Office of
Aeronautics and
Space
Technology

INFORMATION SCIENCES AND
HUMAN FACTORS DIVISION

PROGRAM OVERVIEW

Presentation to

AIAA/OAST SPACE TECHNOLOGY CONFERENCE

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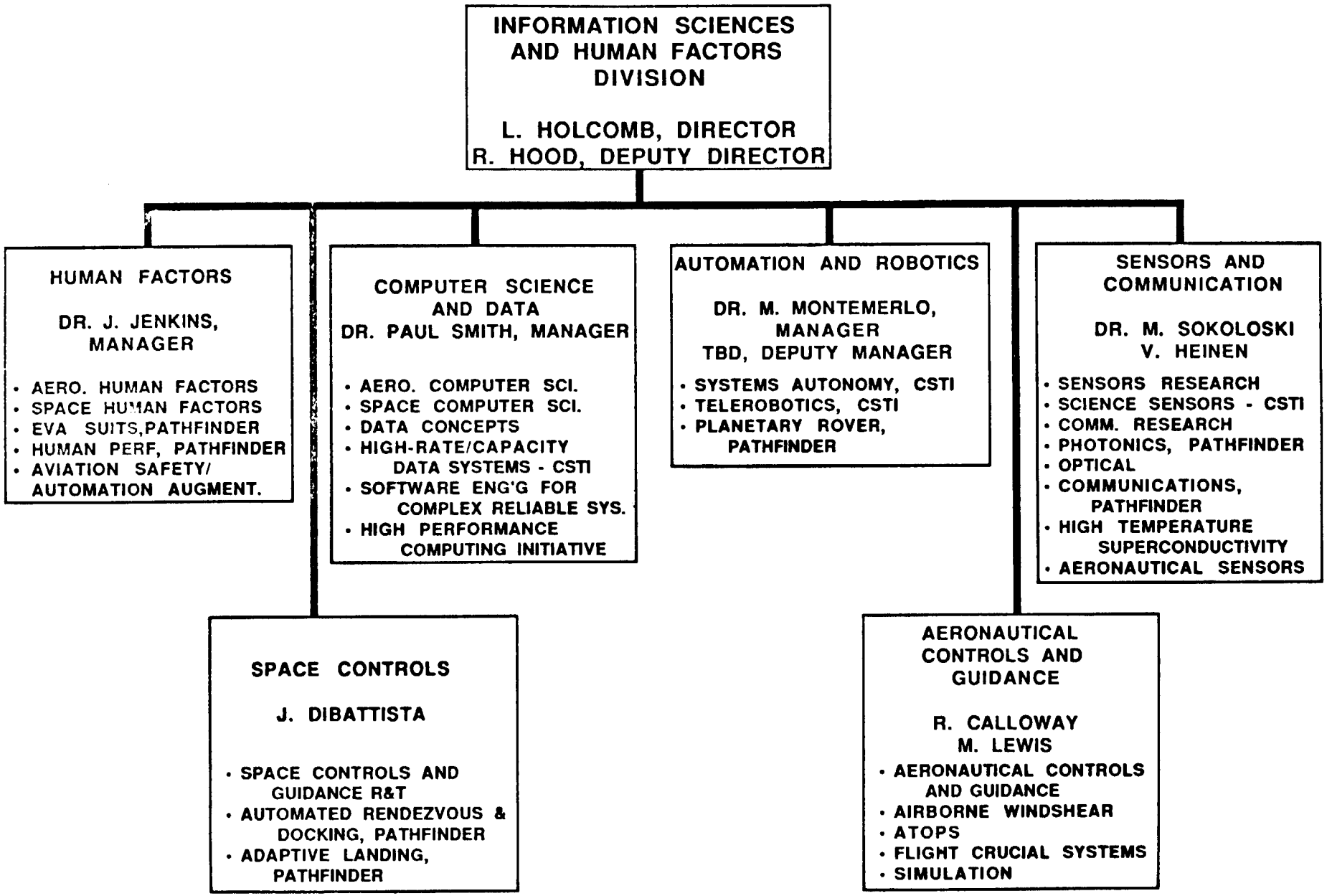
Director
September 13, 1988

