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PRESENTATION 2.2

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FLIGHT ELEMENTS

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM

FLIGHT ELEMENTS SUBPANEL

INTRODUCTION & OVERVIEW

PAUL E. SOLLOCK NOVEMBER 7, 1989

FLIGHT ELEMENTS TOPICS

- ADVANCED AVIONICS SYSTEMS ARCHITECTURES

  Fault-tolerant distributed processing configurations

  Accomodate Growth and tailored functional reliability

- ADVANCED PROCESSORS

  Digital, symbolic and photonic technologies

  Increased capabilities for on-board autonomous operations

- INTEGRATED GPS/GN&C

  Autonomous navigation, alternative attitude determination

  Power, weight and performance enhancements

FLIGHT ELEMENTS TOPICS (cont.)

- ADVANCED DISPLAYS AND CONTROLS
  - Improved flight safety and operational efficiency
  - Commonality & flexibility for multiple program support

- ADVANCED COMMUNICATIONS AND TELEMETRY
  - Maximize data rate with very low power consumption
  - Fiber Optics and Gallium Arsenide Technologies

- ADVANCED SENSORS AND INSTRUMENTATION
  - Higher accuracies with local signal conditioning
  - Self-calibrating and local data recording

FLIGHT ELEMENTS TOPICS (cont.)

- FAULT DETECTION AND FAULT MANAGEMENT
  - Monitor, diagnose and reconfigure at all levels
  - Blend with maintenance/operations functions

- ADVANCED ELECTRICAL POWER DISTRIBUTION & CONTROL
  - Intelligent power switching and control devices
  - Adaptable distribution architectures for varied users

- EMA POWER SYSTEMS
  - Replace classical hydraulics for obvious benefits
  - Electromagnetic Actuators and associated power systems

FLIGHT ELEMENTS TOPICS (cont.)

- IN-FLIGHT CREW TRAINING

  Maintain crew proficiency during long duration missions

  "Real-time" training for unplanned scenarios

FLIGHT ELEMENTS--PAST, PRESENT & FUTURE

- PAST PROGRAMS

  Relatively short lead times--pick a design and build it

  Utilized off-the-shelf components and tailored OR

  Built unique one-time hardware and software

  Relatively short duration missions

  Programs ended before technology reached obsolescence

- PRESENT TRENDS

  Becoming sensitive to effects of evolving technologies on long-duration programs and need for reduced costs

  Long-duration programs inevitably attract unforeseen new missions stretching capabilities of original avionics

  Commercial technology boom has created abundance of potential basic technologies for specific adaptations

FLIGHT ELEMENTS--PAST, PRESENT & FUTURE (cont.)

- FUTURE PROSPECTS

  Future programs will likely have longer periods for study, selection and maturation of technologies

  Challenge will be to *select* a technology which can be brought to maturation BUT not be *obsolete before* Phase C/D

  NASA must strive for commonality accross major programs to *reduce everyone's* cost of *ownership*--requires careful planning of upgrades to ongoing programs AND commitments *from* planned programs

  Potential users of new technologies; i.e., new programs or planned upgrades should "invest" in OAST programs to *focus* development programs toward specific products--Space Station Advanced Development Program (1984-86) was pathfinder.

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM

FLIGHT ELEMENTS

ADVANCED AVIONICS SYSTEMS ARCHITECTURES

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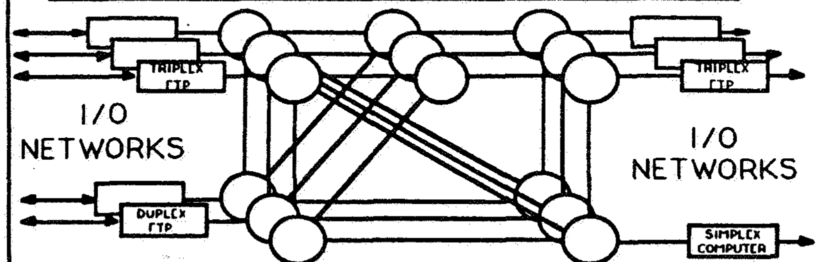
Advanced Information Processing System



Features:
- ADA Operating System
- Fault-Tolerant Distributed Processing Sites
- Fault-Tolerant Inter-computer Network
- Appropriate Function Reliability
- Low Fault Tolerance Overhead
- Growth Capability
- Redundancy Transparent to User

Major Goals and Objectives:

- Improved Reliability at Lower Cost
- Low Recurring Hardware and Operations Cost
- Enable/Support Launch-On-Demand
- Open-Ended Architectures that Support System Growth and Change
- Vehicle-Wide Standardization of Architectural Concepts
- Autonomous, Factory-To-Flight Subsystem Integrity and Confirmation
- Enable/Support Autonomous Long Duration/Distance Flight Operations
- Flexible/Secure Interfaces for Payload and Other Non-Avionic System Support
- Autonomous Pre-Flight System Support and Test

Key Contacts:

JSC- Tom Barry, Tom Morre	BAC - D. Johnson
LaRC - C. Meissner, F. Pitts	CSDL - J. Lala
LeRC - H. Wimmer	GD - J. Karas
MSFC - W. Chubb, W. Brantley	HI - J. Weyrauch
WDRC - J. Stanley, R. Bortner	RIC - L. Shockley
JPL - D. Rennels	MMC - R. Gates

Facilities

-JSC Avionics Eng. Lab
-MSFC Avionics Productivity Center
-LaRC AIRLAB

Major Milestones (1990-1995):

TECHNOLOGY DEMO'S IN WORK:

- MPRAS
- Common Module Military Aircraft Flight Tests

RECOMMENDED DEMOS:

- Define System Goals and P31 Planning (90 and 91)
- Joint Lab Demo's at MSFC/JSC with FLT Test at Ames (92 and 93)
- Insertion on Combined STS and Shuttle-C Upgrades

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM

FLIGHT ELEMENTS

ADVANCED AVIONICS SYSTEMS ARCHITECTURES

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Technology Issues:

- Level of Fault Tolerance
- Cost vs. Reliability
- Utility of Building-Block Architectures
- Modeling/Test Mix for Validation
- Design for Launch-With-Failures
- EME-HARD Design and Assessment
- Software Development Environment
- ADA Software for High-Bandwidth Control

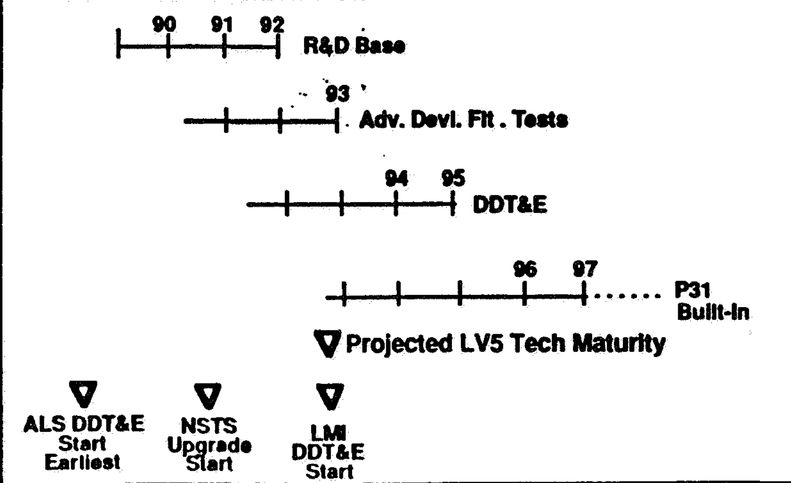
Candidate Programs:

- Assured Shuttle Availability, Unmanned Orbiter
- NASP, CERV
- Shuttle-C, ALS
- Existing Launch Vehicles
- SSP, Lunar Mars Initiative

Major Accomplishments:

- Space Station Avionics Design Captures Some Objectives
- ALS Requirements and Advanced Technology Development Meets/Exceeds Objectives
- Advanced Military Aircraft in DDT&E (A-12 and ATF) Captures Objectives and Developing Usable Hardware
- Commercial aircraft fault-tolerant / distributed systems

Significant Milestones:

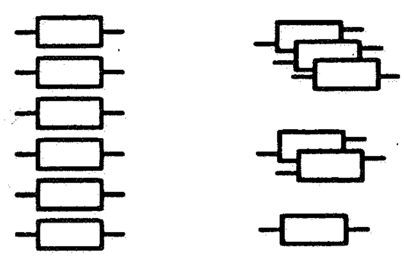


SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED AVIONICS ARCHITECTURE

NOVEMBER 1989

ADVANCED AVIONICS CONCEPTS

EXPLOIT THE POTENTIAL SYNERGISM BETWEEN PARALLEL PROCESSING AND REDUNDANCY



MAJOR OBJECTIVES:

