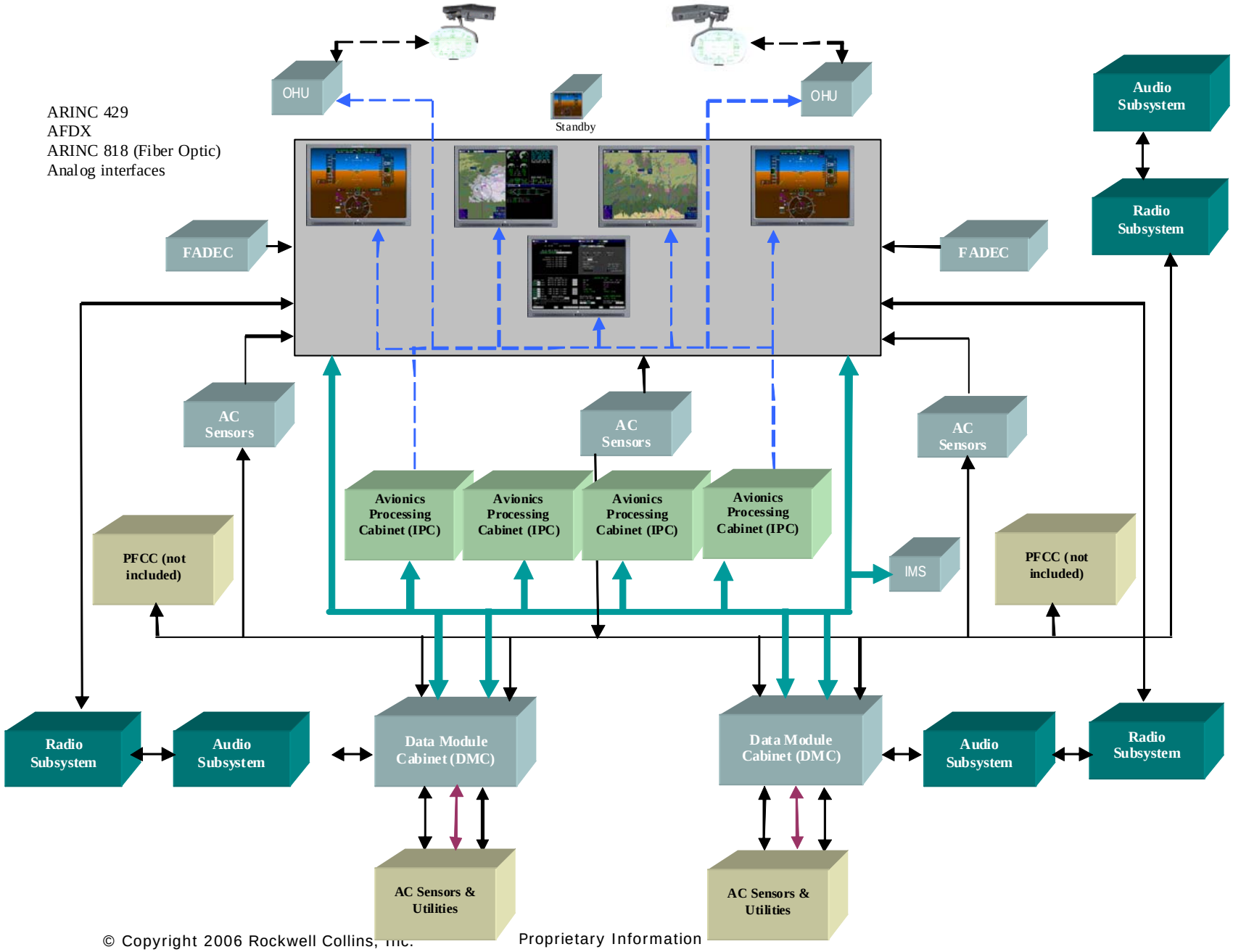
MC-21 Program
Technical Discussion

July 24, 2009

Rockwell Collins

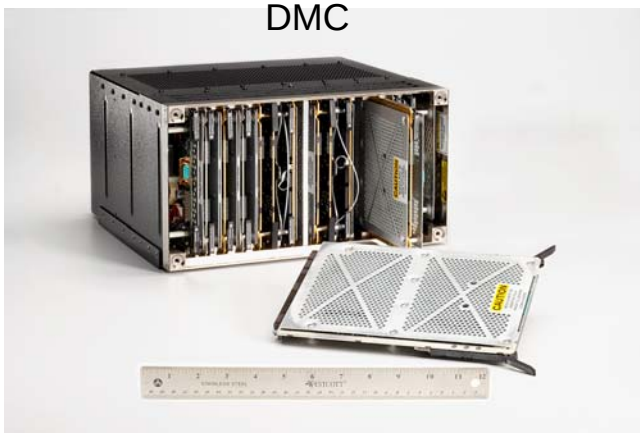
ARINC 429
AFDX
ARINC 818 (Fiber Optic)
Analog interfaces

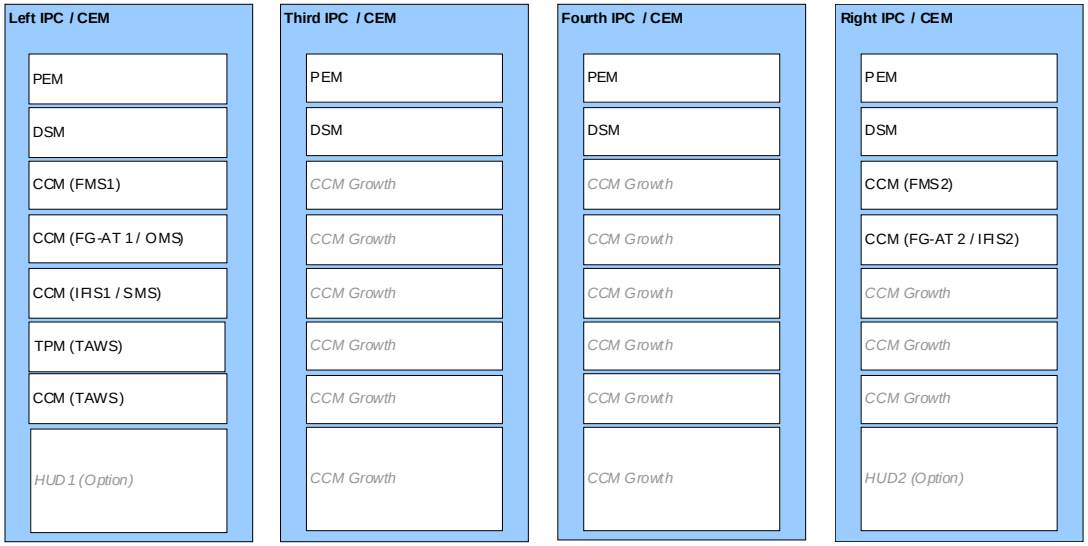


IMA Cabinet

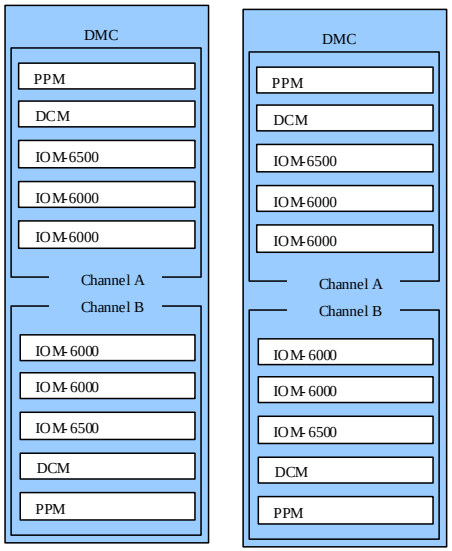
- Data concentrator Module Cabinet provides the I/O concentration for the system
  - Consists of two channels physically partitioned, each channel having its own set of modules
  - ARINC 429, Analog, discrete, and AFDX