INFORMATION SCIENCES AND HUMAN FACTORS DIVISION
ORGANIZATION

OAST



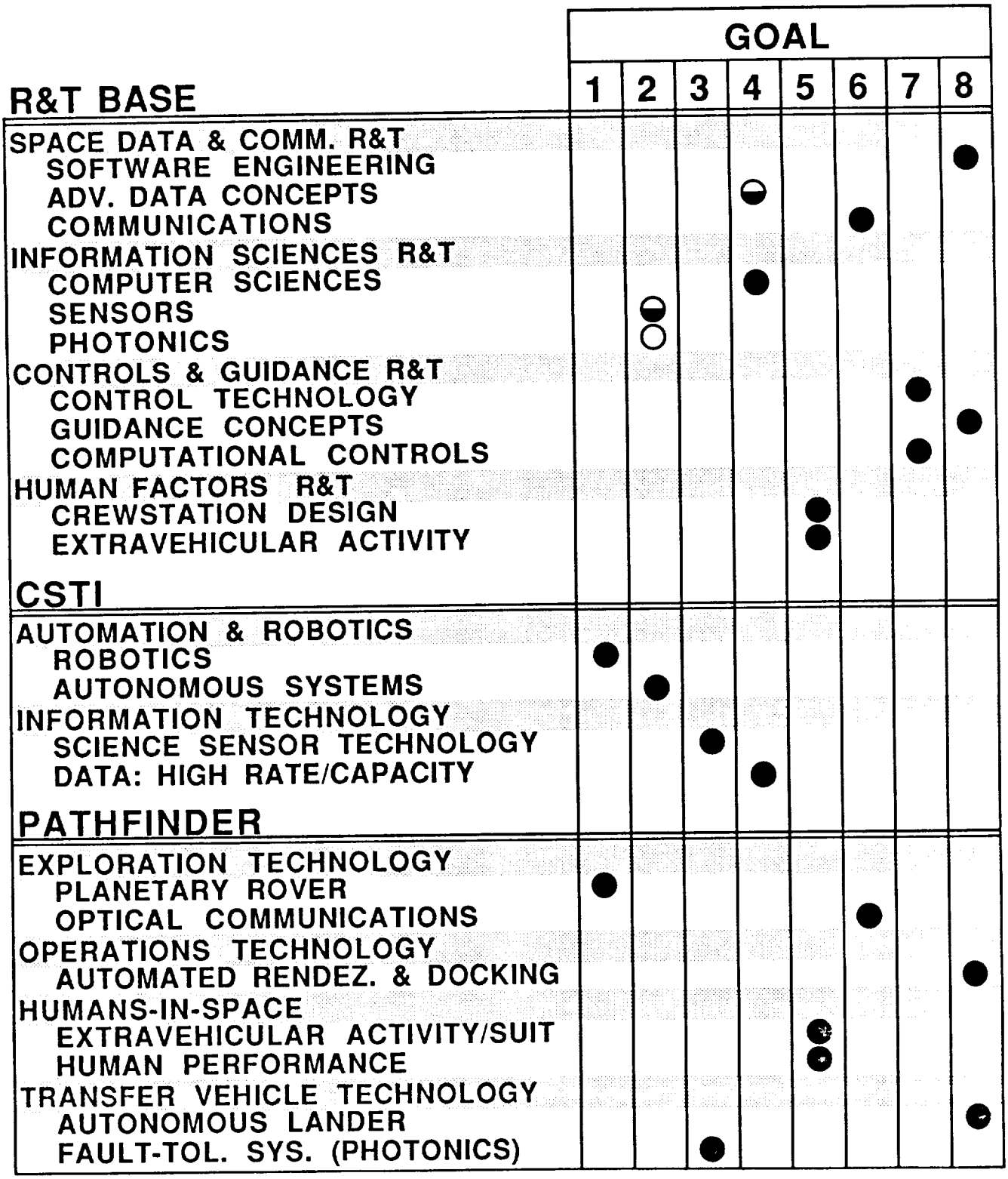
GOALS

OAST

1. EVOLVING SPACE TELEROBOTICS CAPABILITY
2. EVOLVING AUTOMATED SPACE SYSTEMS CAPBILITY
3. NASA-UNIQUE SPACE SENSING CONCEPTS
4. EFFICIENT ACQUISITION, PROCESSING, DISTRIBUTION AND ANALYSIS OF SPACE-DERIVED DATA
5. EFFECTIVE UTILIZATION OF HUMANS-IN-SPACE
6. ADVANCED SPACE COMMUNICATIONS CAPABILITY
7. CONTROL OF COMPLEX/FLEXIBLE SPACE SYSTSMS
8. RELIABLE AND ADAPTIVE GUIDANCE, NAVIGATION AND CONTROL OF ADVANCED TRANSPORTATION VEHICLES