PROVIDE THE SYSTEM ARCHITECTURE TO ACHIEVE

- HIGH PERFORMANCE (.1 TO 10 GOPS)
- RELIABILITY FOR EXTENDED MISSIONS (1,000 - 10,000 HRS)
- AUTONOMY TO ADAPT TO CHANGING SITUATIONS AND MISSION MODES
- SEAMLESS HARDWARE AND SOFTWARE TRANSITIONS BETWEEN EPOCHS
- BUILT IN -
  - ON-LINE MODULE LEVEL VALIDATION
  - OFF-LINE COMPONENT LEVEL SELF TESTABILITY
- LOW POWER , WEIGHT, AND VOLUME
- RADIATION HARDNESS

KEY CONTACTS:

- H. BENZ (LaRC)
- J. DEYST (CSDL)
- T. DE YOUNG (DARPA)
- B. J. THOMAS (IBM)

MAJOR MILESTONES (1990-1995):

CONCEPT DEFINITION 1990

ARCHITECTURE DEFINITION 1990

LABORATORY PROTOTYPE 1991

BRASS BOARD PROTOTYPE 1993

FLIGHT SYSTEM PROTOTYPE 1995

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED AVIONICS ARCHITECTURE

NOVEMBER 1989

TECHNOLOGY ISSUES:

INTERCONNECTION TOPOLOGY

THROUGHPUT OVERHEADS
- PARALLEL COMPUTATION
- INFORMATION TRANSFER
- FAULT TOLERANCE

SOFTWARE
- OPERATING SYSTEM
- REDUNDANCY MANAGEMENT

QUANTIFIABLE PERFORMANCE AND RELIABILITY

VALIDATION METHODOLOGY

LOW POWER/SMALL FEATURE SIZE/RADIATION HARDNESS

CANDIDATE PROGRAMS:

LUNAR/MARS INITIATIVE

NASP

FUTURE AUTONOMOUS SPACECRAFT

MAJOR ACCOMPLISHMENTS:

RECOGNITION OF THE NEED FOR SUCH SYSTEMS.

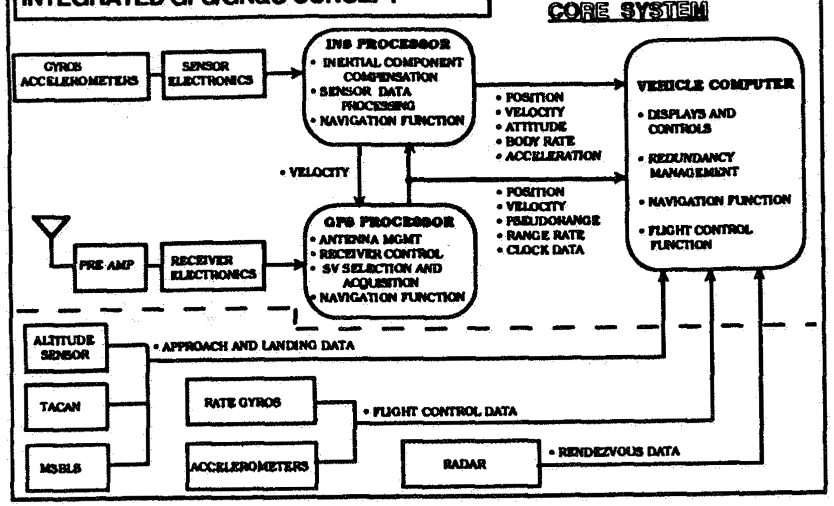
SIGNIFICANT MILESTONES:

91	92	93	94	R & D BASE					
		93	94	95	96	ADV. DEVEL.			
				95	96	97	98	FLIGHT SYSTEM	

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
INTEGRATED GPS/GN&C

NOVEMBER 1989

INTEGRATED GPS/GN&C CONCEPT



MAJOR OBJECTIVES

- REDUCE MAINTENANCE COSTS
  REDUCED LRU COUNT
  HIGHER MTBF
- REDUCE WEIGHT, POWER, AND VOLUME
- AVOID OBSOLESCENCE OF DELETED SYSTEMS
- REDUCE VEHICLE LAUNCH AND TURNAROUND TIME
  TESTING - CALIBRATION - ALIGNMENT
- DEVELOP COMMON MODULAR SYSTEMS FOR MULTIPLE NASA APPLICATIONS
- PROVIDE AUTONOMOUS NAVIGATION CAPABILITY
  ASCENT - ORBIT - REENTRY
- PROVIDE AUTOLAND CAPABILITY
- REDUCE GROUND SUPPORT
- PROVIDE ATTITUDE DETERMINATION CAPABILITY
  ELIMINATE SENSORS THAT PROVIDE ATTITUDE UPDATE

KEY CONTACTS

PARTICIPANTS

TOM BARRY - NASA/JSC
JIM BLUCKER - NASA/JSC
MANNY FERNANDEZ - LITTON
HENDRIK GELDERLOOS - HONEYWELL
IRVING HIRSCH - BOEING AEROSPACE
PENNY SAUNDERS - NASA/JSC
AL ZEITLIN - ROCKWELL/STSD

SUPPLIERS

- AUTONETICS
- COLLINS
- HAMILTON STANDARD
- HONEYWELL
- LITTON
- MOTOROLA
- NORTHROP
- RAYTHEON
- SMITH INDUSTRIES
- TEXAS INSTRUMENTS

USERS

- BOEING (ALS; E-6; AOA; AIWS)
- MDAC (SPACE STATION)
- ROCKWELL (NSTS; NASP; GUNSHIP)
- NASA (NSTS; SPACE STATION; OMV; SHUTTLE C; EDO)
- ARMED SERVICES (VARIOUS AIRCRAFT APPLICATIONS)
- JOINT PROGRAM OFFICE (NASP)
- FAA
- DARPA (GPS GUIDANCE PACKAGE)

FACILITIES

- NASA JSC GPS LABORATORY
- AF GEOPHYSICS LABORATORY
- JET PROPOLUSION LABORATORY
- GPS JPO GPS STANDARD AND PRECISE POSITIONING SERVICE
- NASA AMES MOBILE DIFFERENTIAL GPS GROUND FACILITY
- OTHER GOVERNMENT AND CONTRACTOR FACILITIES

MAJOR MILESTONES

- STANDARD RLG INS AND GPS INTEGRATED SYSTEMS DELIVERED TO NAVY AND AIR FORCE
- INTEGRATED GPS/INS SYSTEMS DELIVERED FOR AF RC-135 AIRCRAFT
- INTEGRATED GPS/INS SYSTEM FOR REMOTELY PILOTED VEHICLE SUCCESSFULLY TESTED
- INS WITH EMBEDDED GPS RECEIVER IN PRODUCTION FOR CIVIL AVIATION (FOREIGN)
- HELICOPTER AND AIRCRAFT LANDING TESTS USING DIFFERENTIAL GPS SYSTEMS CONDUCTED BY NASA-AMES
- HIGH PRECISION ORBIT NAVIGATION FILTER (KALMAN) DEVELOPED BY NASA-JSC
- RELATIVE NAVIGATION CAPABILITY FOR RENDEZVOUS OPERATIONS INVOLVING TWO VEHICLES WITH GPS RECEIVERS EVALUATED BY NASA-JSC

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
INTEGRATED GPS/GN&C

NOVEMBER
1989

TECHNOLOGY/APPLICATION ISSUES

- ACQUISITION OF TARGET VEHICLE DATA FOR AUTONOMOUS NAVIGATION DURING RENDEZVOUS, PROXIMITY, AND DOCKING OPERATIONS
  - COOPERATIVE TARGET
  - 'ANCHOR' SATELLITE
- VEHICLE ATTITUDE DETERMINATION USING GPS
  - ANTENNA SEPARATION LIMITED BY VEHICLE DIMENSIONS
- TRACKING SATELLITE VEHICLE SIGNAL THROUGH PLASMA
- MEETING AUTOLAND PERFORMANCE REQUIREMENTS
  - ACCURACY OF ALTITUDE DATA
- GPS UTILIZATION ABOVE 11,000 NM (e.g.; LUNAR MISSION RETURN)
  - REDUCED SATELLITE VEHICLE VISIBILITY

CANDIDATE PROGRAMS

- ASSURED SHUTTLE AVAILABILITY (ASA)
- SHUTTLE C
- EXTENDED DURATION ORBITER (EDO)
- ASSURED CREW RETURN VEHICLE (ACRV)
- SPACE STATION
- ORBITAL MANEUVERING VEHICLE
- ADVANCED LAUNCH STAGE
- ADVANCED UPPER STAGES
- NATIONAL AERO SPACE PLANE (NASP)
- LUNAR AND MARS MISSIONS RETURN

