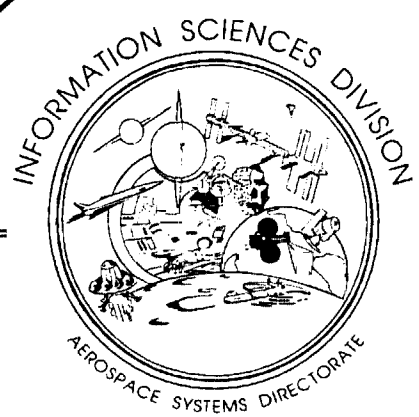
Mission Critical Technology Development

Nancy Sliwa, NASA/Ames Research Center
Intelligent Systems Technology Branch

This talk will cover specific technology developments in system reliability modeling, fault tolerance and fault diagnosis. In addition, it will present future mission control applications of optical processing.



MISSION CRITICAL TECHNOLOGY DEVELOPMENT

Nancy Sliwa, Assistant Chief
Intelligent Systems Technology Branch

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OUTLINE

- Organization/Philosophy Overview
- Fault Management Technology
- Introduction to Optical Processing

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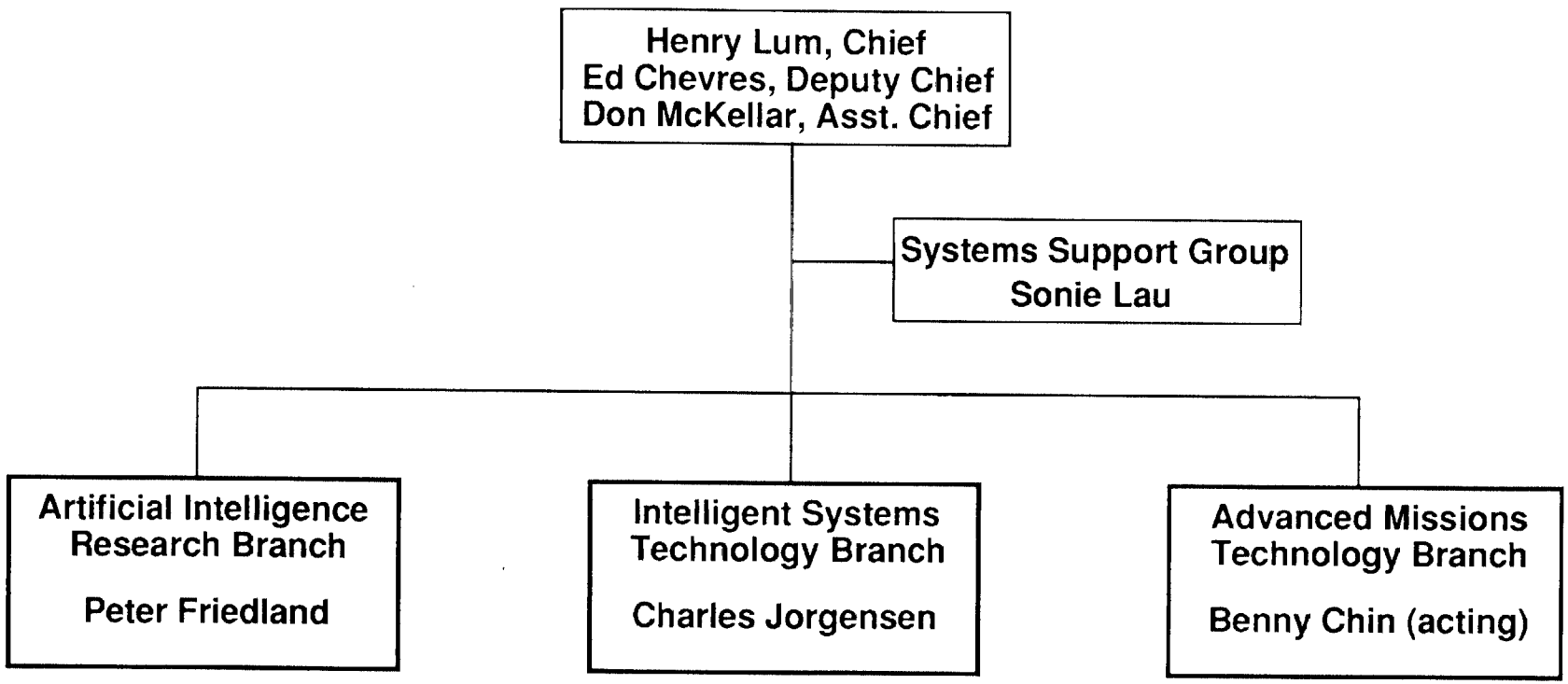
INFORMATION SCIENCES DIVISION ORGANIZATION