DMC





IPC



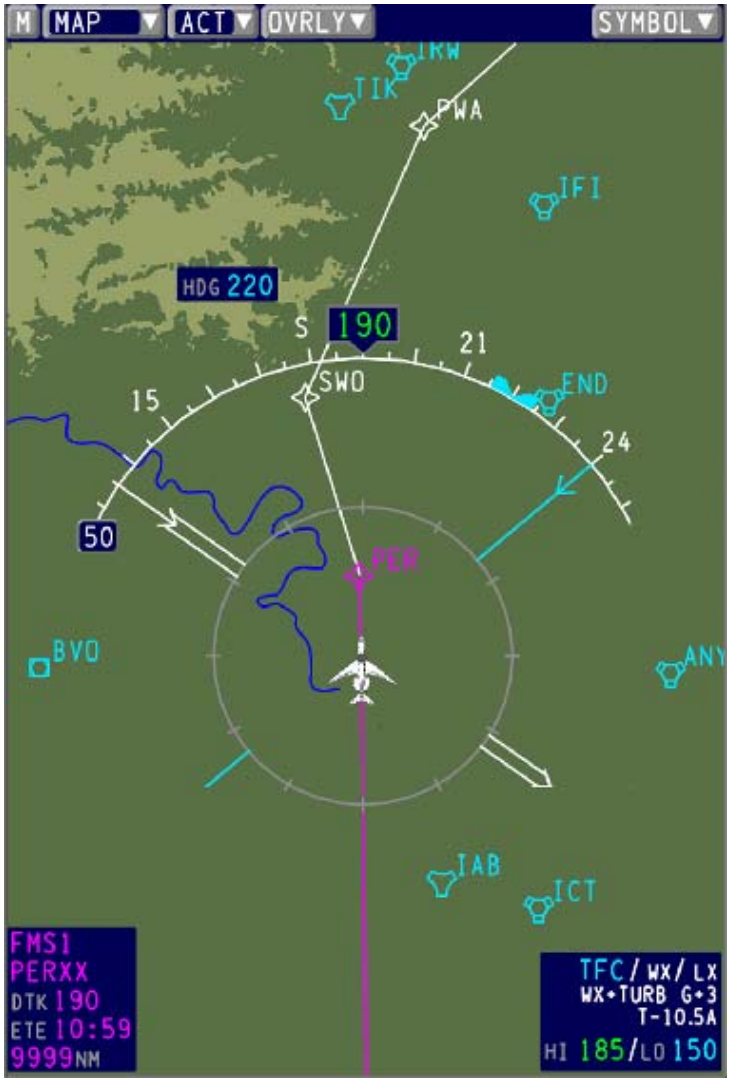
DMC

Integrated Processing System - Overview

- Foundation modules are modules that have been developed for the IPS infrastructure
  - Foundation modules include:
    - Common Computing Module (CCM)
    - Digital Switching Module (DSM)
    - Power and Environment Module (PEM)
- Two different types of cabinet are used in the IPS architecture; the common computing cabinet and the situational awareness cabinet
  - The common computing cabinet provides:
    - Power/cooling
    - Common computing modules
    - A local area network
      - Allowing communication between LRMs/LRUs inside or outside the cabinet
  - The situation awareness cabinet provides:
    - Power/cooling
    - Common computing modules
    - A local area network
    - Specialized interfaces to host peripheral modules
      - (i.e. Terrain Awareness Warning System, Synthetic Vision System)

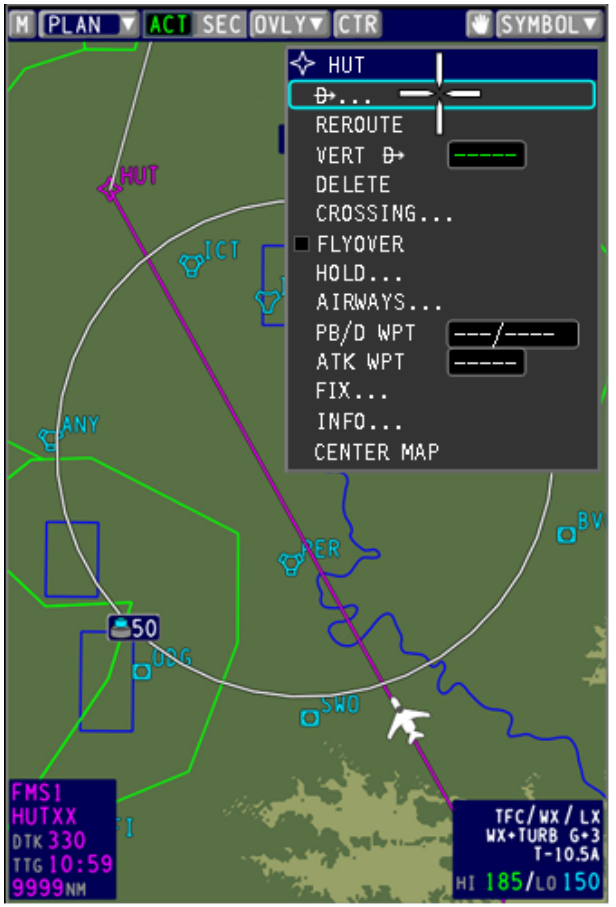
Flight Management System

- Totally Integrated within the Flight Deck
  - Full function 3D Navigation
    - Coupled LNAV
    - Coupled VNAV
    - FMS Automated Speed Command
  - Aircraft-Specific Performance Management
    - Time and Fuel Management
    - Take-Off and Landing Performance
  - Eyes forward presentation
    - Primary Flight Guidance
    - Graphical Flight Planning
    - Vertical Situation Display (VSD)
- Leading the way in Flight Deck transformation for CNS/ATM
  - Multi-Sensor RNAV
  - SBAS Operations
  - LPV Approach
  - RNP AR



Flight Management System (cont.)

- Flexible, Redundant Input Controls
  - Track Ball CCP provides free cursor control, ideal for graphical flight planning
  - MKP provides alpha-numeric and tabbed cursor control
    - Similar to traditional CDU interface
- Market Leading Graphical Flight Planning Features
  - Insert or delete waypoints, procedures, or airway routes
  - Quick re-route
  - Perform lateral or vertical direct-to and course intercept
  - Modify speed, altitude, RNP, or RTA at any waypoint
  - Create pilot defined waypoints and up to 10 fixes
  - Define holding patterns
- Define temperature compensation for VNAV approaches
  - Define fly-over points
  - Graphically tune navaids and air route traffic control center frequencies
  - Define a parallel offset
  - Perform a vectors to approach transition
  - Define VNAV descent path