MAJOR ACCOMPLISHMENTS

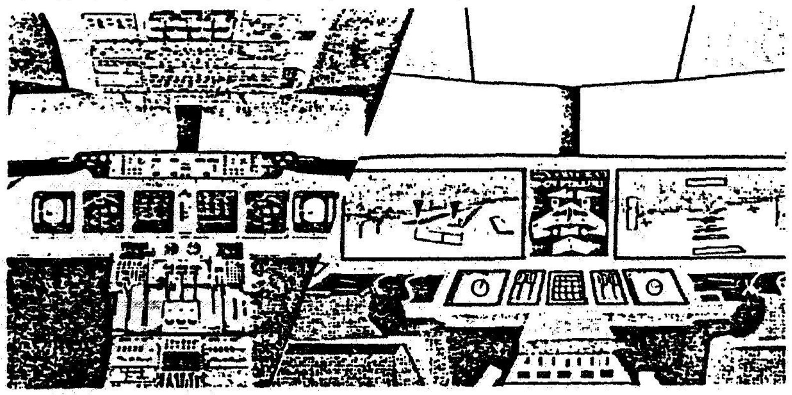
- F-15 FLIGHT TESTS DEMONSTRATE INERTIAL NAVIGATION ASSEMBLY CAPABILITY TO PROVIDE NAVIGATION AND FLIGHT CONTROL DATA - 1988
- INTEGRATED INS WITH EMBEDDED GPS FLOWN IN BOEING 767
  - FLIGHT TESTS PROGRAM - 1988
- FAA CERTIFICATION OF INS WITH EMBEDDED GPS - LATE 1990
- NATIONAL AERO SPACE PLANE SUBSYSTEM CONSORTIUM INVESTIGATING ANTENNA DESIGNS, ADVANCED ELECTRONICS, PLASMA TRANSMIT/RECEIVE LIMITATIONS
- SHUTTLE INTEGRATED GPS/GN&C CONCEPT AND FEASIBILITY STUDY
  - STUDY COMPLETE - 1990
  - FLIGHT DEMONSTRATION - 1993
- PRELIMINARY DESIGN STUDY OF INTEGRATED GPS & INS (MSFC)
  - INTEGRATED AND SEPARATE INS/GPS
  - MODULARIZED CONFIGURATION
- LABORATORY SIMULATIONS AND EVALUATIONS
  - ON-ORBIT OPERATIONS
  - AUTONOMOUS NAVIGATION
  - AUTOLAND

SIGNIFICANT MILESTONES

- IMPLEMENT STANDARD, MODULAR GPS RECEIVER
  - COST EFFECTIVE
  - SUPPORTS MULTIPLE PROGRAMS
  - CONFIGURABLE TO SPECIFIC APPLICATION.
  - INCLUDE TESTABILITY AS DESIGN REQUIREMENT
- CONDUCT TRADE STUDY OF TECHNIQUES TO ACCOMPLISH AUTOLAND, INCLUDING A FLIGHT DEMONSTRATION
- CONDUCT TRADE STUDY OF TECHNIQUES TO PERFORM AUTONOMOUS NAVIGATION, BY MISSION PHASE, FOR VARIOUS TRANSPORTATION PROGRAMS
  - ASCENT - ORBIT - REENTRY
- CONDUCT TRADE STUDY OF TECHNIQUES FOR GPS DETERMINATION OF VEHICLE ATTITUDE, INCLUDING A FLIGHT DEMONSTRATION

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED DISPLAYS AND CONTROLS

ADVANCED DISPLAYS & CONTROLS CONCEPTS:



MD11 COCKPIT ADVANCED COCKPIT TECHNOLOGY CONCEPT

MAJOR OBJECTIVES:

- LOWER COST, IMPROVED MAINTAINABILITY/RELIABILITY
- FOR SHUTTLE IN PARTICULAR, ELIMINATE PARTS/SKILLS OBSOLESCENCE
- REDUCED WEIGHT, VOLUME, AND POWER CONSUMPTION
- INHERENT GROWTH CAPABILITY FOR NEW FUNCTIONS OR ADVANCING TECHNOLOGY (I.E., PAYLOAD USER I/F)
- IMPROVEMENT IN PILOT'S SITUATIONAL AWARENESS
- REDUCTION IN PILOT'S/OPERATOR'S WORKLOAD
- IMPROVED FLIGHT SAFETY AND OPERATING EFFICIENCY
- COMMONALITY AND SOFTWARE RECONFIG. INTERFACE FOR FLEXIBILITY AND LOWER COST IN THE SUPPORT OF MULTIPLE PROGRAMS
- ELIMINATION OF PAPER/MANUAL CLUTTER THROUGH USE OF INTERACTIVE OPTICAL DISK TECHNOLOGY
- IMPROVED AUTONOMY THROUGH USE OF AI AND HUMAN-CENTERED AUTOMATION

KEY CONTACTS:

- DEAN KOCIAN/ WRIGHT R & D CENTER/ SUPERCOCKPIT PROGRAM
- DOC DOUGHERTY/ DARPA/ PILOT'S ASSOCIATE PROGRAM
- FRANK GOMER/ HONEYWELL/ PHEONIX RESEARCH CENTER
- GENE ADAM/ McDONNEL DOUGLAS/ "BIG PICTURE" DISPLAY PROGRAM
- ANDREW FARKAS/ JOHNSON SPACE CENTER/ EF2
- DR. McGREEVY/ AMES RESEARCH CENTER/ AEROSPACE HUMAN FACTORS DIV.
- BILL RUCKS/ ROCKWELL STSD
- TERRY EMERSON/ WRIGHT R & D CENTER/ COCKPIT INTEGRATION DIRECTORATE

FACILITIES:

- JSC/ EF2 D & C PORTION OF ADV. SYSTEMS DEVELOPMENT LAB
- JSC/ SHUTTLE ENGINEERING SIMULATOR
- LaRC/ ADV. CONCEPTS SIMULATOR & CREW STATION SYSTEMS RESEARCH LAB
- LaRC/ TRANSPORT SYSTEMS RESEARCH VEHICLE (AFT FLT. DECK W/COLOR DISPLAYS)
- ARC/ MAN VEHICLE SYSTEMS RESEARCH FACILITY & FLIGHT SIMULATION COMPLEX
- WRIGHT R & D CENTER/ SUPERCOCKPIT LAB & "MAGIC" COCKPIT FACILITY

MAJOR MILESTONES (1990 - 1995):

• SIGNIFICANT IMPROVEMENTS IN FLAT-PANEL TECHNOLOGIES	
— FULL-COLOR, SUNLIGHT-LEGIBLE LIQUID CRYSTAL DISPLAYS	FY 90-91
— FULL-COLOR PLASMA PANEL (15-IN. DIAG.), PHASE II SBIR	FY 91-92
• FLIGHT-WORTHY GRAPHICS GENERATORS CAPABLE OF REAL-WORLD 3-D PICTORIAL DISPLAYS	FY 91-92
• IMPROVEMENTS IN VOICE, TOUCH, AND HAND-CONTROLLER INPUT TECHNOLOGIES	FY 91-92
• FINALIZED SPACE STATION MULTI-PURPOSE APPLICATIONS CONSOLE DESIGN	FY 91-92
• RESULTS OF AIR FORCE SUPERCOCKPIT AND BIG PICTURE PROGRAMS	FY 92-93
• RESULTS OF DARPA PILOT'S ASSOCIATE AND HDTV STUDIES	FY 93-94
• RESULTS OF NASA AIRCRAFT SAFETY/AUTOMATION PROGRAM	FY 93-94
• ORBITER GLASS COCKPIT DISPLAY UPGRADE	FY 93-95

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SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED DISPLAYS AND CONTROLS

TECHNOLOGY ISSUES:

- ORBITER DOWN-TIME FOR HARDWARE INSTALLATION
- MATURITY OF FLAT-PANEL DISPLAY TECHNOLOGY
- DANGER OF MAKING CREW BORED/MACHINE MINDERS
- ADVANCED DISPLAY SYMBOLOGY/PICTORIAL FORMATS
- MATURITY AND UTILIZATION OF AI TECHNOLOGY
- GROWTH AND FLEXIBILITY
- INTERACTIVE DISPLAY/CONTROL NEEDS MORE RESEARCH
- IMPACT OF ELECTRONIC DISPLAYS & CONTROLS (ALL-GLASS COCKPIT) ON CREW TRAINING

CANDIDATE PROGRAMS:

- SPACE SHUTTLE (ASSURED SHUTTLE AVAILABILITY)
- SPACE STATION MPAC
- NATIONAL AERO-SPACE PLANE
- COMBINED AFT MANIPULATOR WORKSTATION (ORBITER)
- AVIATION SAFETY/AUTOMATION
- ADVANCED COCKPIT/FLIGHT MANAGEMENT TECHNOLOGY (PROPOSED FY 92 NEW INITIATIVE IN AERO)