DISCIPLINARY CROSSWALK

OAST



SYSTEMS AUTONOMY

OAST

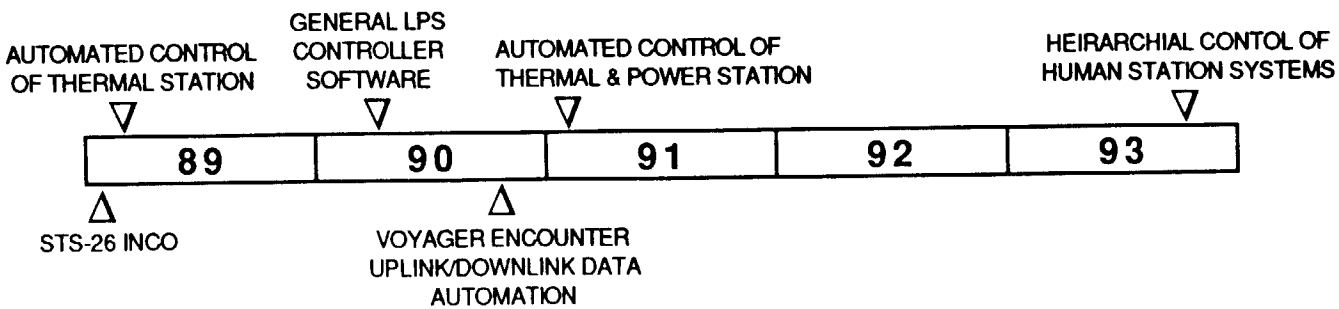
LONG RANGE GOAL:
TO PROVIDE AND VALIDATE THE BASIC TECHNOLOGY TO ACHIEVE SUCCESSIVELY HIGHER LEVELS OF AUTONOMY IN SPACE OPERATIONS

THRUSTS:
- SYSTEMS AUTONOMY DEMONSTRATIONS
- ARTIFICIAL INTELLIGENCE
- SYSTEM ARCHITECTURE AND INTEGRATION

FY 88 ACCOMPLISHMENTS:
- SHUTTLE INTEGRATED COMMUNICATIONS OFFICER REAL-TIME EXPERT SYSTEM
- SPACE STATION THERMAL CONTROL EXPERT SYSTEM EVALUATED ON BRASSBOARD
- INITIAL PLANNING FOR COMBINED SPACE STATION THERMAL AND POWER SYSTEMS
- MACHINE LEARNING APPLIED TO ANALYSIS OF INFRARED ASTRONOMY DATA

FY 89 PROGRAM FOCUS
- SPACE STATION SYSTEM AUTONOMY DEMONSTRATIONS
- REAL-TIME EXPERT SYSTEM CONTROL OF SHUTTLE LAUNCH PROCESSING SYSTEMS
- HUBBLE SPACE TELESCOPE DESIGN/ENGINEERING KNOWLEDGE CAPTURE

LONG RANGE MILESTONES:



TELEROBOTICS

OAST

LONG RANGE GOAL:

TO PROVIDE AND VALIDATE THE BASIC TECHNOLOGY TO ACHIEVE SUCCESSFULLY HIGHER LEVELS OF SPACE ROBOTIC CAPABILITY

THRUSTS:

- TELEROBOTIC DEMONSTRATIONS
- SENSING AND PERCEPTION
- PLANNING AND REASONING
- CONTROL EXECUTION
- OPERATOR INTERFACE

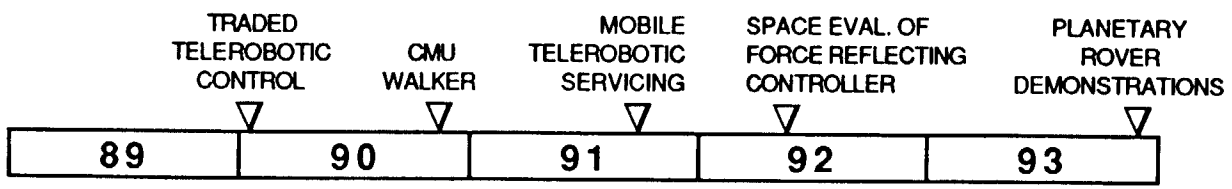
FY 88 ACCOMPLISHMENTS:

- EASE STRUCTURE ASSEMBLY BY BAT
- FORCE CONTROL OF MULTI ARM MANIPULATOR
- TELEROBOTIC INTERACTIVE PLANNING SYSTEM
- AUTOMATED VISION-BASED SATELLITE GRAPPLING
- TELEROBOTIC INTELLIGENT INTERFACE FLIGHT EXPERIMENT

FY 89 PROGRAM FOCUS

- SHARED HUMAN/AUTOMATION CONTROL TELEROBOTIC DEMONSTRATION
- SUPPORT OF SATELLITE SERVICING CAPABILITY
- INITIATION OF NEW APPLICATIONS DEMOS: SHUTTLE RMS AND UMBILICAL
- INITIATION OF PLANETARY ROVER
- CONTINUED CORE TECHNOLOGY

LONG RANGE MILESTONES:



SPACE SENSORS

OAST

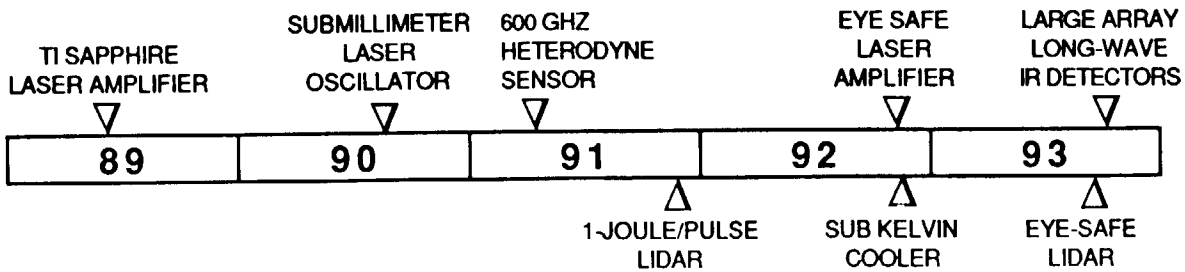
LONG RANGE GOAL:
TO PROVIDE SPACE QUALIFIABLE TECHNOLOGY FOR THE EFFECTIVE AND EFFICIENT DETECTION OF ELECTROMAGNETIC RADIATION FROM THE MILLIMETER TO THE GAMMA-RAY WAVELENGTH REGION

THRUSTS:
- DETECTOR SENSORS
- SUBMMW SENSORS
- LIDAR SENSORS
- COOLER SYSTEMS
- SOLID STATE TECHNOLOGY (INCLUDING PHOTONICS)

FY 88 ACCOMPLISHMENTS:
- EXCELLENT LOW-BACKGROUND IR ARRAY PERFORMANCE
- HELIUM-3 COOLER (0.25°K) FOR ROCKET-BORNE IR EXPERIMENTS
- DIODE-PUMPED Nd:YAG SPACE LASER FOR RANGING AND ALTIMETRY
- IMAGING X-RAY AND COSMIC RAY SPECTROMETERS
- SUBMILLIMETER OSCILLATORS DEMONSTRATED AT
- SOLID-STATE LASER DESIGN DATA BASE

FY89 PROGRAM FOCUS:
- SOLID-STATE LASER TECHNOLOGY
- LONG-LIFE, STABLE 10-JOULE-PER-PULSE (CO2) SPACE LASER FOR LASER ATMOSPHERIC WIND SOUNDER
- HUBBLE SPACE TELESCOPE DESIGN/ENG'G KNOWLEDGE CAPTURE
- COMPONENTS FOR 600-3000 GHZ SUB-mm SENSORS
- INCOHERENT DETECTORS FOR IR, UV, X-RAY & COSMIC RAY SENSORS

LONG RANGE MILESTONES:



HUMANS IN SPACE

OAST

LONG RANGE GOAL:

TO PROVIDE GUIDELINES, METHODS AND TECHNOLOGY TO ASSURE THE SAFE AND EFFECTIVE UTILIZATION OF HUMANS IN SPACE

THRUSTS:

- HUMAN PERFORMANCE
- HUMAN/INTELLIGENT SYSTEM INTERFACE
- SENSORY AND INFORMATION FUSION
- EVA SYSTEMS

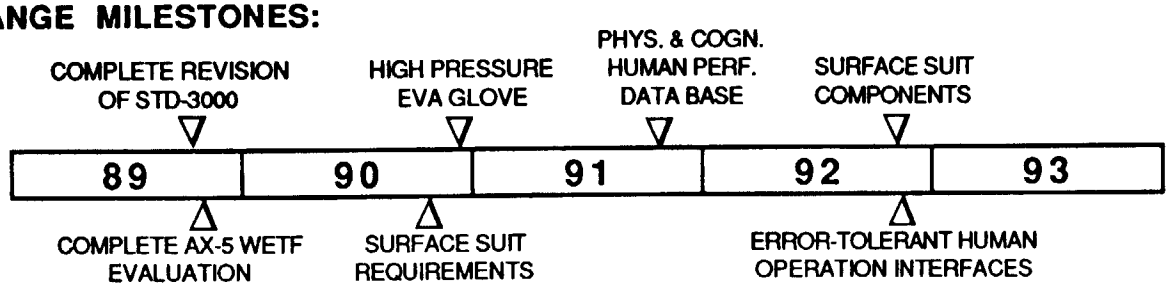
FY 88 ACCOMPLISHMENTS:

- ADVANCED HARD SPACE SUIT STRENGTH/MOTION TESTING IN WETF
- VIRTUAL WORKSTATION
- EVA HELMET MOUNTED DISPLAY PROTOTYPE
- HUMAN INTERFACE TO THERMAL EXPERT SYSTEM
- PYRAMID IMAGE CODES DEVELOPED FOR HUMAN DISPLAY INTERFACES AND FOR ROBUST COMPUTER VISION

FY89 PROGRAM FOCUS:

- STUDY OF HUMAN FACTORS IMPLICATION IN NASA'S OPERATIONAL EXPERIENCE
- EVALUATION OF HARD SUIT AND GLOVES FOR EVA
- EVALUATION OF VIRTUAL WORKSTATION FOR TELEROBOTIC CONTROL AND "EXPLORATION" OF PLANETARY SURFACES
- INITIATION OF SURFACE SUIT AND HUMAN PERFORMANCE ELEMENTS OF PATHFINDER

LONG RANGE MILESTONES:



SPACE COMMUNICATIONS

OAST

LONG RANGE GOAL:

DEVELOP DEVICES, COMPONENTS & ANALYTICAL METHODS TO SUPPORT THE COMM. RQMTS. OF NASA'S FUTURE NEAR-EARTH, DEEP-SPACE & SPACE STATION MISSIONS

THRUSTS:

- HIGH EFFICIENCY TUBES
- SOLID STATE DEVICES
- LARGE ANTENNAS
- OPTICAL COMMUNICATIONS

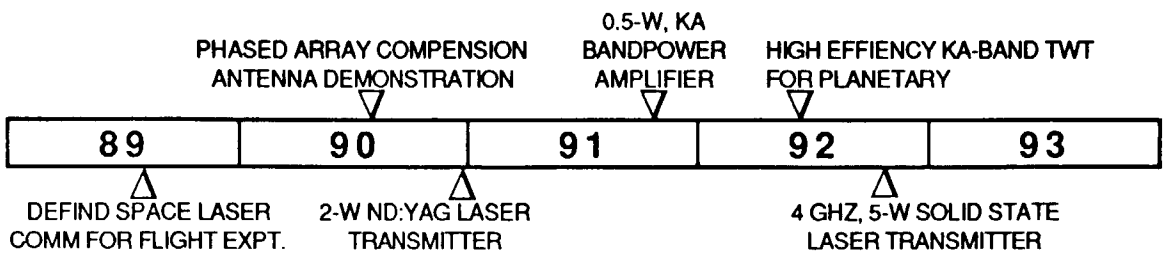
FY 88 ACCOMPLISHMENTS:

- Ka-BAND MMIC POWER AMPLIFIER FOR DEEP SPACE MISSIONS
- SPACE ANTENNA DISTORTION COMPENSATION BY ADAPTIVE ELECTRONIC FEED
- HIGH-EFFICIENCY DEEP SPACE OPTICAL COMMUNICATIONS LASER
- PHASED-ARRAY SEMICONDUCTOR LASER
- NEAR-EARTH LASER TRANSMITTER AND RECEIVER
- HIGH-EFFICIENCY X-BAND TWT FOR MARS OBSERVER

FY89 PROGRAM FOCUS:

- HIGH-FREQUENCY, HIGH-EFFICIENCY TWTS
- COMPENSATION FOR FLEXIBLE SPACE ANTENNAS
- HIGH-DATA-RATE EARTH ORBIT AND PLANETARY
- SPACE LASER COMMUNICATIONS
- HIGH-EFFICIENCY MMIC TECHNOLOGY FOR PLANETARY COMMUNICATIONS