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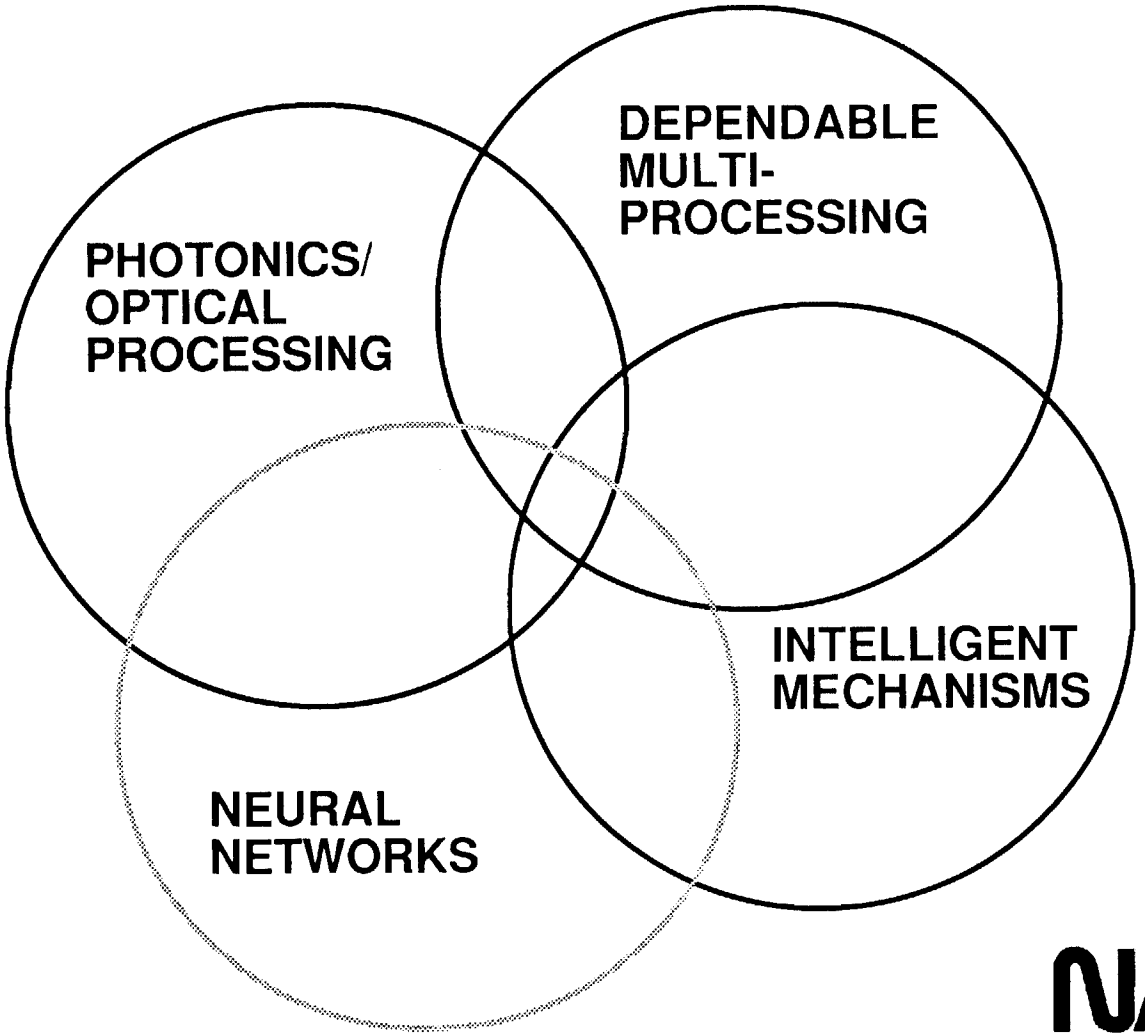
DISCIPLINES