MAJOR ACCOMPLISHMENTS:

- EMERGENCE OF SEVERAL GLASS COCKPITS IN MILITARY AND COMMERCIAL AIRCRAFT (747-400, GULFSTREAM G IV, MD11, F-15E, AND BEECH STARSHIP)
- EMERGENCE OF COLOR ACTIVE-MATRIX LCD TECHNOLOGY
- EMERGENCE OF HIGH-DEFINITION TV (HDTV) TECHNOLOGY
- EMERGENCE OF REAL-TIME GRAPHICS DISPLAY TECHNOLOGY
- EMERGENCE CONTINUOUS-SPEACH, SPEAKER-INDEPENDENT VOICE RECOGNITION TECHNOLOGY

SIGNIFICANT MILESTONES:

● SPACE STATION PERMANENT MANNED CAPABILITY, MPAC	1995-96
● CREW EMERGENCY RETURN VEHICLE	1997
● MANNED LUNAR MISSION	2001
● MANNED MARS MISSION	2016
● ORBITER BLOCK II COCKPIT	- - - -

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM

FLIGHT ELEMENTS

ADVANCED COMMUNICATIONS AND TELEMETRY

NOVEMBER 1989

ADVANCED TECHNOLOGY :

1. GALLIUM ARSENIDE VHSIC
2. FIBER OPTICS
3. ADVANCED ANTENNA DESIGN
4. FREE SPACE OPTICAL COMMUNICATION
5. ADVANCED SIGNAL PROCESSING
6. ADVANCED MODEM / CODEC DEVELOPMENT

MAJOR OBJECTIVES:

. UTILIZE NEW SPECTRUM
. MAXIMIZE DATA RATE THROUGH AVAILABLE SPECTRUM
. PROVIDE FLEXIBLE WIDEBAND DATA DISTRIBUTION NETWORKS (DDNs)
. VERY LOW POWER CONSUMPTION
. DENSE PACKAGING
. RFI/EMI IMMUNITY
. GRACEFUL DEGRADATION
. MULTIBEAM ANTENNAS

KEY CONTACTS:

JSC/ K. LAND
LeRC/ R. LEONARD, J. HARROLD
GSFC/ M. FITZMAURICE, D. DALTON
NMSU/ F. CARDEN, S. HORAN

KEY FACILITIES:

JSC- C&T ENGIINEERING LAB.
LeRC: MMW TEST FACILITY; DSP LAB.
GSFC: LASER COM. LAB.
NMSU- CENTER FOR SPACE TELEM. & TELECOM. SYSTEMS

MAJOR MILESTONES:

DARPA MIMIC PHASE I (MAY'89), PHASE II (1991-94)

EVOLUTION OF STANDARDS
- FDDI STANDARD

ACTS COM SYSTEM
32 GHz TWTA 7W 1992, 50W 1995

"COMMON" SIGNAL PROCESSOR (CSP, GSP, EMSP, GASP)

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED COMMUNICATIONS AND TELEMETRY

NOVEMBER 1989

TECHNOLOGY ISSUES:

1. PRODUCIBILITY OF GaAS
2. POWER LIMITS ON DISTRIBUTION
3. PACKAGING @ HIGH (> 20 GHz)
4. POINTING ACCURACY/ STABILITY
5. SOFTWARE DEVELOPMENT
6. SOFTWARE DEVELOPMENT

CANDIDATE PROGRAMS:

- SPACE STATION
- STS UPGRADES
- LUNAR MARS EXPLORATIONS
- ATDRSS

MAJOR ACCOMPLISHMENTS:

- 32GHz PHASED ARRAY UNDER DEVELOPMENT
- Gbps FIBER OPTICS LINKS IN LABORATORY TEST
- VHSIC PHASE I CHIPS AVAILABLE

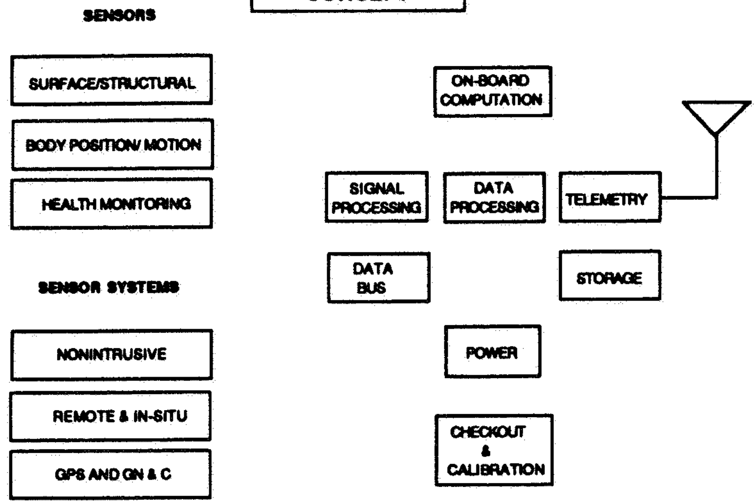
SIGNIFICANT MILESTONES:

- SMALLER, LIGHTER, LOWER POWER PACKAGING
- IMPROVED RELIABILITY
- STANDARDIZATION OF INTERFACES

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS

ADVANCE SENSORS & INSTRUMENTATION

CONCEPT



MAJOR OBJECTIVES

LOW, WEIGHT, VOLUME, POWER & COST

	CURRENT CAPABILITY	NEW REQUIREMENTS
SENSORS - AIR DATA - TRANSITION - PRESSURE/TEMPERATURE INSTRUMENTATION NONINTRUSIVE AIR DATA		HIGH ACCURACY HIGH SPATIAL DENSITY HIGH FREQUENCY HIGH RELIABILITY
SMART DATA SYSTEMS		300Mb/sec
ON-BOARD PROCESSING		DATA COMPRESSION
ON-BOARD COMPUTATION		DATA PRODUCTS
ON-BOARD STORAGE		> TERABIT
DATA BUS		
CHECKOUT/CALS/AUTO RANGE		
POWER		
SOLID STATE LASERS		2 JOULE SOLID STATE
LIGHT WEIGHT OPTICS		
LG REFLECTORS/ANTENNAS		
SMART STRUCTURES/SERVOS		NDE
DETECTORS		
CRYOGENICS		20K COOLERS

KEY CONTACTS

LaRC	
GLEN TAYLOR	88-928-1733
BRUCE CONWAY	88-928-4755
DON LAWRENCE	88-928-5380
MSFC	
JOE ZIMMERMAN	88-824-3458
JSC	
PAUL SOLLOCK	88-525-8225
MIKE GAUDIANO (EH6)	88-525-8318
G.HARMON (EH6)	
K. DOUGLAS (LOCKHEED)	
K.PETERSON (NOVA SENSORS)	

FACILITIES

CLEAN ROOMS
ENVIRONMENTAL CHAMBERS
THERMO VAC CHAMBERS
CALIBRATION
NDE LABS
SENSOR LABS
ENVIRONMENTAL
R & QA
MICROELECTRONIC/MATERIALS

EMI/EMC
CAD/CAE & ASIC
LASER LAB
DETECTOR LAB
COMPUTATIONAL SUPPORT

ADVANCE SENSORS & INSTRUMENTATION

TECHNOLOGY ISSUES:

- O SMART SKINS - FIBEROPTIC TRANSDUCERS & TRANSMISSION LINES EMBEDDED IN ADVANCED COMPOSITES
- O MICRO-MACHINED TRANSDUCERS - EMPLOYING CLASSICAL SEMICONDUCTOR PROCESSING TECHNIQUES TO BUILD MECHANICAL STRUCTURES & TRANSDUCERS
- O SMART TRANSDUCERS - INTEGRATION OF A TRANSDUCER, SIGNAL CONDITIONERS, PROGRAMMABLE EMBEDDED MICROCONTROLLERS
- O ADVANCED INSTRUMENTATION - INTEGRATION OF SMART TRANSDUCERS INTO A DISTRIBUTED BUS OR FAULT TOLERANT LOCAL AREA NETWORK (LAN)
- O HYBRID ELECTRONICS & SURFACE MOUNT TECHNOLOGY
- O INTEGRATION OF DIVERSE TRANSDUCERS & SIGNAL TYPES INTO SMART TRANSDUCER MODULE
- O APPLICATION SPECIFIC INTEGRATED CIRCUIT (ASIC) DESIGN CAPABILITY TO MINIMIZE WEIGHT, POWER, & VOLUME PARAMETERS
- O SMART, MINIATURE & RELIABLE DATA ACQUISITION SYSTEMS (DAS)
- O ON BOARD DATA PROCESSING
- O ON BOARD COMPUTATION
- O ON BOARD STORAGE
- O ADVANCED DATA TRANSMISSION
- O LASER - BASED RENDEZVOUS SYSTEMS
- O 2 MICRON LASERS FOR EYE-SAFE AND WINDS
- O LIGHT WEIGHT OPTICS FOR WIND SHEAR LIDAR
- O CRYOGENICS : DEVELOP 20K COOLERS FOR SOLVING MOST DETECTOR PROBLEMS
- O LARGE REFLECTORS/ANTENNAS
- O INVESTIGATE & DEVELOP SENSORS FOR SMART STRUCTURES
- O DEVELOP MORE EFFECTIVE ELECTROMAGNETIC MEASUREMENT, MODELING, INJECTION & DETECTION SENSORS