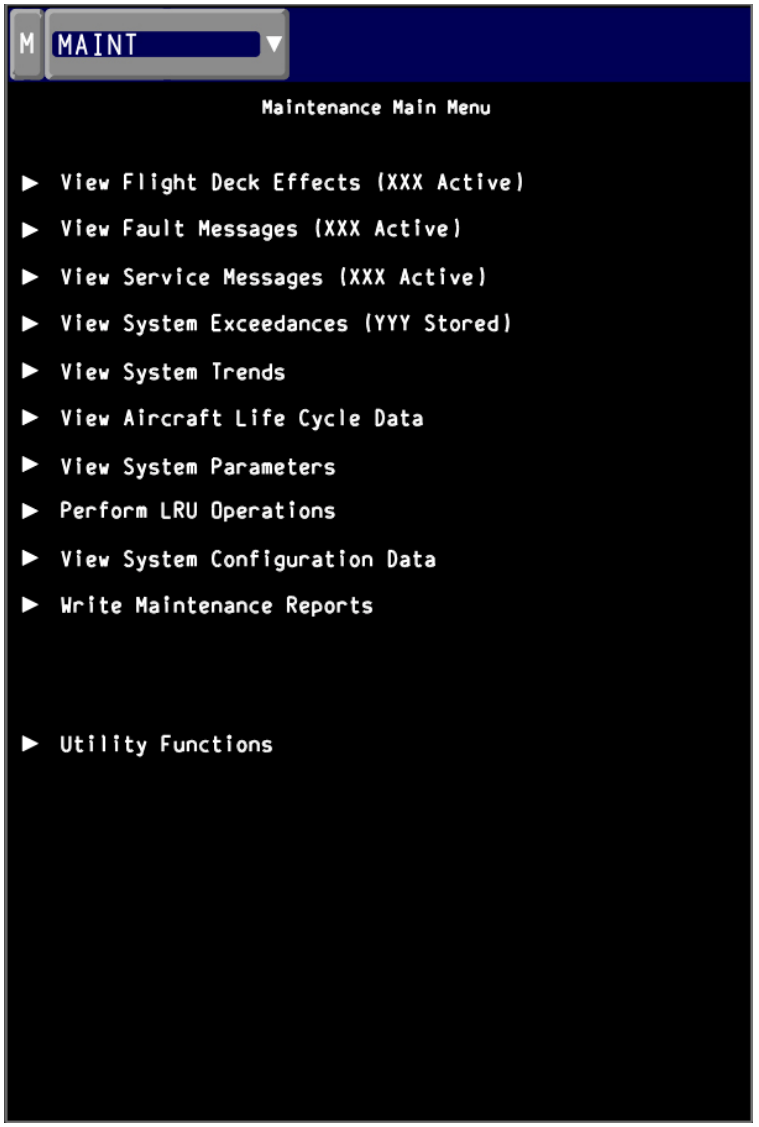


Flight Management System

- Integrated CDU (ICDU)
  - ICDU normally presented on lower display
  - Provides a quick and clean way to program the FMS
  - Increases operational efficiency by using 11 ICDU pages that contain the same amount of information that had traditionally been provided on 80+ CDU pages
  - Logically groups data by flight phase and function

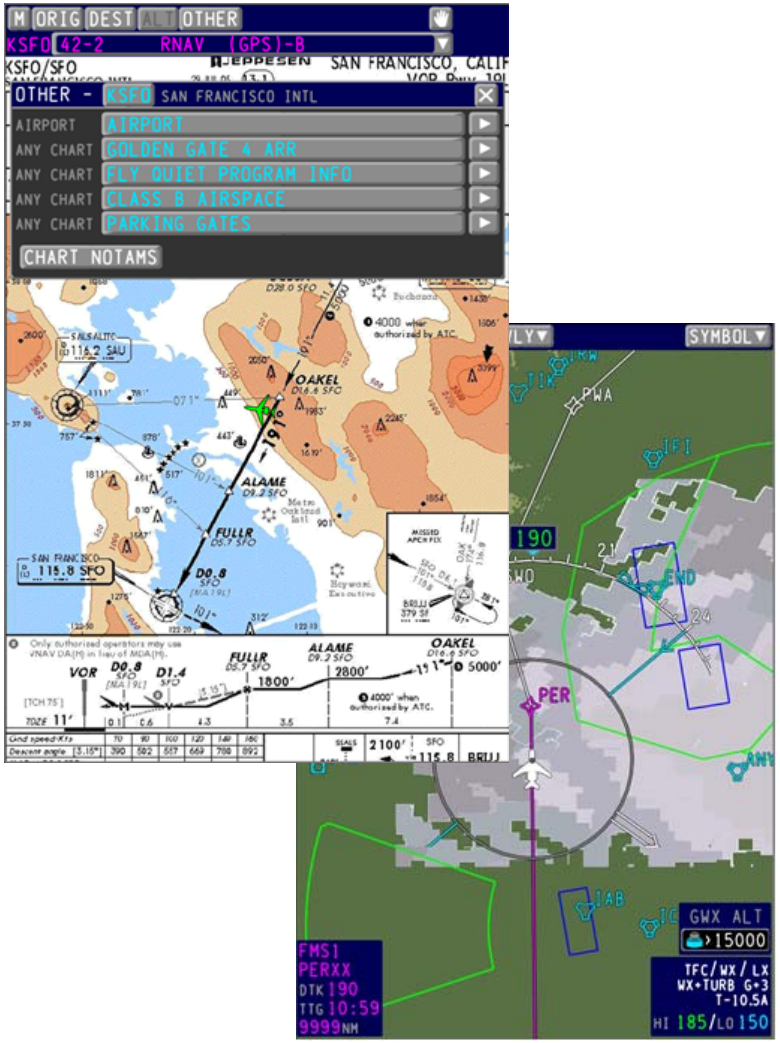
Onboard Maintenance System

- OMS application hosted in IPC
- Active Fault Monitoring
- Fault History
- Service Messages
- Life Cycle Data
- Test and Rigging functions
- Onboard Data Reader enables troubleshooting without tools
- Aircraft system trend and exceedance monitoring
- Download OMS data from aircraft for analysis and history via data link or IMS
- System Configuration Data
- Onboard Data Loading



Integrated Flight Information System

- Integrated Electronic Charts
  - ChartLink™ automated user interface
  - Departure Charts
  - Arrival Charts
  - Approach Charts
  - Airport Charts
- Enhanced Maps
  - Controlled and Special Use Airspace
  - Political Boundaries
  - Oceans and Detailed Inland Water
- Graphical Weather Products
  - Data Link Weather



Baseline Operational Philosophy Overview

Control Ergonomics and Spatial Consistency

- Controls appropriate for the size of an airline aircraft cockpit and for the rigor of airline timetables
  - Robust, ergonomically designed controls that provide direct access to the functions that the flight crew uses during high work load phases of flight
- Minimize unnecessary pilot activity though cursor and keyboard control

Prudent Use of Automation:

- Automation to reduce pilot workload, especially during critical phases of flight
  - Prudently applied to ensure pilot cognizance of system state
- Automation implemented as a tool to aid and never to hinder normal pilot procedures or decision making processes

Error Prevention:

- Interfaces designed to prevent flight crew mistakes by limiting entry values to valid ranges, segregating controls and requiring crew confirmation before entries become active.

Baseline Operational Philosophy Overview (Cont)

Extensive Situational Awareness:

- Awareness of the operating parameters of the aircraft and the aircraft's surroundings are critical to flight safety
- The display of EICAS and synoptic images provide the flight crew with an easily interpreted, graphic-rich display of all systems statuses
- The electronic charting system provides the flight crew with a large, heads-forward view of the current procedure being flown
- The Synthetic Vision System (SVS) depicts terrain, obstacles and the landing runway on a full screen flight display, giving the flight crew a clear image of the operating environment during all operations, including night and IFR conditions.