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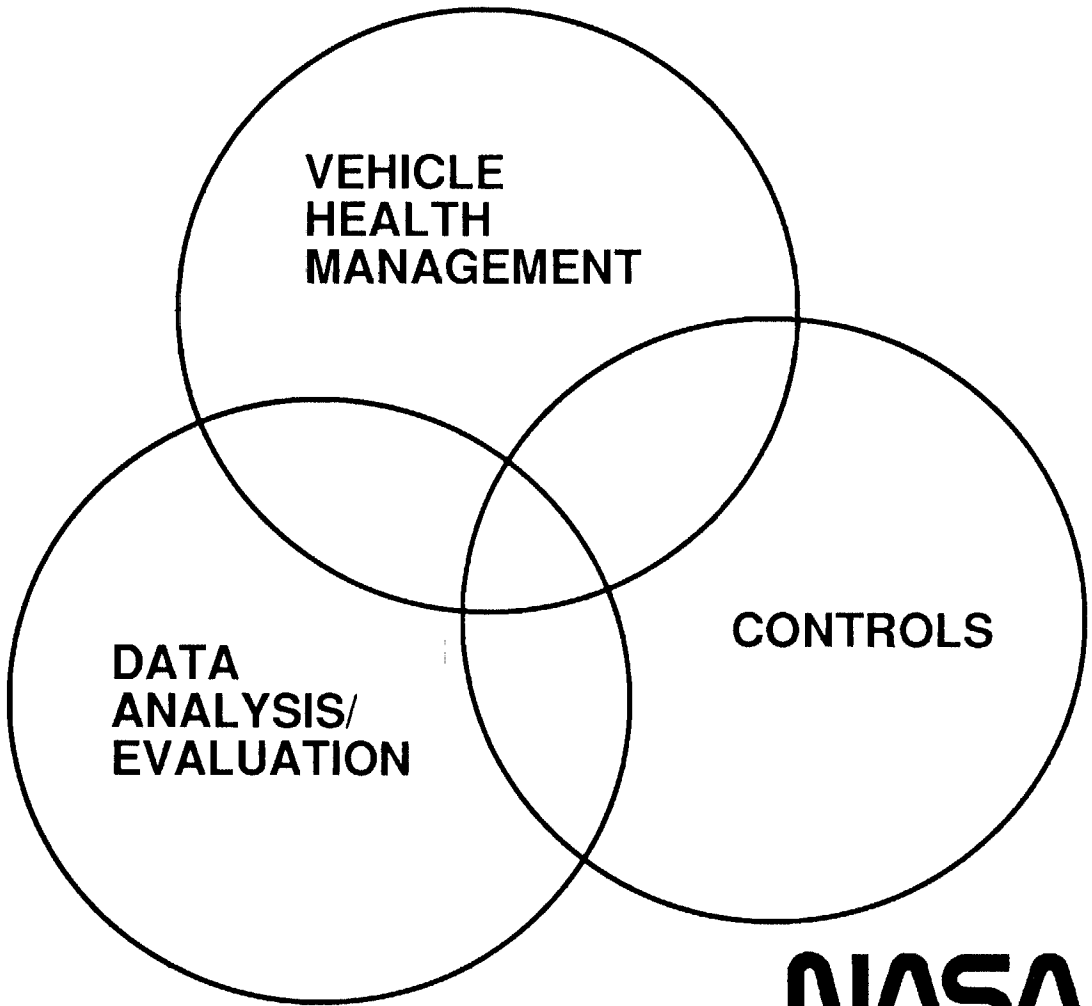
GENERAL APPLICATION AREAS



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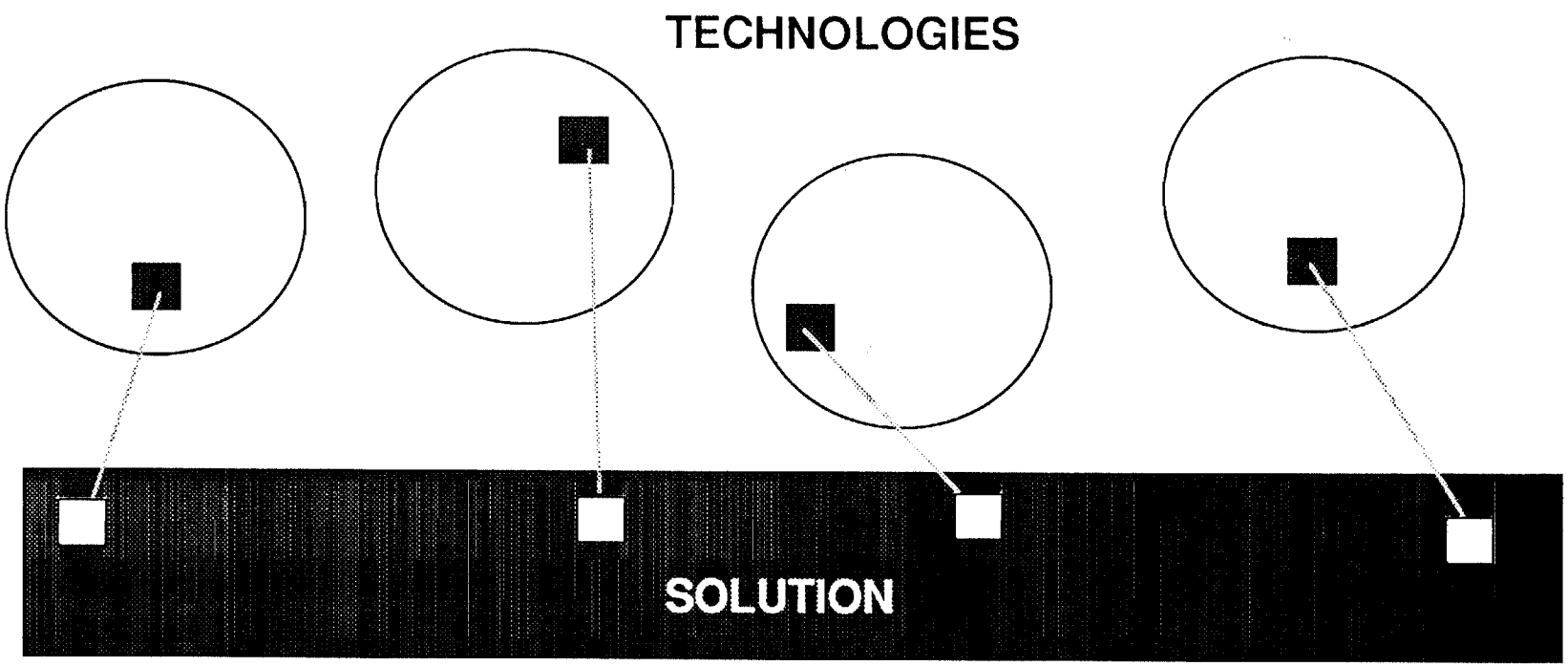
TECHNOLOGY TRANSITION