CANDIDATE PROGRAMS:

UPGRADE OF ORBITER MODULAR AUXILIARY DATA SYSTEM (MADS)

UARS

EOS

SHUTTLE C

SPACE STATION FREEDOM

ELV

MISSION TO PLANET EARTH

MANNED MISSION TO MARS

LUNAR BASE

MAJOR ACCOMPLISHMENTS

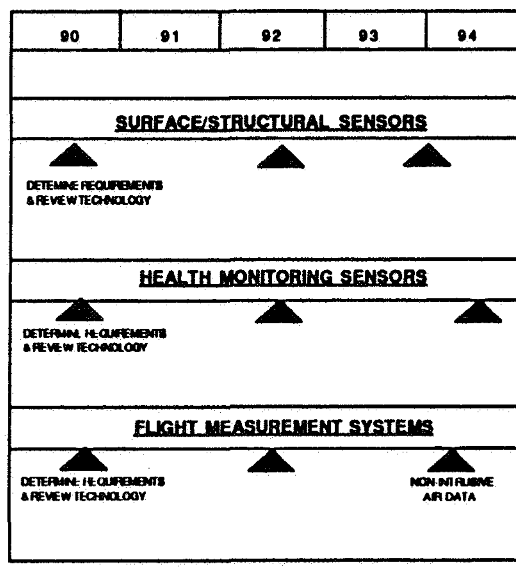
LIDAR

OPTICAL DISK

HIGH PRESSURE STAND ALONE PRESSURE MEASUREMENT DEVICE

ON-BOARD COMPUTING

SIGNIFICANT MILESTONES



GOALS

- O SMART SENSORS
- O SMART SKINS
- O SMART, SMALL & RELIABLE DAS
- O ON BOARD DATA PROCESSING
- O ON BOARD COMPUTATION
- O ON BOARD STORAGE
- O ADVANCED DATA TRANSMISSION
- O SMART STRUCTURES
- O LASER APPLICATIONS
- O DETECTORS
- O NDE

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
FAULT DETECTION AND FAULT MANAGEMENT

TECHNOLOGY CONCEPT:

Sensors
Reconfiguration
Design Knowledge Capture
Operations
Software
FAULT MANAGEMENT:
AN INTEGRATED APPROACH
FDIR
Diagnosis
Detection/Isolation
Hardware
Testability
Digraph Matrix Analysis
Performance

MAJOR OBJECTIVES:

- Monitoring, diagnosis, and reconfiguration at all system levels
- Unambiguous isolation of failures
- Integration with maintenance support and operations
- Optimize system operations to manage degraded system performance
- Lower development/operations costs
- Develop fault tolerant/FDIR requirements and specifications

KEY CONTACTS:

ARC - A. Patterson-Hine
JSC - J.T. Edge
LaRC - C. Meissner
MSFC - D. Weeks
KSC - T. Davis
JPL - D. Miller
HQ - G. Swietek (OSS), J. Di Battista (OAST)

Industry contacts: TBD

KEY FACILITIES:

JSC Testbeds
MSFC SSM/PMAD & ECLSS Testbeds
ARC Advanced Architectures Testbed

MAJOR MILESTONES:

- Review technology, investigate leveraging opportunities (1990)
- Define concept and develop integrated program technology development and integration plan(1990)
- Develop integrated testbed(s) (1992)
- Proof of concept demo (1993)

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
FAULT DETECTION AND FAULT MANAGEMENT

TECHNOLOGY ISSUES:

- Design accomodation of fault detection and fault management (FD/FM)
- Integrated program database support of FD/FM
- Design knowledge capture to support FD/FM
- Evolutionary, automated modeling techniques
- Scalability of current technologies
- Scope of human interface/interaction
- Software FD/FM
- Development of smart sensors and specialized processing functions with high reliability and lower power consumption
- Autonomous detection and recovery from faults

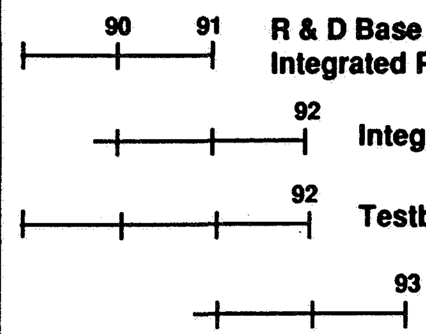
CANDIDATE PROGRAMS:

- SSFP
- ALS
- Shuttle C
- Lunar/Mars missions

MAJOR ACCOMPLISHMENTS:

- Space Station Advanced Development Program already addressing some of the technology issues
- DARPA and ONR activities leveraged to some of the technology issues
- Basic testbeds already in place
- Core Technology Team available

SIGNIFICANT MILESTONES:



R & D Base
Integrated Program Plan

Integrated Design Strategies

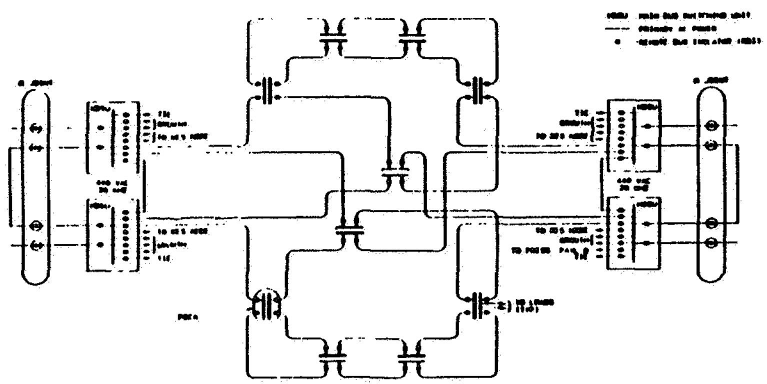
Testbed Demonstrations

Proof of concept demonstration & optimization of system requirements document

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED ELECTRICAL POWER, DISTRIBUTION AND CONTROL

NOVEMBER 1989

ADVANCED ELECTRICAL POWER, DISTRIBUTION AND CONTROL



SPACE STATION RING DISTRIBUTION SYSTEM (EXTERNAL LOAD AREAS ONLY).

MAJOR OBJECTIVES:

- REDUCE COSTS TO LEO, LUNAR/MARS SURFACE
- REDUCE WEIGHT
- INCREASE AVAILABLE POWER/ENERGY
- IMPROVED REDUNDANCY MANAGEMENT
- IMPROVED POWER QUALITY, USER AVAILABILITY
- FAULT TOLERANT, INTEGRATED BITE

KEY CONTACTS:

H. BRANDHORST/LeRC
I. HANSEN/LeRC
J. MILDICE/GDSS
J. BIESS/TRW
R. BECHTEL/MSFC

FACILITIES:

LeRC POWER TECHNOLOGY TESTBED

MAJOR MILESTONES (1990-1995):

SPACE STATION FREEDOM

1990 ADV. DEV. TEST BED DEMOS

ADVANCED LAUNCH SYSTEM

1990 —— 1992 ADV. DEV. DEMO OF IEPS

CIVIL AERO-FBL/PBW

TECH. VALID. ▽ DDT&E ▽ FLIGHT DEMO. ▽

1991 —— 1993 | 1995 | 1996

LUNAR/MARS INITIATIVE

1992 —— 1995

STUDIES ---------- ADV. DEV. PROG.