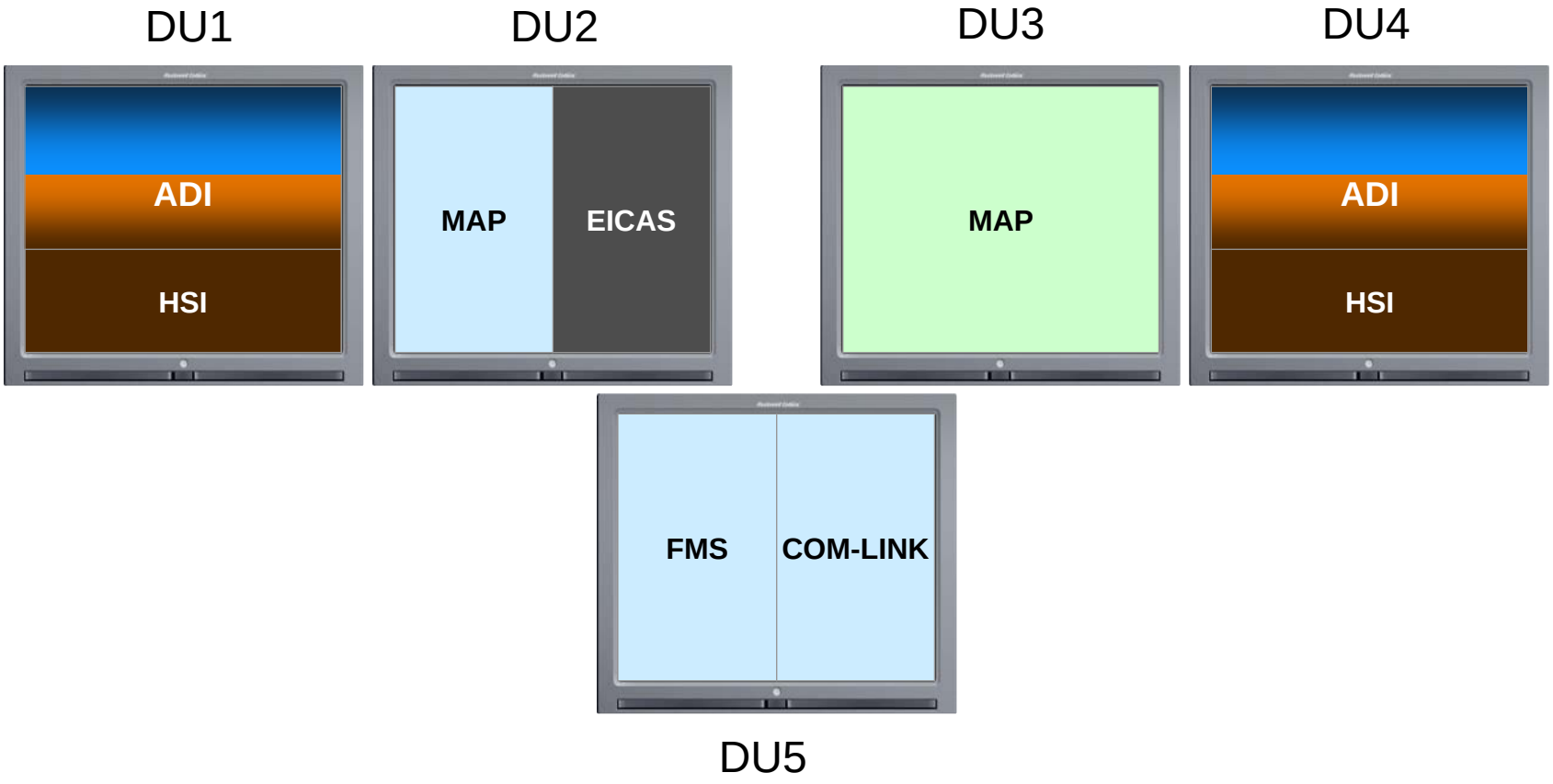
Error Prevention:

- Interfaces designed to prevent flight crew mistakes by limiting entry values to valid ranges, segregating controls and requiring crew confirmation before entries become active.

Common Display Symbology Sets:

- Wherever possible, Rockwell Collins designs utilize common failure annunciations, color philosophies, data presentation formats, data flashing philosophies, engine indications and information priorities.