- Technology has a wide gulf to traverse to become useful operationally
  - Technology developers have solutions looking for problems
  - Project managers have problems that need a solution, the best given a number of constraints
- Project managers need to build confidence in a newer technology to minimize perceived project risk
- Technology developers need to be cognizant of full spectrum of demands on project managers, and not inappropriately recommend an immature technology

TECHNOLOGY TRANSITION



- Essential to get the right pieces of different technologies to form the solution to a particular problem

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ISSUES

- ISD is fundamentally an R&D organization and no apologies
  - Agency needs some percentage of very long range technology development
- Intend to change OAET's heretofore poor reputation in the transition of technology to operational uses
- Using "vertical integration" approach within each technical discipline
  - Each group responsible for broad range of technology maturity development, from theoretical to lab demo to flight test
- "Technology transfer is a body contact sport"
  - Most important to get the people together: those with problems and those with solutions
- Mission Control is an ideal NASA proving ground for new information sciences technology
  - Has already been on the cutting edge of introducing technology to NASA operational use

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FAULT MANAGEMENT TECHNOLOGY

- Fault management covers the development/operations spectrum
  - Requirements, design, manufacturing, assembly/integration, operations, maintenance

- Reliability vs. Fault Management
  - A system is reliable if it has a long mean time between failures (MTBF)
  - Fault management allows failures to occur, while maintaining system functioanlity through intelligent control of the system configuration and function

- Fault Management integrates Modeling, Testing, and System Diagnosis/Troubleshooting

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FAILURE ENVIRONMENT ANALYSIS TOOL (FEAT)

- Developed by Lockheed for Space Station
  - funded by EF/JSC
- Builds models in digraphs and schematics
- Propagates failures forwards and backwards
- Propagates single or double failures
- Shows single- and double-point failure effects
- Does not account for probablility of failure, or temporal effects