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED ELECTRICAL POWER, DISTRIBUTION AND CONTROL

NOVEMBER 1989

TECHNOLOGY ISSUES:

END-TO-END EPS MANAGEMENT WITH FAULT LIMITING, RECOVERY AND FAIL SAFE/FAIL OPERATIONAL RECONFIGURATION

DISTRIBUTED vs. DEDICATED PMAD FOR REDUNDANCY, RELIABILITY, OPERABILITY

BITE INTEGRATED INTO DESIGN AT MANUFACTURE

ASA: DDT&E FOR ELECTRICAL ACTUATORS RETROFIT BY INSPECTION DATE

CANDIDATE PROGRAMS:

ADVANCED LAUNCH SYSTEM

ASSURED SHUTTLE AVAILABILITY

CIVIL AERO - POWER-BY-WIRE/FLY-BY-LIGHT

LUNAR/MARS INITIATIVE

AF/WRDC - MORE ELECTRIC AIRPLANE - RETROFIT F-16

DAVID TAYLOR SHIP R&DC - ELECTRONIC NAVY

MAJOR ACCOMPLISHMENTS:

- DEMONSTRATED MULTI-REDUNDANT, FAULT TOLERANT, MICROPROCESSOR CONTROLLED SSF 20 kHz ELECTRICAL POWER DISTRIBUTION SYSTEM
- DEMONSTRATED VARIABLE SPEED DRIVES TO 200 HP, ELECTRICAL ACTUATORS TO 25 HP/DESIGNS TO 75 HP

SIGNIFICANT MILESTONES:

1990 R&T BASE - COMPS, POWER SEMI'S

1991 1992 ADV. DEV. - SSF, ALS

1995 DDT&E

▽ LEV. 5 MATURITY

△ NSTS NEED DATE

△ LUNAR/MARS NEED DATE

VALIDATION NEAR COMPLETE:

- ADVANCED HIGH POWER PMAD CONCEPTS APPLICABLE TO CANDIDATE PROGRAMS
- ADVANCED MOTOR CONTROL ENABLING INDUCTION MOTOR EXPLOITATION FOR LUNAR/MARS VEHICLES

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
EMA/POWER SYSTEMS

NOVEMBER 1989

TECHNOLOGY ISSUES:

ASA: DDT&E FOR EMA RETROFIT BY INSPECT. DATE

END-TO-END EPS MANAGEMENT WITH FAULT LIMITING, RECOVERY AND FAIL SAFE/FAIL OPERATIONAL RECONFIGURATION

DISTRIBUTED vs. DEDICATED PMAD FOR REDUNDANCY, RELIABILITY, OPERABILITY

BITE INTEGRATED INTO DESIGN AT MANUFACTURE

CANDIDATE PROGRAMS:

ADVANCED LAUNCH SYSTEM

ASSURED SHUTTLE AVAILABILITY

CIVIL AERO - POWER-BY-WIRE/FLY-BY-LIGHT

LUNAR/MARS INITIATIVE

AF/WRDC - MORE ELECTRIC AIRPLANE - RETROFIT F-16

DAVID TAYLOR SHIP R&DC - ELECTRONIC NAVY

MAJOR ACCOMPLISHMENTS:

- PRELIMINARY ASA STUDIES COMPLETED
- KSC TURNAROUND FLOW ANALYSIS INITIATED
- TECHNOLOGY DEMOS/ASSESSMENT INITIATED
- DEMONSTRATED ELECTRIC ACTUATORS/ DRIVES TO 25 HP/DESIGNS TO 75 HP
- DEMONSTRATED MULTI-REDUNDANT, FAULT TOLERANT, MICROPROCESSOR CONTROLLED SSF 20 kHz ELECTRICAL POWER DISTRIBUTION SYSTEM

SIGNIFICANT MILESTONES:

1990 R&T BASE - COMPS, POWER SEMI'S

1991 1992 ADV. DEV. - SSF, ALS

1995 DDT&E

▽ LEV. 5 MATURITY

△ NSTS NEED DATE

△ LUNAR/MARS NEED DATE

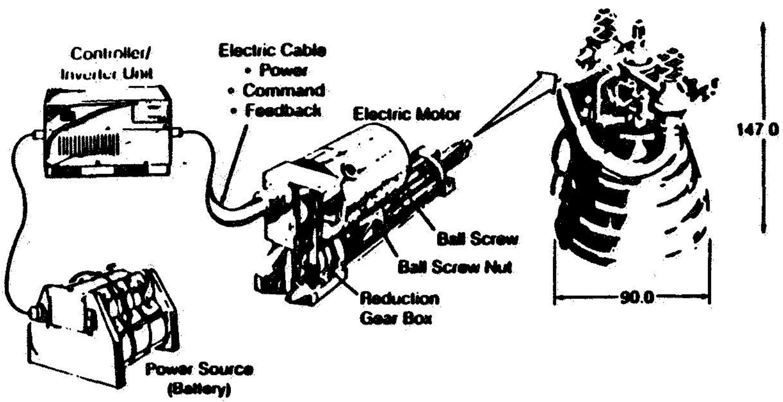
VALIDATION NEAR COMPLETE:

- ADVANCED HIGH POWER PMAD CONCEPTS APPLICABLE TO CANDIDATE PROGRAMS
- ADVANCED MOTOR CONTROL ENABLING INDUCTION MOTOR EXPLOITATION

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
EMA/POWER SYSTEMS

NOVEMBEF 1989

EMA/POWER SYSTEMS



MAJOR OBJECTIVES:

REDUCE KSC TURN AROUND COSTS ; INCREASE LAUNCH RATE
- ELIMINATE EXCESSIVE MAN TESTS AND VERIFICATIONS
- ADD SELF CHECKOUT THROUGH BUILT-IN-TEST (BITE)
- ELIMINATE GROUND SUPPORT CARTS AND EQUIPMENT

IMPROVE REDUNDANCY, RELIABILITY AND DECREASE WEIGHT
- MATCH FLIGHT CONTROLS, POWER SOURCE, ACTUATORS
- USE DEMAND DRIVEN SYSTEM - SIMPLE IMPLEMENTATION

IMPROVE DISPATCH RELIABILITY
- AUTOMATED VEHICLE CHECKOUT
- LOW STANDBY POWER/ENERGY
- ELIMINATE HYDRAULIC SILTING

REDUCE STANDDOWN TIME

TECHNOLOGY TRANSFER TO CIVIL SECTOR

KEY CONTACTS:

G. SUNDBERG/LeRC
J. T. EDGE/JSC
C. CORNELIUS/MSFC
C. McCLESKEY/KSC
B. LUM/RI-DOWNEY
S. TAQUI/GDSS
J. ANDERSON/BAC

FACILITIES:

MSFC ACTUATOR TEST FACILITY
ROCKWELL-DOWNEY
AIRFORCE WRDC-FLIGHT DYNAMICS

MAJOR MILESTONES (1990-1995):

ASSURED SHUTTLE AVAILABILITY (ASA)

1990 TECHNOLOGY, RISK, COST ASSESSMENT

ADVANCED LAUNCH SYSTEM

1990	1991	1992		2000
▽ EMA DESIGNS		▽ COMPLETE DEMOS/ COST/OPERABILITY		▽ IOC

CIVIL AERO-FBL/PBW

1991	1992	1993	1994	1995	1996
▽ VALID. STUDIES REVIEW TECH.			DDT&E ▽		FLIGHT DEMO. ▽

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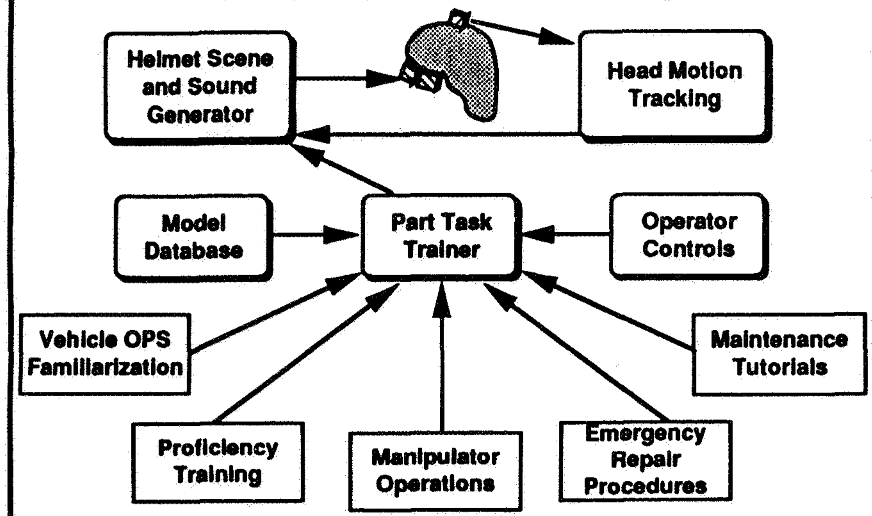
SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
IN - FLIGHT CREW TRAINING

IN - FLIGHT CREW TRAINING



MAJOR OBJECTIVES:

- Provide more effective training environments
  - Video or animated task descriptions
  - Interactive training environments
    - •• Computer generated, synthetic 3-D training scenarios
    - •• Active computer control of hand input devices during scene playback for tactile training
- Provide accelerated in-flight training capability
  - Refresh crew skills
  - Practice unplanned contingency operations in a realistic environment
- Enhance crew preparedness
- Enhance crew safety