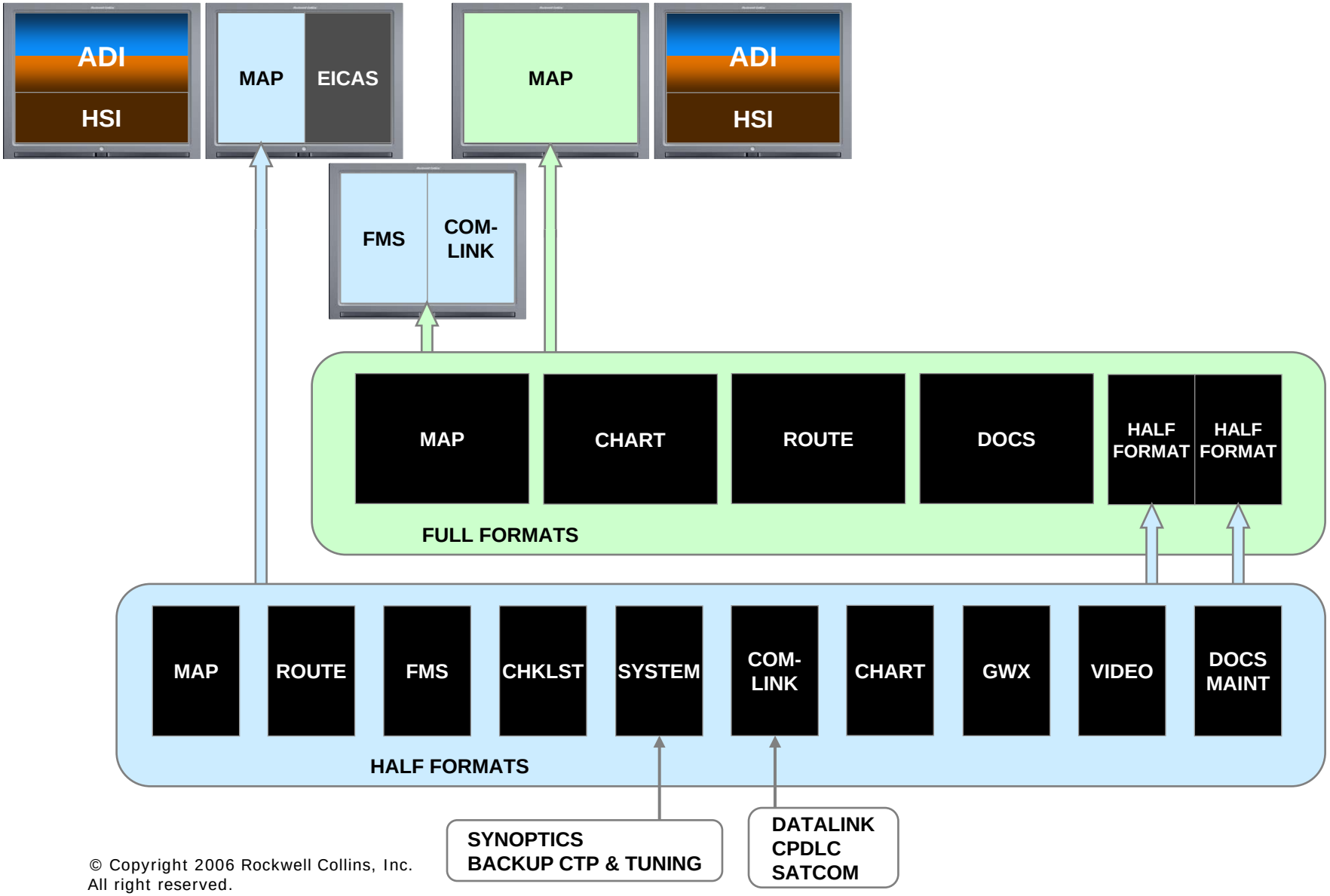
Baseline Flight Deck Layout



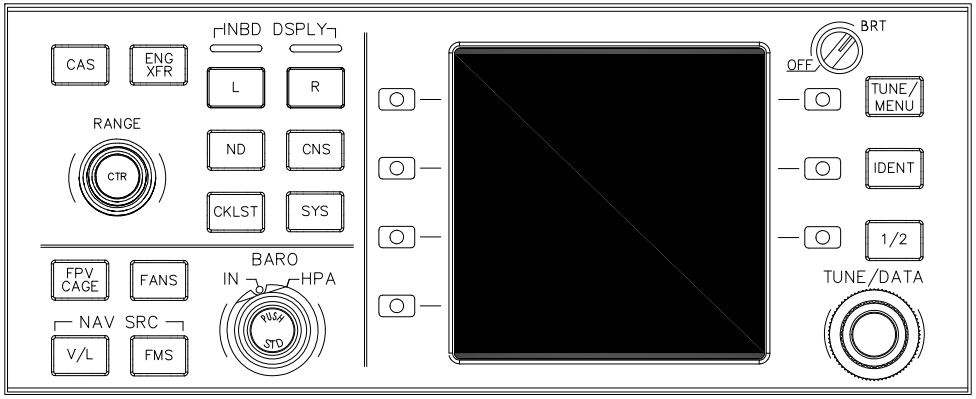
Glareshield

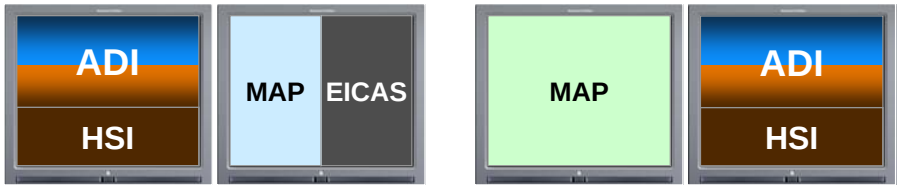
Aisle Stand

Display Format Flexibility Example



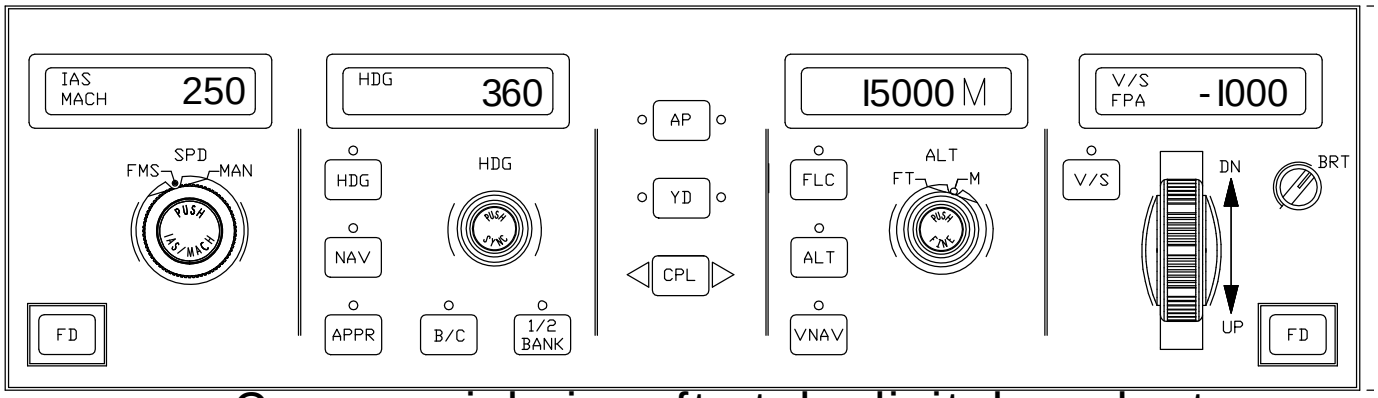
Control Tuning Panel (CTP)





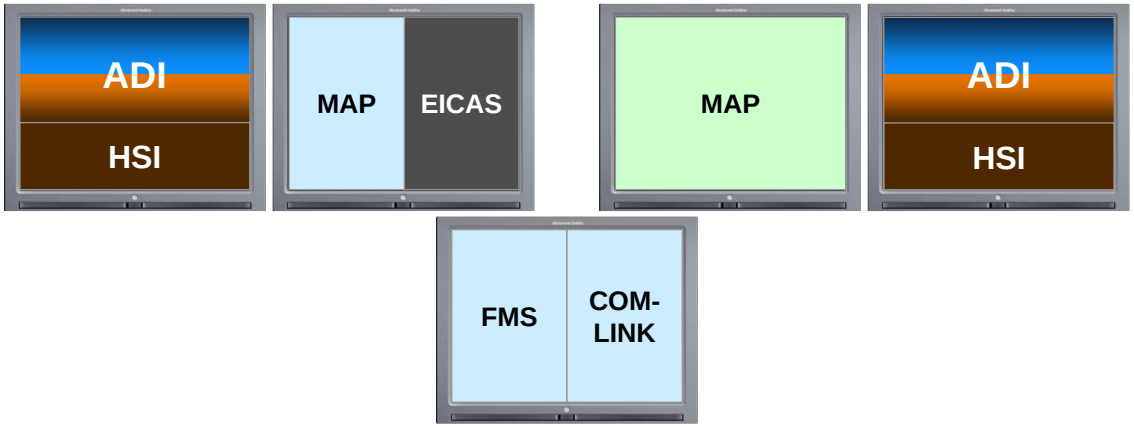
- Glareshield controls co-located for PFD, ND and EICAS
  - Direct Access Buttons
    - CAS Paging
    - EICAS transfer
    - Format Selection
      - Map, DU Radio Tuning, Checklist, System
    - Range Control
    - FPV CAGE control
    - FANS CPDLC inbox
    - NAV Source Control
    - Baro Control
    - Radio tuning - near full time display and control
  - Menu Controls
    - Manual Weather Radar Control
    - Minimums (BARO / RA)
    - Bearing Pointers
    - Selected Course
    - HUD Control
    - Standby NAV Page

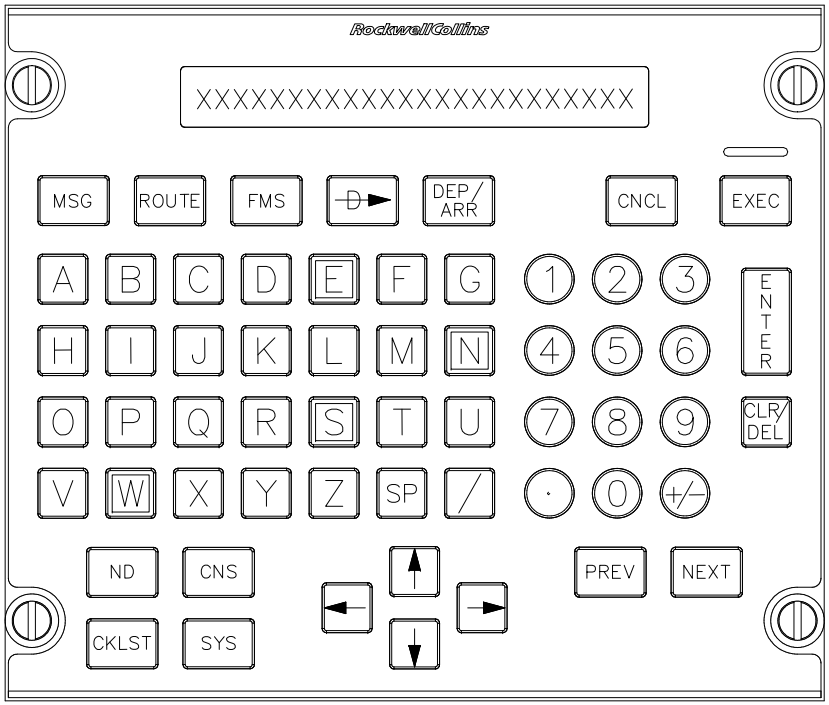
Flight Control Panel (FCP)