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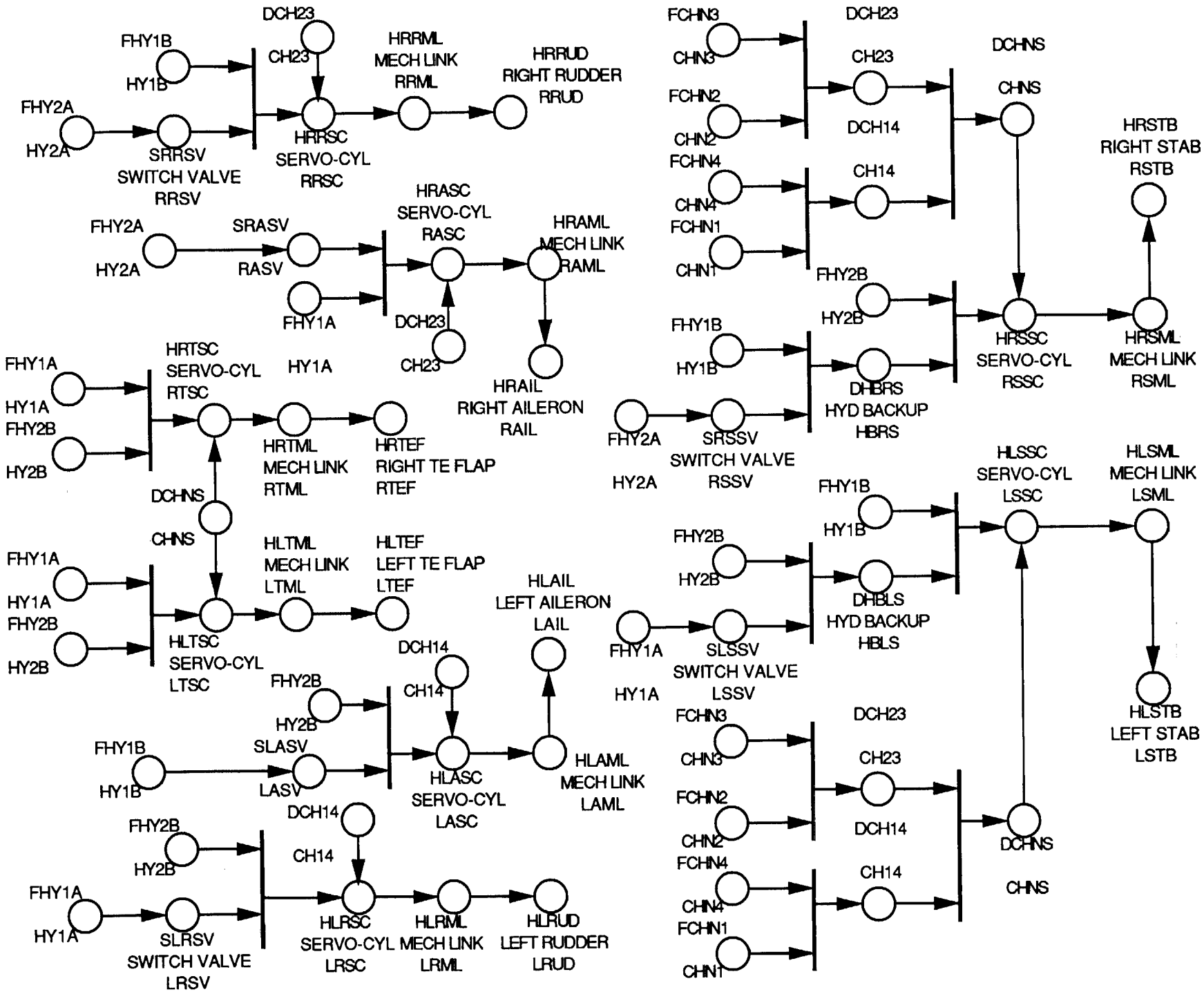
Figure 1-0. Three-quarter View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