LONG RANGE MILESTONES:



SPACE DATA SYSTEMS

OAST

LONG RANGE GOAL:

TO PROVIDE AGENCY FOUNDATION IN FUNDAMENTAL AEROSPACE COMPUTER SCIENCE TO ENABLE EFFICIENT AND EFFECTIVE ACQUISITION, PROCESSING, DISTRIBUTION AND ANALYSIS OF SPACE-DERIVED INFORMATION

THRUSTS:

- CONCURRENT PROCESSING
- INFORMATION MANAGEMENT
- ADVANCED ATA CONCEPTS
- ON-BOARD PROCESSING TECHNIQUES
- HIGH PERFORMANCE STORAGE TECHNOLOGY

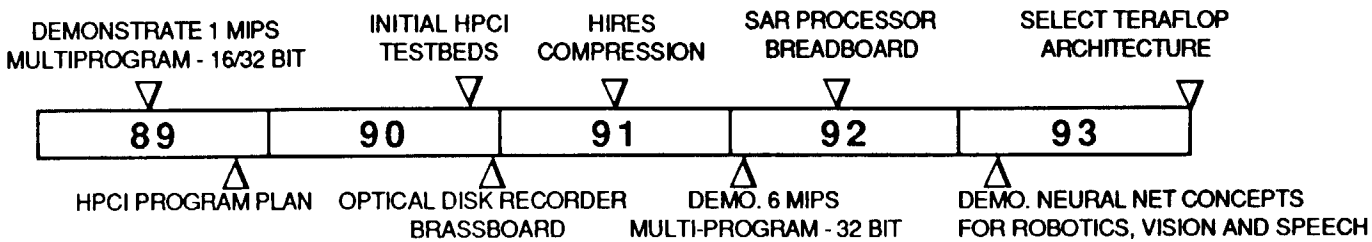
FY 88 ACCOMPLISHMENTS:

- ESTABLISHMENT OF CENTER OF EXCELLENCE IN SPACE DATA AND INFORMATION SCIENCES AT THE UNIVERSITY OF MARYLAND AND GSFC
- DEMONSTRATED REVERSIBLE, VAR. STRENGTH ELECTRONIC "NEURAL NETWORK" DEVICE
- DEVELOPED HARDWARE SIMULATOR OF SPARSE DISTRIBUTED NETWORK
- COMPLETED DESIGN FOR REAL-TIME FOCAL PLANE PROCESSOR FOR HIGH RESOLUTION IMAGING SPECTROMETER
- DEMONSTRATED FEASIBILITY OF OPTICAL NEED, LASER DIODES AND MEDIA FOR TERABIT ERASIBLE OPTICAL DISK RECORDER

FY 89 PROGRAM FOCUS:

- NEURAL NETWORK RESEARCH
- ON-BOARD PROCESSING SYSTEMS
- MODULAR TERABIT OPTICAL DISK BRASSBOARD
- PLAN HIGH PERFORMANCE COMPUTING INITIATIVE (HPCI)

LONG RANGE MILESTONES:



TRANSPORTATION VEHICLE GUIDANCE AND CONTROL

OAST

LONG RANGE GOAL:

TO PROVIDE COST EFFECTIVE, RELIABLE AVIONICS FOR ADVANCED EARTH-TO-ORBIT TRANSFER AND PLANETARY VEHICLES

THRUSTS:

- FAULT TOLERANT PROCESSING
- SOFTWARE ENGINEERING
- ADAPTIVE G, N. AND C CONCEPTS
- SENSORS AND ACTUATORS

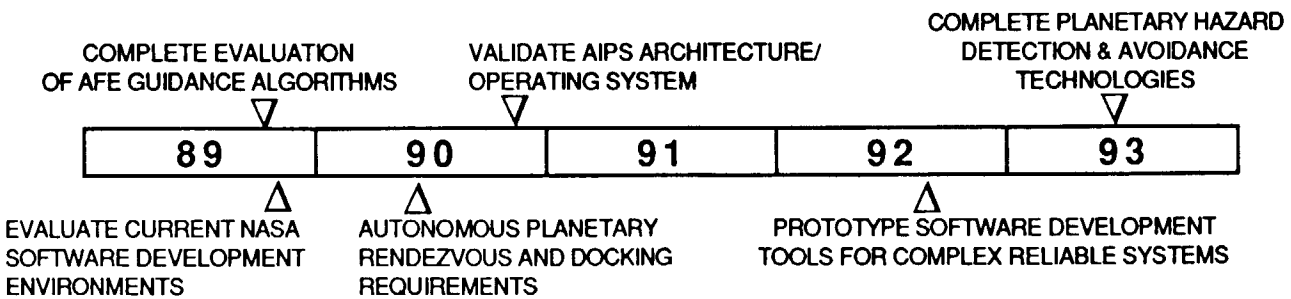
FY 88 ACCOMPLISHMENTS:

- ADVANCED 8-COMPONENT FIBER OPTIC GYRO BREADBOARD
- INCREASED "QUIET TIME" FOR AFE
- LANDING ANALYSIS FOR MARS SAMPLE RETURN MISSION
- IMPACT OF ADA ON FLIGHT CONTROL
- EVALUATION OF AIPS FAULT-TOLERANT PROCESSOR
- EMPIRICAL COMPARISON OF FAULT TOLERANCE AND FAULT ELIMINATION

FY89 PROGRAM FOCUS:

- VALIDATION OF AIPS OPERATING SOFTWARE
- AUTOMATED RENDEZVOUS AND DOCKING, PATHFINDER
- ADAPTIVE LANDING, PATHFINDER
- SOFTWARE ENGINEERING FOR COMPLEX RELIABLE SYSTEMS

LONG RANGE MILESTONES:



SPACECRAFT CONTROL

OAST

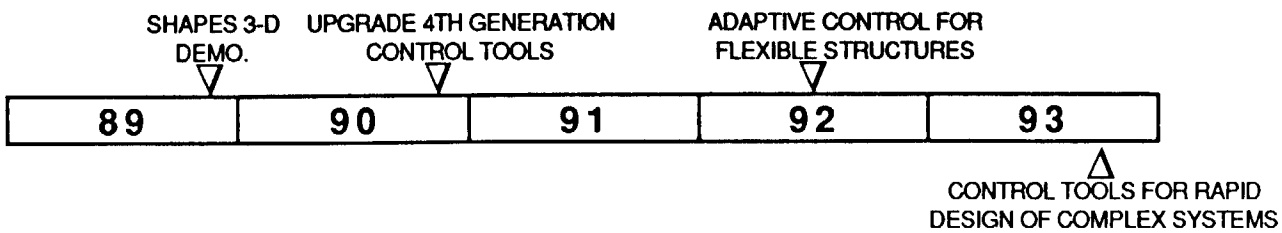
LONG RANGE GOAL:
TO PROVIDE THE CONTROL ALGORITHMS, COMPUTATIONAL METHODS, AND SYSTEMS MODELS TO ENABLE THE CONTROL OF COMPLEX/FLEXIBLE SPACE SYSTEMS

THRUSTS:
- COMPUTATIONAL CONTROL
- ADVANCED CONTROL
- CONTROL OF FLEXIBLE STRUCTURES
- CONTROL OF LARGE APERATURE SEGMENTED OPTICS/INTERFEROMETERS

FY 89 ACCOMPLISHMENTS
- CONTROL TECHNIQUES EVALUATED ON ADVANCED CONTROL EVALUATION FOR STRUCTURES (ACES)-1 TEST ARTICLE
- NON-LINEAR, MULTI-BODY COMPUTER ANALYSIS TOOL ENHANCEMENTS
- COMPUTATIONALLY EFFICIENT CONTROL TECHNIQUES EVALUATED ON SPACECRAFT
- CONTROL LABORATORY EXPERIMENT (SCOLE)
- LQG CONTROL FOR THE MINI-MAST EXPERIMENT
- COMPLETED DESIGN FOR 3-D SHAPES BREADBOARD AND DETAILED PERFORMANCE CHARACTERIZATION

FY 89 PROGRAM FOCUS
- CONTROL OF FLEXIBLE STRUCTURES; LARGE ANTENNAS AND PLATFORMS
- CONTROL OF PRECISION OPTICAL SYSTEMS
- COMPUTATIONAL METHODS FOR MULTI-BODY CONTROL

LONG RANGE MILESTONES:



INFORMATION SCIENCES AND HUMAN FACTORS DIVISION
MAJOR PROGRAM DIRECTIONS IN SPACE

OAST

GENERAL

- INCREASE UNIVERSITY RESEARCH BLOCK GRANTS
- INCREASE PROGRAM OFFICE AND INDUSTRY INVOLVEMENT IN CSTI AND PATHFINDER ELEMEN
- EXPLIOT OPPORTUNITIES OF PHOTONICS AND HIGH-TEMPERATURE SUPERCONDUCTIVITY
- INCREASE EMPHASIS ON SPACE FLIGHT EXPERIMENTS

EVOLVING SPACE ROBOTIC CAPABILITY:

- MAINTAIN LONG-TERM TECHNOLOGY BASE
- TRANSFER INITIAL DEMONSTRATION RESULTS/CAPABILITY TO FTS AND SATELLITE SERVICING CONCEPTS
- INCREASED EMPHASIS ON APPLICATIONS DEMONSTRATIONS AND TECHNOLOGY FLIGHT EXPERIMENTS
- INITIATE PLANETARY ROVER PROGRAM

INTELLIGENT SYSTEMS RESEARCH:

- MAINTAIN NATIONAL REPUTATION IN ARTIFICIAL INTELLIGENCE RESEARCH
- PERFORM EFFECTIVE GROUND-BASED DEMONSTRATIONS FOR SPACE STATION, SHUTTLE AND SCIENCE MISSIONS
- INITIATE RESEARCH TO MERGE INTELLIGENT SYSTEMS WITH EXPLORATION VEHICLES

INFORMATION SCIENCES AND HUMAN FACTORS DIVISION
MAJOR PROGRAM DIRECTIONS IN SPACE

OAST

NASA-UNIQUE SPACE SENSING CONCEPTS:

- ADDRESS NASA-UNIQUE DETECTOR REQUIREMENTS IN CSTI SCIENCE SENSORS PROGRAM
  - LOW-BACKGROUND INFRARED DETECTORS
  - SUBMILLIMETER SENSORS
  - ACTIVE LASER SENSING
- INITIATE NEW THRUST IN SCIENCE SENSORS AND OPTICS FOR GLOBAL CHANGE

ADVANCED SPACE COMMUNICATIONS CAPABILITY:

- CONTINUE TWT, SOLID STATE MMIC DEVICE AND ANTENNA RESEARCH
- INCREASE SUPPORT TO NEAR-EARTH AND PLANETARY OPTICAL COMMUNICATIONS

EFFICIENT ACQUISITION, PROCESSING, DISTRIBUTION AND ANALYSIS OF SPACE DERIVED DATA:

- MAINTAIN STRONG COMPUTER SCIENCE PROGRAM IN COST-EFFECTIVE SOFTWARE, CONCURRENT PROCESSING AND INFORMATION MANAGEMENT
- IMPLEMENT CSTI HIGH-RATE/CAPACITY DATA PROGRAM
- INITIATE NEW INITIATIVE IN HIGH PERFORMANCE COMPUTING

INFORMATION SCIENCES AND HUMAN FACTORS DIVISION
MAJOR PROGRAM DIRECTIONS IN SPACE

OAST

EFFECTIVE UTILIZATION OF HUMANS IN SPACE:

- FOCUS ON HUMAN-INTELLIGENT SYSTEM INTERFACE, SENSOR AND INFORMATION FUSION, AND EVA SYSTEMS
- INITIATE PATHFINDER EXTRAVEHICULAR ACTIVITY/SUIT AND HUMAN PERFORMANCE PROGRAM ELEMENTS

CONTROL OF COMPLEX/FLEXIBLE SPACE SYSTEMS:

- SUPPORT CONTROL STRUCTURES INTERACTION RESEARCH
- INITIATE RESEARCH FOR CONTROL OF PRECISION OPTICS
- INITIATE COMPUTATIONAL CONTROLS RESEARCH PROGRAM

GUIDANCE, NAVIGATION AND CONTROL TECHNOLOGY FOR TRANSPORTATION VEHICLES:

- SUPPORT REAL-TIME FAULT TOLERANT CONTROL ARCHITECTURE RESEARCH
- ADVOCATE FAULT TOLERANT FLIGHT SYSTEMS INITIATIVE
- IMPLEMENT NEW THRUST IN SOFTWARE ENGINEERING FOR COMPLEX RELIABLE SYSTEMS
- INITIATE PATHFINDER AUTONOMOUS LANDER AND AUTONOMOUS RENDEZVOUS AND DOCKING PROGRAM ELEMENTS