- Commercial aircraft style digital readouts
- FMS / MAN speed control
- Lateral mode control
  - HDG, NAV, APPR, (B/C), ½ BANK
- AP engage/ YD engage / CPL switch
- Vertical mode control
  - FLC, ALT, VNAV
- ALT pre-selector settings and mode control
- V/S / FPA selection and control
- FD selection / deselection

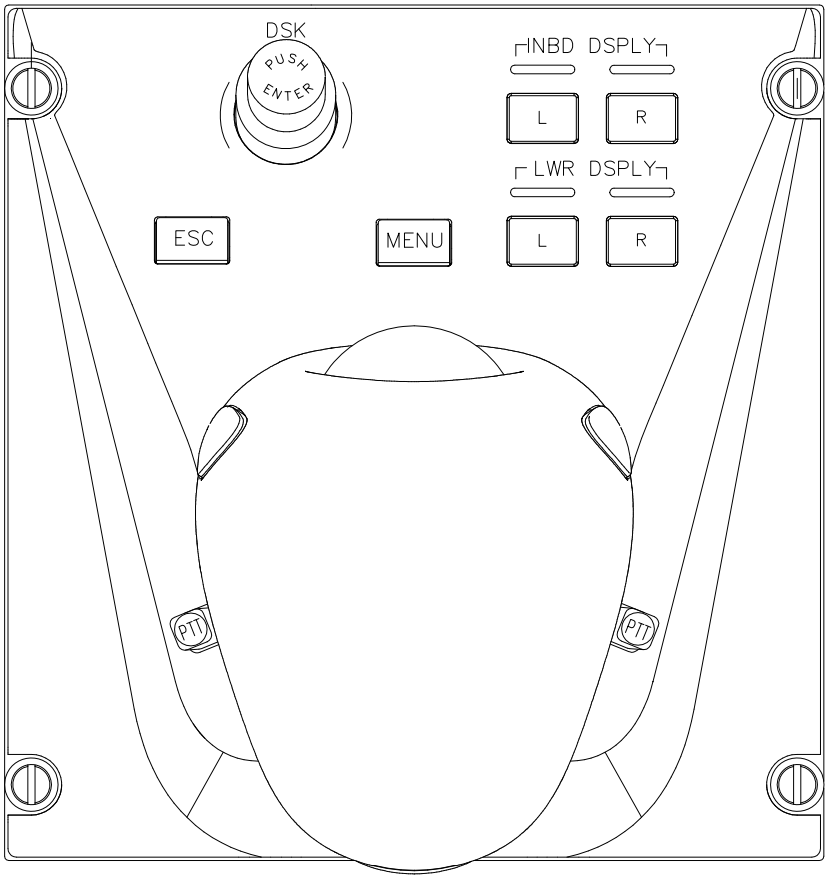
Multifunction Keyboard Panel (MKP)





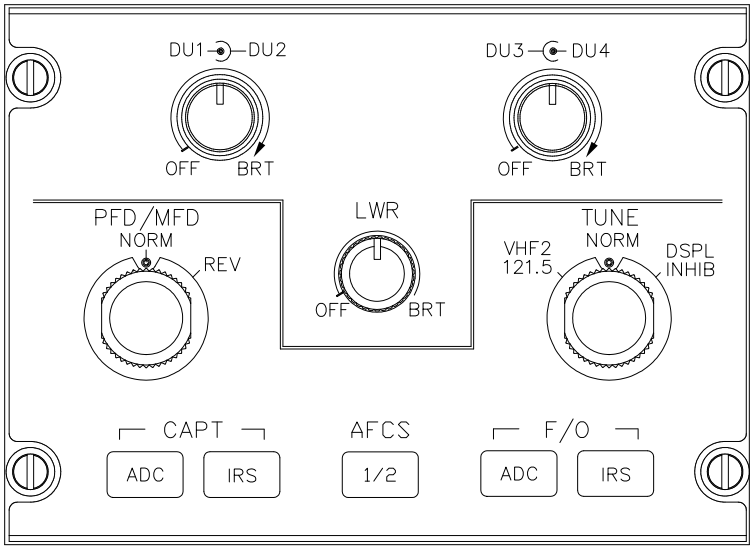
- **Features / Functions**
  - Incorporated FMS buttons
    - MSG
    - ROUTE
    - DEP/ARR
  - Format control for lower on-side DU
  - Alpha-numeric entry
  - Arrow keys backup cursor control
  - 24 character scratchpad

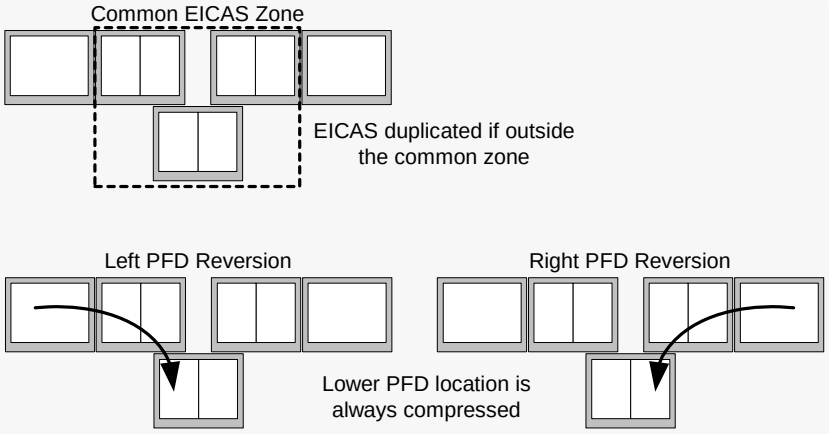
Cursor Control Panel (CCP)



- **Features / Functions**
  - Trackball for Cursor Movement
  - Double Stacked Knob for Data Entry, Quick Browse, and FMS Operation
  - Control for Backup CTP GUI Panels
  - Display Select Control Tailored for Intended Use, Example Assumes,
    - Shared Lower Display
    - Full Formats on Lower Display