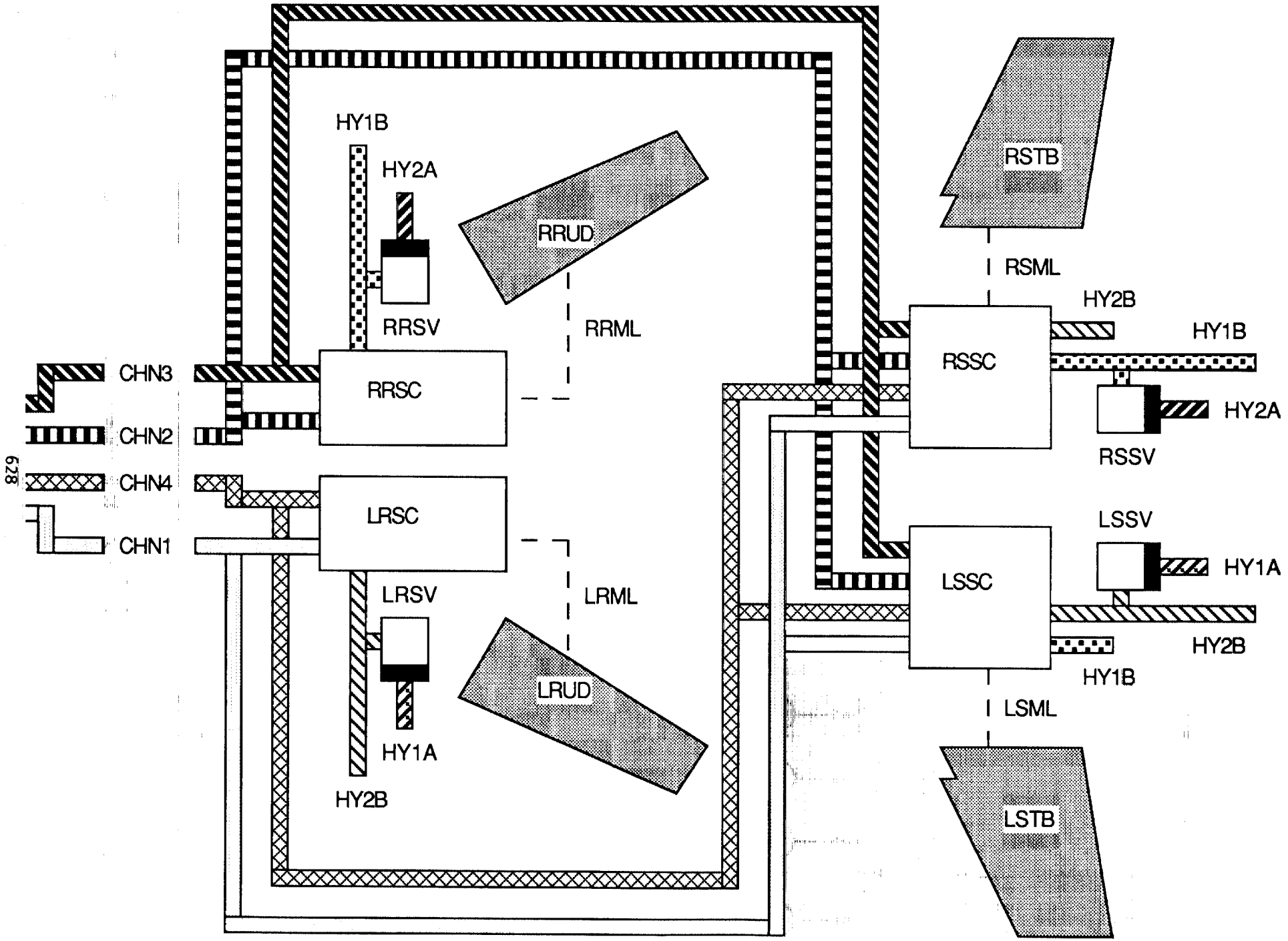
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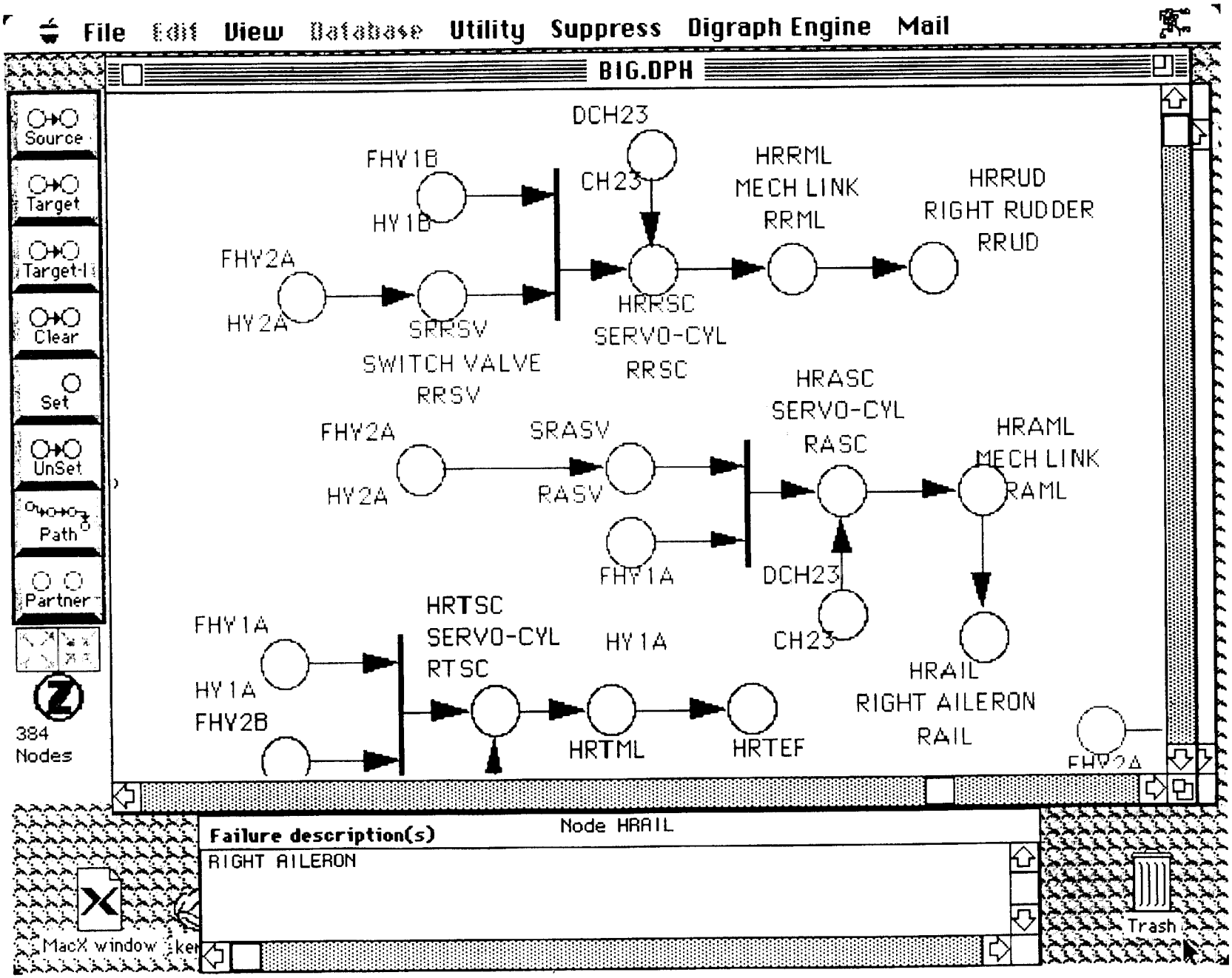
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