KEY CONTACTS:

C. Gott / JSC / FM8

P. Galicki / JSC / FM8

S. Murray / JSC / VG3

FACILITIES:

- Integrated Graphics Operations Analysis Laboratory (IGOAL)
  - RMS MIL Simulators: Shuttle, SSF
  - Proximity Operations Simulators: Shuttle, Shuttle-C, OMV, MMU
- JSC Systems Engineering Simulator

MAJOR MILESTONES (1990 - 1995)

- Test and evaluate faster machines with graphics capability
- Test simulation interaction with current hardware
- Develop non-realtime system with dynamics and collision detection on current hardware
- Test and evaluate stereo graphics hardware
- Investigate malfunction training concepts to establish viability

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
IN - FLIGHT CREW TRAINING

TECHNOLOGY ISSUES:

- Integration with existing flight systems
- Display and processor capabilities
  - Low weight, volume and power requirements
  - Provide for multiple trainees interacting within a realistic synthetic 3-D training scenario
  - Allow local storage of "digital" tapes of training scenarios
  - Facilities to upload from remote training library

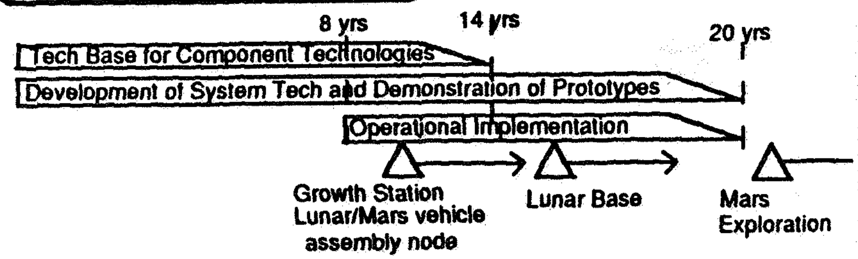
CANDIDATE PROGRAMS:

- Space Station Freedom (SSF)
  - Remote Manipulator Systems (SRMS, SSRMS)
  - Flight Telerobotic Servicer (FTS)
  - Orbital Maneuvering Vehicle (OMV) Piloting
  - Shuttle Piloting and Landing
- Space Shuttle
  - Remote Manipulator System
  - Proximity Operations
  - Approach and Landing

MAJOR ACCOMPLISHMENTS:

- Development of kinematic and dynamic simulators for generic remote manipulator systems
- Teleoperated systems technology investigations
  - Helmet mounted display
  - Stereoscopic vision systems
- Man-in-the-loop simulator development
  - Manipulator Simulations: SRMS, SSRMS, FTS
  - Spacecraft Simulators: Shuttle, OMV
- RMS Partial Task Trainer hosted on Silicon Graphics IRIS 4D/70GT
  - Kinematic simulation with near real-time performance using low fidelity models
  - RMS control panel and hand controllers

SIGNIFICANT MILESTONES:



- Identify appropriate training tasks
- Determine system requirements
- Define system architecture
- Develop and integrate system hardware
- Develop training software for prototype system
- Flight demonstration of training capabilities
- Operational trainer development
- Training plan implementation

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SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM

FLIGHT ELEMENTS

ADVANCED AVIONICS SYSTEMS ARCHITECTURES

NOVEMBER 1989

Technology Issues:

- Level of Fault Tolerance
- Cost vs. Reliability
- Utility of Building-Block Architectures
- Modeling/Test Mix for Validation
- Design for Launch-With-Failures
- EME-HARD Design and Assessment
- Software Development Environment
- ADA Software for High-Bandwidth Control

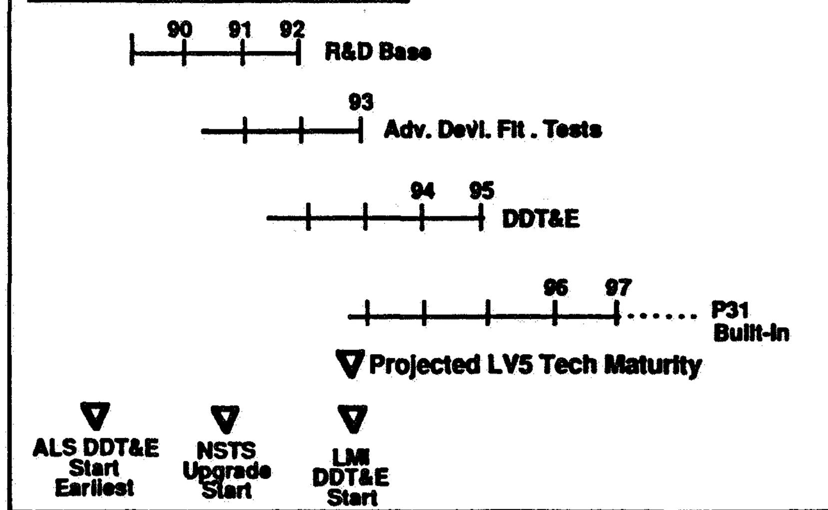
Candidate Programs:

- Assured Shuttle Availability, Unmanned Orbiter
- NASP, CERV
- Shuttle-C, ALS
- Existing Launch Vehicles
- SSP, Lunar Mars Initiative

Major Accomplishments:

- Space Station Avionics Design Captures Some Objectives
- ALS Requirements and Advanced Technology Development Meets/Exceeds Objectives
- Advanced Military Aircraft in DDT&E (A-12 and ATF) Captures Objectives and Developing Usable Hardware
- Commercial aircraft fault-tolerant / distributed systems

Significant Milestones:

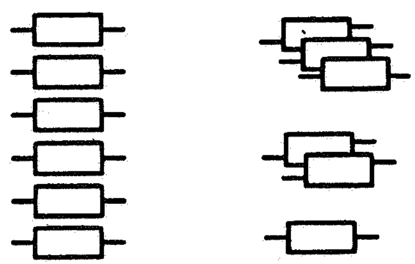


SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED AVIONICS ARCHITECTURE

NOVEMBER 1989

ADVANCED AVIONICS CONCEPTS

EXPLOIT THE POTENTIAL SYNERGISM BETWEEN PARALLEL PROCESSING AND REDUNDANCY



MAJOR OBJECTIVES:

PROVIDE THE SYSTEM ARCHITECTURE TO ACHIEVE

- HIGH PERFORMANCE (.1 TO 10 GOPS)
- RELIABILITY FOR EXTENDED MISSIONS (1,000 - 10,000 HRS)
- AUTONOMY TO ADAPT TO CHANGING SITUATIONS AND MISSION MODES
- SEAMLESS HARDWARE AND SOFTWARE TRANSITIONS BETWEEN EPOCHS
- BUILT IN -
  - ON-LINE MODULE LEVEL VALIDATION
  - OFF-LINE COMPONENT LEVEL SELF TESTABILITY
- LOW POWER , WEIGHT, AND VOLUME
- RADIATION HARDNESS

KEY CONTACTS:

- H. BENZ (LaRC)
- J. DEYST (CSDL)
- T. DE YOUNG (DARPA)
- B. J. THOMAS (IBM)

MAJOR MILESTONES (1990-1995):

CONCEPT DEFINITION 1990

ARCHITECTURE DEFINITION 1990

LABORATORY PROTOTYPE 1991

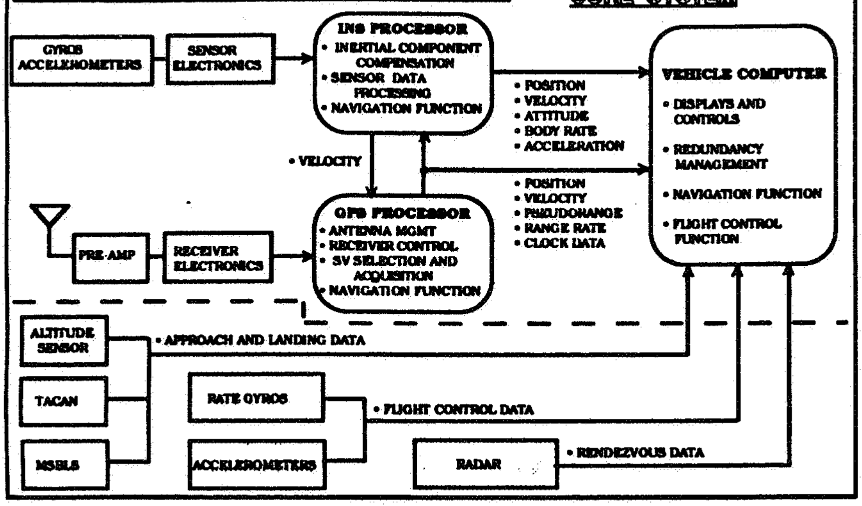
BRASS BOARD PROTOTYPE 1993

FLIGHT SYSTEM PROTOTYPE 1995

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
INTEGRATED GPS/GN&C

NOVEMBER 1989

INTEGRATED GPS/GN&C CONCEPT



MAJOR OBJECTIVES

- REDUCE MAINTENANCE COSTS
  REDUCED LRU COUNT
  HIGHER MTBF
- REDUCE WEIGHT, POWER, AND VOLUME
- AVOID OBSOLESCENCE OF DELETED SYSTEMS
- REDUCE VEHICLE LAUNCH AND TURNAROUND TIME
  TESTING - CALIBRATION - ALIGNMENT
- DEVELOP COMMON MODULAR SYSTEMS FOR MULTIPLE NASA APPLICATIONS
- PROVIDE AUTONOMOUS NAVIGATION CAPABILITY
  ASCENT - ORBIT - REENTRY
- PROVIDE AUTOLAND CAPABILITY
- REDUCE GROUND SUPPORT
- PROVIDE ATTITUDE DETERMINATION CAPABILITY
  ELIMINATE SENSORS THAT PROVIDE ATTITUDE UPDATE