Reversion Principles

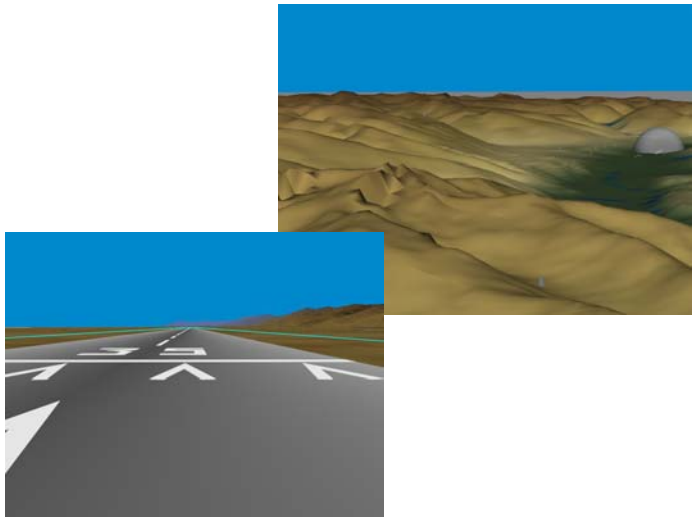


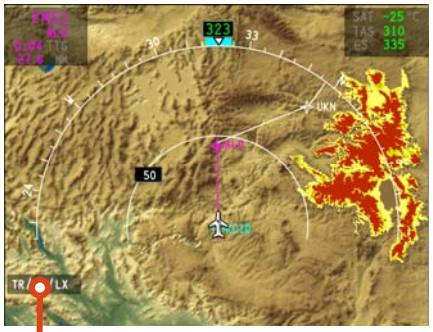


- Automatic and manual reversion
  - PFD
  - EICAS
  - Sensors
  - AFCS
- Manual reversion
  - Tuning
- Maintain normal formats with one or two display failures
- Compressed PFD with three or four display failures
- Compressed PFD on lower displays
- EICAS duplicated if outside the common EICAS zone
- PFD and EICAS remain displayed with one DU operational

Technology Excellence - Synthetic Vision Systems (SVS) and High Integrity Terrain Database

3-D Perspective View

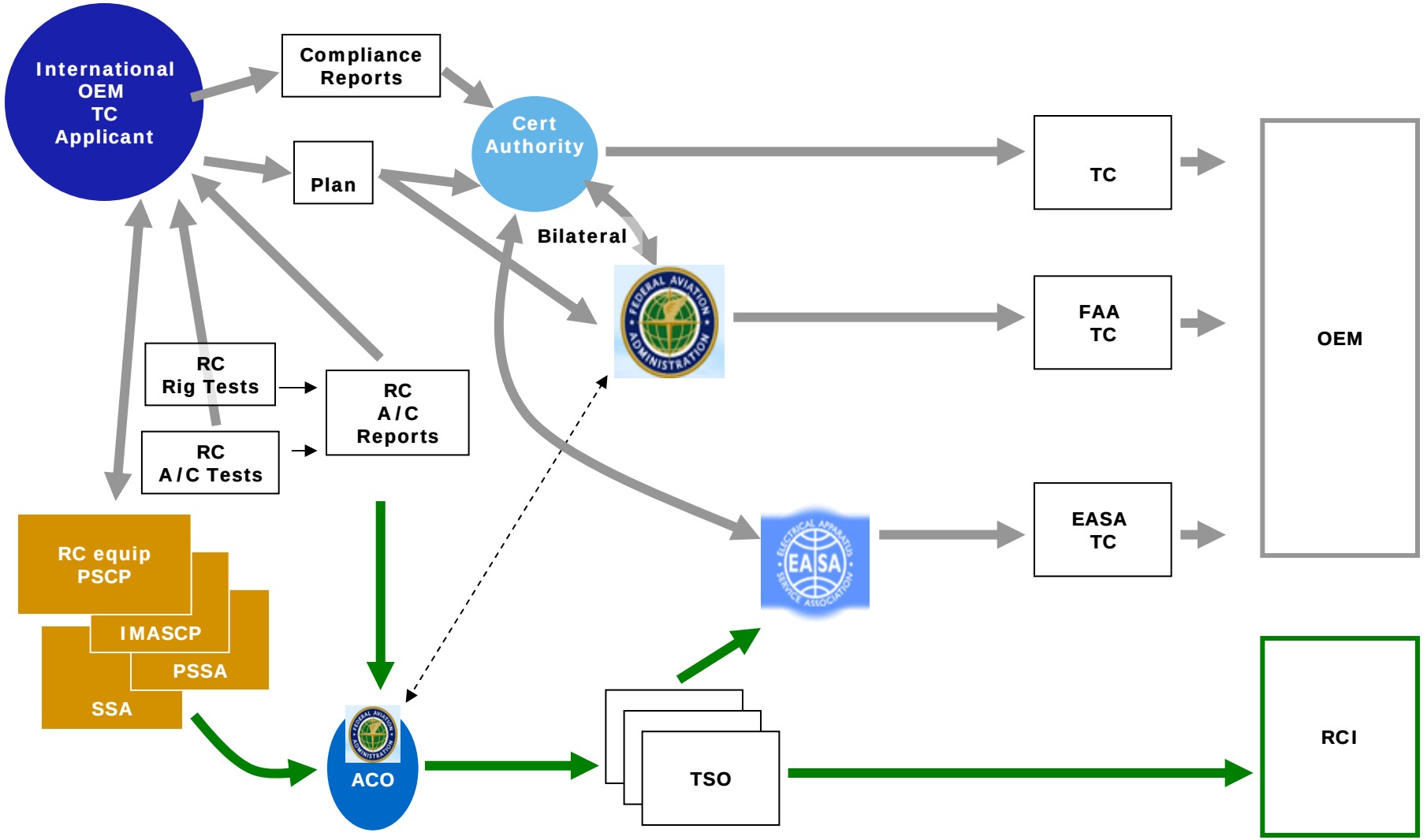




2-D Top-Down View

IMA Regulatory Environment Overview

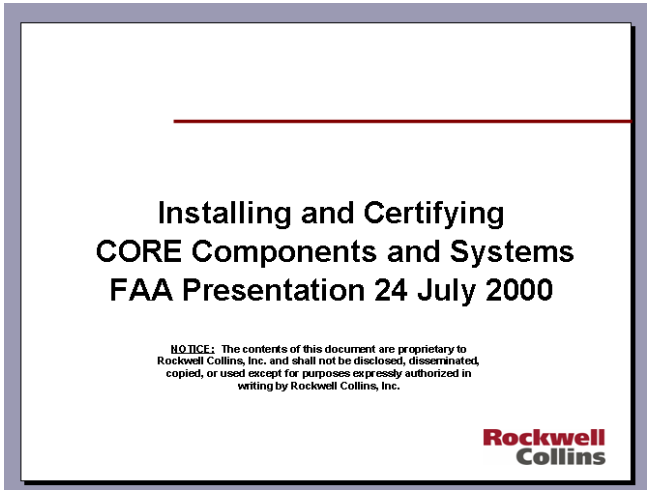
Rockwell Collins



Rockwell Collins Involvement with FAA in IMA Development

- Rockwell Collins has been working with the FAA through the Partnership for safety program since 2000
- The foundation for our architecture has been the level a design assurance process
- Rockwell Collins a strong partner with the FAA through programs and industry committees such ARAC FAA/JAA/

  EASA harmonization, RTCA, ARINC groups
- RC is very aware and attentive with respect to regulatory trends and experiences in industry
- This has been a long engagement to ensure that our systems are designed to be compliant


Installing and Certifying
CORE Components and Systems
FAA Presentation 24 July 2000