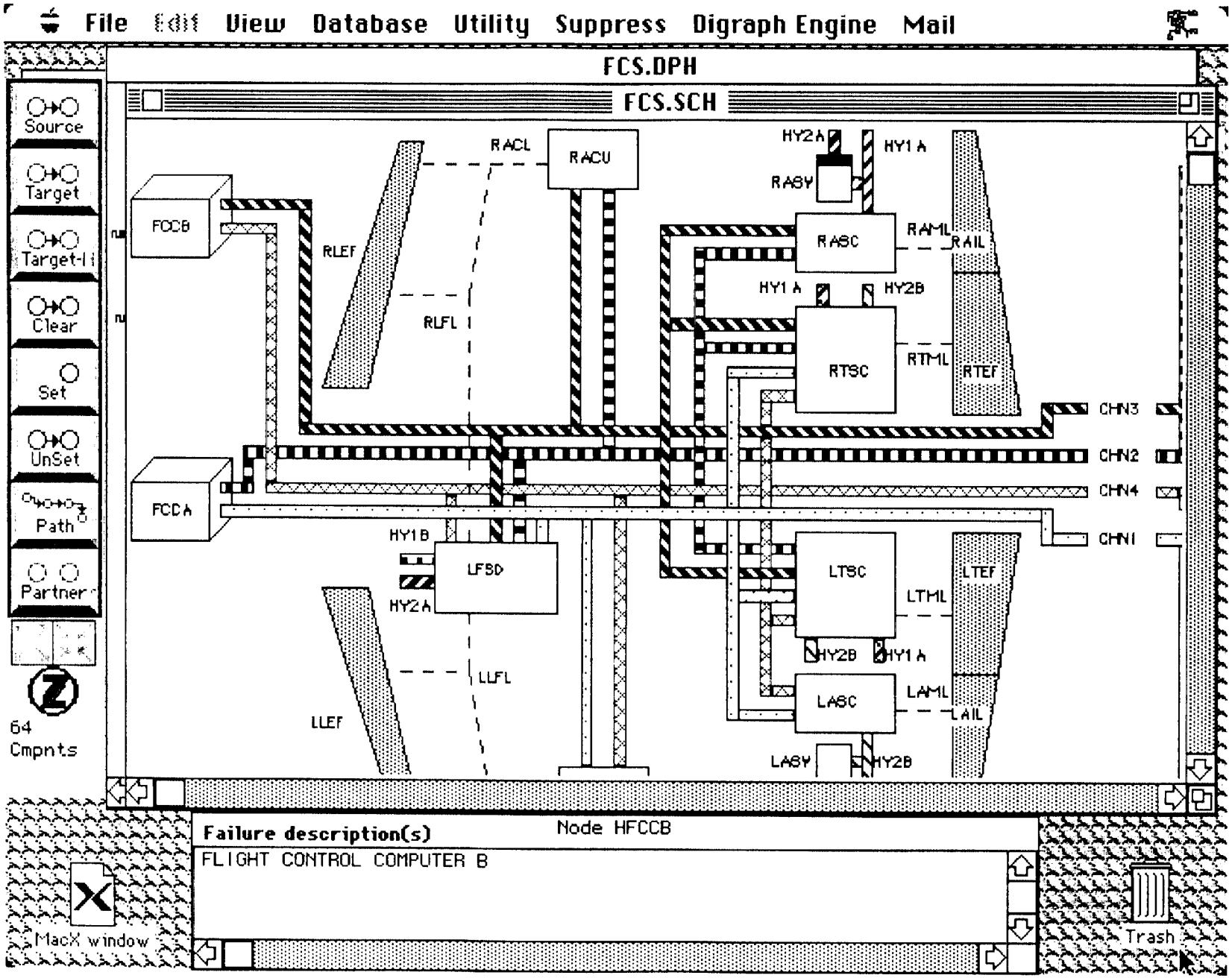
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Failure description(s)
Node HFCCB
FLIGHT CONTROL COMPUTER B
MacX window
Trash