KEY CONTACTS

PARTICIPANTS

TOM BARRY - NASA/JSC
JIM BLUCKER - NASA/JSC
MANNY FERNANDEZ - LITTON
HENDRIK GELDERLOOS - HONEYWELL
IRVING HIRSCH - BOEING AEROSPACE
PENNY SAUNDERS - NASA/JSC
AL ZEITLIN - ROCKWELL/STSD

SUPPLIERS

- AUTONETICS
- COLLINS
- HAMILTON STANDARD
- HONEYWELL
- LITTON
- MOTOROLA
- NORTHROP
- RAYTHEON
- SMITH INDUSTRIES
- TEXAS INSTRUMENTS

USERS

- BOEING (ALS; E-6; AOA; AIWS)
- MDAC (SPACE STATION)
- ROCKWELL (NSTS; NASP; GUNSHIP)
- NASA (NSTS; SPACE STATION; OMV; SHUTTLE C; EDO)
- ARMED SERVICES (VARIOUS AIRCRAFT APPLICATIONS)
- JOINT PROGRAM OFFICE (NASP)
- FAA
- DARPA (GPS GUIDANCE PACKAGE)

FACILITIES

- NASA JSC GPS LABORATORY
- AF GEOPHYSICS LABORATORY
- JET PROPOLUSION LABORATORY
- GPS JPO GPS STANDARD AND PRECISE POSITIONING SERVICE
- NASA AMES MOBILE DIFFERENTIAL GPS GROUND FACILITY
- OTHER GOVERNMENT AND CONTRACTOR FACILITIES

MAJOR MILESTONES

- STANDARD RLG INS AND GPS INTEGRATED SYSTEMS DELIVERED TO NAVY AND AIR FORCE
- INTEGRATED GPS/INS SYSTEMS DELIVERED FOR AF RC-135 AIRCRAFT
- INTEGRATED GPS/INS SYSTEM FOR REMOTELY PILOTED VEHICLE SUCCESSFULLY TESTED
- INS WITH EMBEDDED GPS RECEIVER IN PRODUCTION FOR CIVIL AVIATION (FOREIGN)
- HELICOPTER AND AIRCRAFT LANDING TESTS USING DIFFERENTIAL GPS SYSTEMS CONDUCTED BY NASA-AMES
- HIGH PRECISION ORBIT NAVIGATION FILTER (KALMAN) DEVELOPED BY NASA-JSC
- RELATIVE NAVIGATION CAPABILITY FOR RENDEZVOUS OPERATIONS INVOLVING TWO VEHICLES WITH GPS RECEIVERS EVALUATED BY NASA-JSC

SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
INTEGRATED GPS/GN&C

NOVEMBER 1989

TECHNOLOGY/APPLICATION ISSUES

- ACQUISITION OF TARGET VEHICLE DATA FOR AUTONOMOUS NAVIGATION DURING RENDEZVOUS, PROXIMITY, AND DOCKING OPERATIONS
  - COOPERATIVE TARGET
  - 'ANCHOR' SATELLITE
- VEHICLE ATTITUDE DETERMINATION USING GPS
  - ANTENNA SEPARATION LIMITED BY VEHICLE DIMENSIONS
- TRACKING SATELLITE VEHICLE SIGNAL THROUGH PLASMA
- MEETING AUTOLAND PERFORMANCE REQUIREMENTS
  - ACCURACY OF ALTITUDE DATA
- GPS UTILIZATION ABOVE 11,000 NM (e.g.; LUNAR MISSION RETURN)
  - REDUCED SATELLITE VEHICLE VISIBILITY

CANDIDATE PROGRAMS

- ASSURED SHUTTLE AVAILABILITY (ASA)
- SHUTTLE C
- EXTENDED DURATION ORBITER (EDO)
- ASSURED CREW RETURN VEHICLE (ACRV)
- SPACE STATION
- ORBITAL MANEUVERING VEHICLE
- ADVANCED LAUNCH STAGE
- ADVANCED UPPER STAGES
- NATIONAL AERO SPACE PLANE (NASP)
- LUNAR AND MARS MISSIONS RETURN

MAJOR ACCOMPLISHMENTS

- F-15 FLIGHT TESTS DEMONSTRATE INERTIAL NAVIGATION ASSEMBLY CAPABILITY TO PROVIDE NAVIGATION AND FLIGHT CONTROL DATA - 1986
- INTEGRATED INS WITH EMBEDDED GPS FLOWN IN BOEING 767
  - FLIGHT TESTS PROGRAM - 1988
- FAA CERTIFICATION OF INS WITH EMBEDDED GPS - LATE 1990
- NATIONAL AERO SPACE PLANE SUBSYSTEM CONSORTIUM INVESTIGATING ANTENNA DESIGNS, ADVANCED ELECTRONICS, PLASMA TRANSMIT/RECEIVE LIMITATIONS
- SHUTTLE INTEGRATED GPS/GN&C CONCEPT AND FEASIBILITY STUDY
  - STUDY COMPLETE - 1990
  - FLIGHT DEMONSTRATION - 1993
- PRELIMINARY DESIGN STUDY OF INTEGRATED GPS & INS (MSFC)
  - INTEGRATED AND SEPARATE INS/GPS
  - MODULARIZED CONFIGURATION
- LABORATORY SIMULATIONS AND EVALUATIONS
  - ON-ORBIT OPERATIONS
  - AUTONOMOUS NAVIGATION
  - AUTOLAND

SIGNIFICANT MILESTONES

- IMPLEMENT STANDARD, MODULAR GPS RECEIVER
  - COST EFFECTIVE
  - SUPPORTS MULTIPLE PROGRAMS
  - CONFIGURABLE TO SPECIFIC APPLICATION
  - INCLUDE TESTABILITY AS DESIGN REQUIREMENT
- CONDUCT TRADE STUDY OF TECHNIQUES TO ACCOMPLISH AUTOLAND, INCLUDING A FLIGHT DEMONSTRATION
- CONDUCT TRADE STUDY OF TECHNIQUES TO PERFORM AUTONOMOUS NAVIGATION, BY MISSION PHASE, FOR VARIOUS TRANSPORTATION PROGRAMS
  - ASCENT - ORBIT - REENTRY
- CONDUCT TRADE STUDY OF TECHNIQUES FOR GPS DETERMINATION OF VEHICLE ATTITUDE, INCLUDING A FLIGHT DEMONSTRATION

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SPACE TRANSPORTATION AVIONICS TECHNOLOGY SYMPOSIUM
FLIGHT ELEMENTS
ADVANCED AVIONICS ARCHITECTURE

NOVEMBER 1989

TECHNOLOGY ISSUES:

INTERCONNECTION TOPOLOGY

THROUGHPUT OVERHEADS
- PARALLEL COMPUTATION
- INFORMATION TRANSFER
- FAULT TOLERANCE

SOFTWARE
- OPERATING SYSTEM
- REDUNDANCY MANAGEMENT

QUANTIFIABLE PERFORMANCE AND RELIABILITY

VALIDATION METHODOLOGY

LOW POWER/SMALL FEATURE SIZE/RADIATION HARDNESS

CANDIDATE PROGRAMS:

LUNAR/MARS INITIATIVE

NASP

FUTURE AUTONOMOUS SPACECRAFT

MAJOR ACCOMPLISHMENTS:

RECOGNITION OF THE NEED FOR SUCH SYSTEMS.

SIGNIFICANT MILESTONES:

91	92	93	94					R & D BASE
		93	94	95	96			ADV. DEVEL.
				95	96	97	98	FLIGHT SYSTEM