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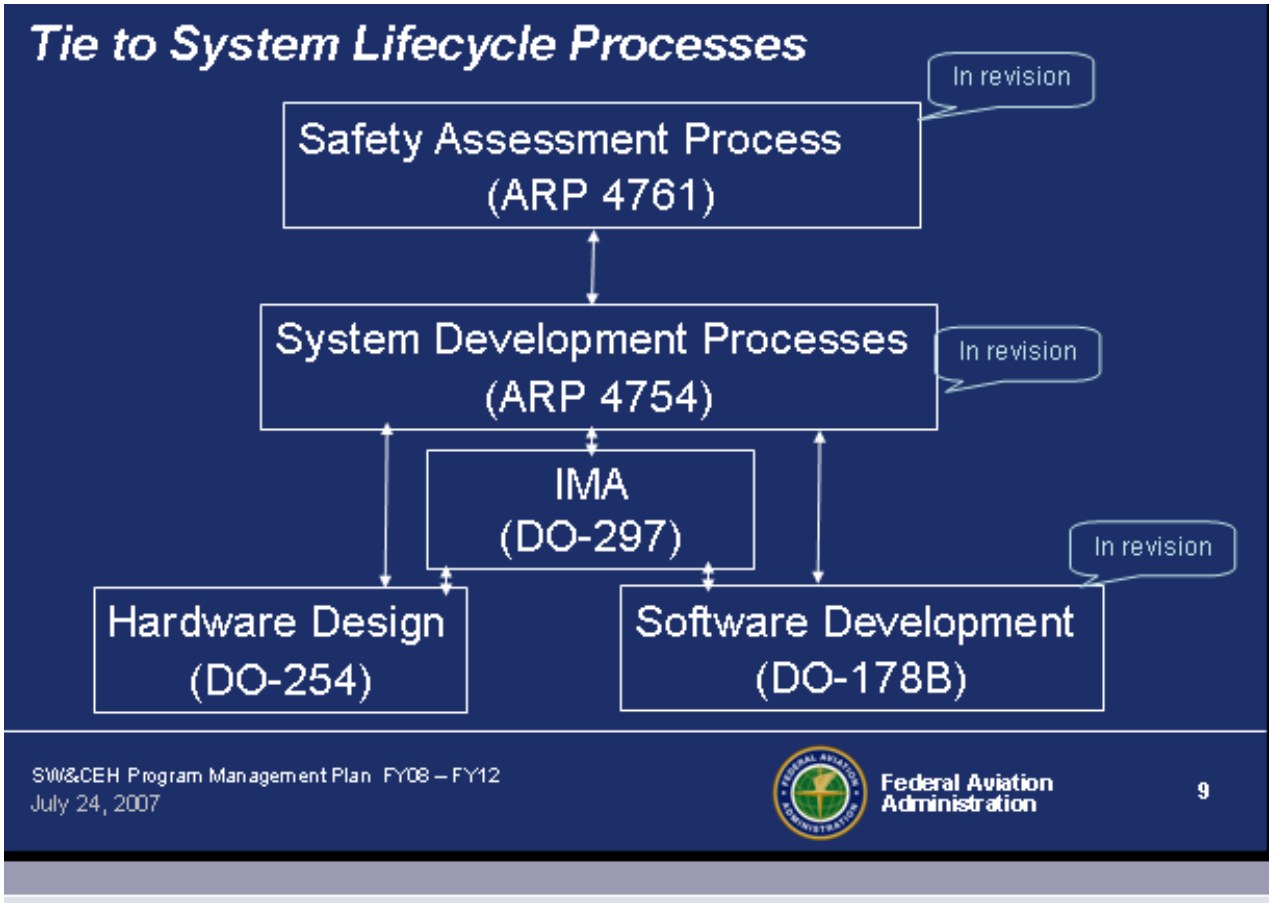
Rockwell Collins

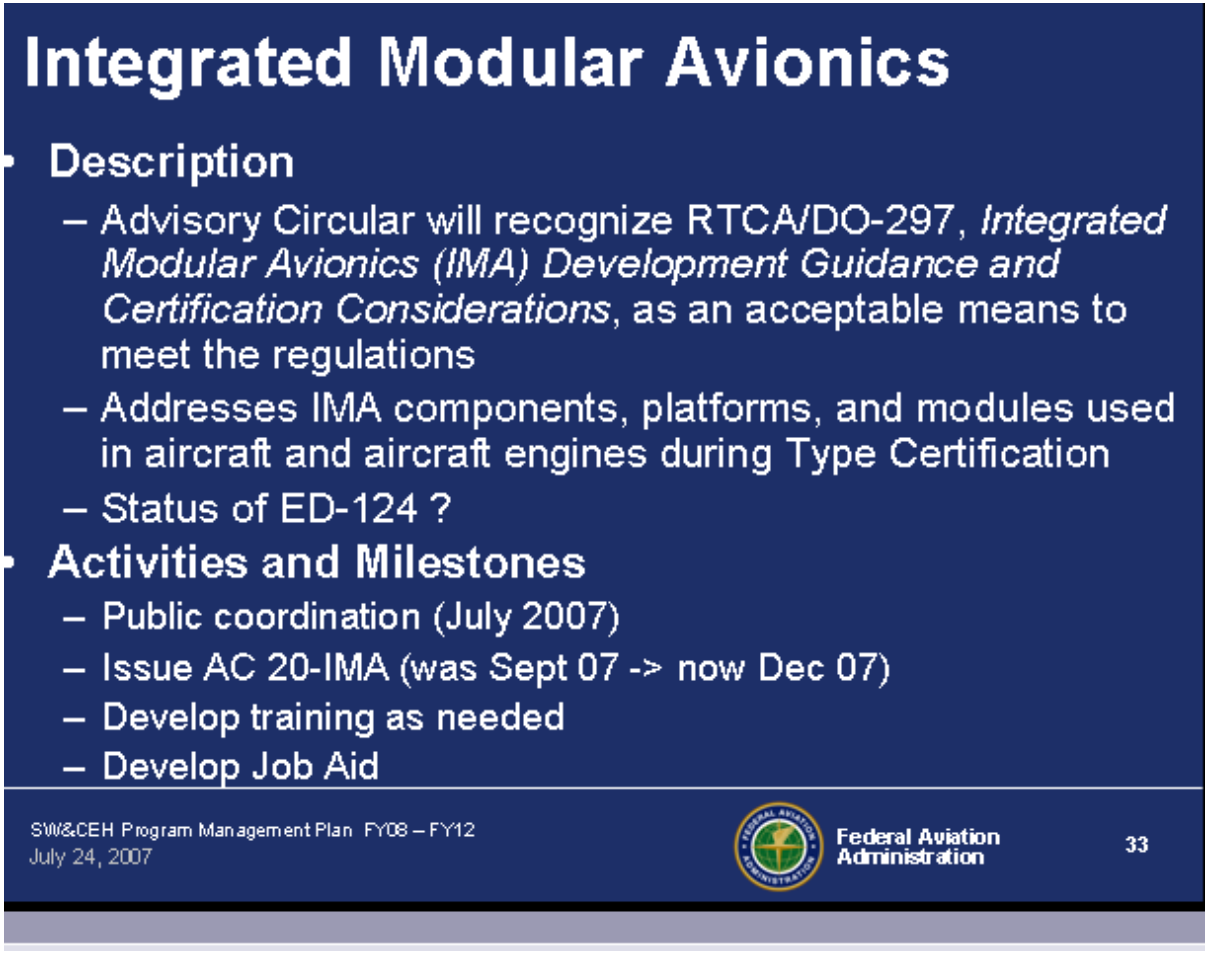

Software Challenges in Integrated Modular Avionics (IMA) System Certification

FAA SACO DER Seminar
November 4, 2003
Will Struck, FAA TAD TSS, will.struck@faa.gov

New Orleans – 2007 SW CEH Conference



FAA 2007 Presentation DO-297



Rockwell Collins System - Regulatory Foundations

AC20-145

DO-297

ARP4754

1309

ARP4761

DO-160E

DO-254

DO-178B

8110.49

TSO C153

Functional TSO

AC 20-152

Putting it all Together

- AC 20-145
- RTCA DO-297
- ARP 4754
- ARP 4761