FAULT TREES

- Fault trees allow propagation of component relaibility/event probability information, and temporal failure relationships
- OBREL - An object-oriented programming tool for modelling systems using fault trees, and analyzing reliability at any node of the tree
- FTDS (Fault Tree Diagnosis System) - uses fault tree models combined with expert heuristics to diagnose system failures
- Digraph-to-Fault-Tree conversion code allows FEAT models to be converted to fault trees for reliability analysis and fault diagnosis modelling
- Modelling and diagnosis projects in progress:
  - F-18
  - Research Animal Holding Facility

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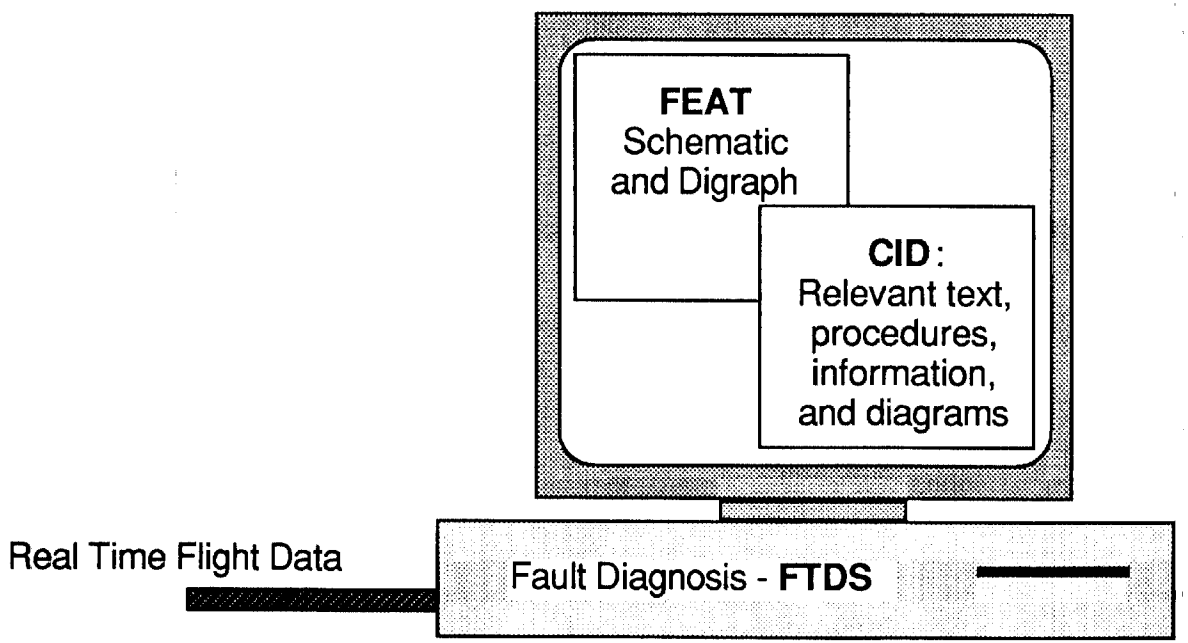
Control Room Advisory Tool

- Accesses real time data stream and activates failed nodes in **FEAT** and **FTDS**
- Displays appropriate **FEAT** Schematic and Digraph
- Diagnoses cause of failure(s) using **FTDS**
- Processes failure information/fault diagnosis and displays relevant text, procedures, information and diagrams using **CID**



F-18 Fault Diagnosis and Emergency Procedures

APPROACH

- Incorporate F-18 HARV system information into:
  - Failure Environment Analysis Tool (FEAT)
  - Fault Tree Diagnosis System (FTDS)
  - Computer Integrated Documentation (CID)
- Restructure digraph models into fault tree format
- Integrate FTDS and CID into a real time advisory tool

BENEFITS OF OPTICAL PROCESSING

- Emphasis on hybrid digital/optical solutions, for a particular set of specialized problems
  - Not general purpose optical processing
- Low weight, power (thermal), and volume
  - Wire bundling not a problem
- Large geometries less susceptible to single event upsets
- Very high speeds for very large problems
  - Tradeoff = low resolution

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