Computing, Information, and Communications Technology (CICT) Program Overview

FCCT Course
April 17, 2003
NASA Ames Research Center

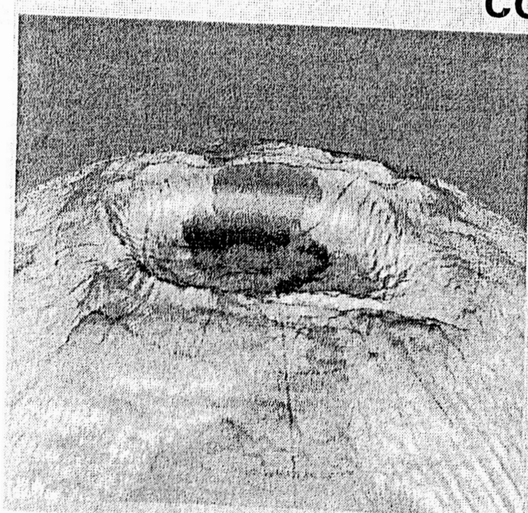
COMPUTING
INFORMATION &
COMMUNICATIONS
TECHNOLOGY

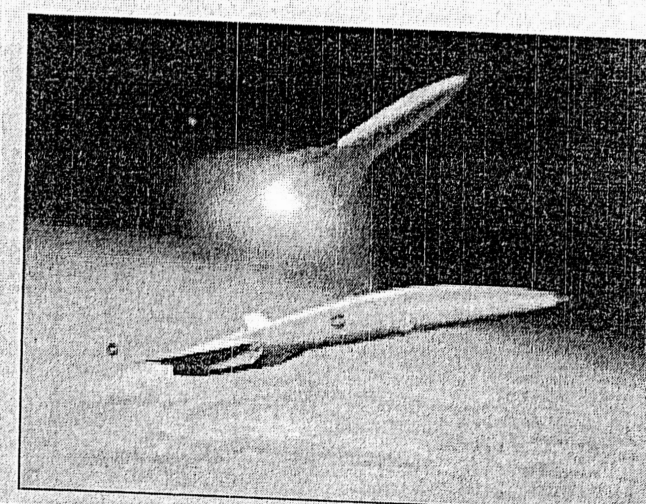
CICT Program Goal

Enable NASA's Scientific Research, Space Exploration, and Aerospace Technology Missions

with greater mission assurance, for less cost, with increased science return

through the development and use of advanced computing, information and communications technologies.

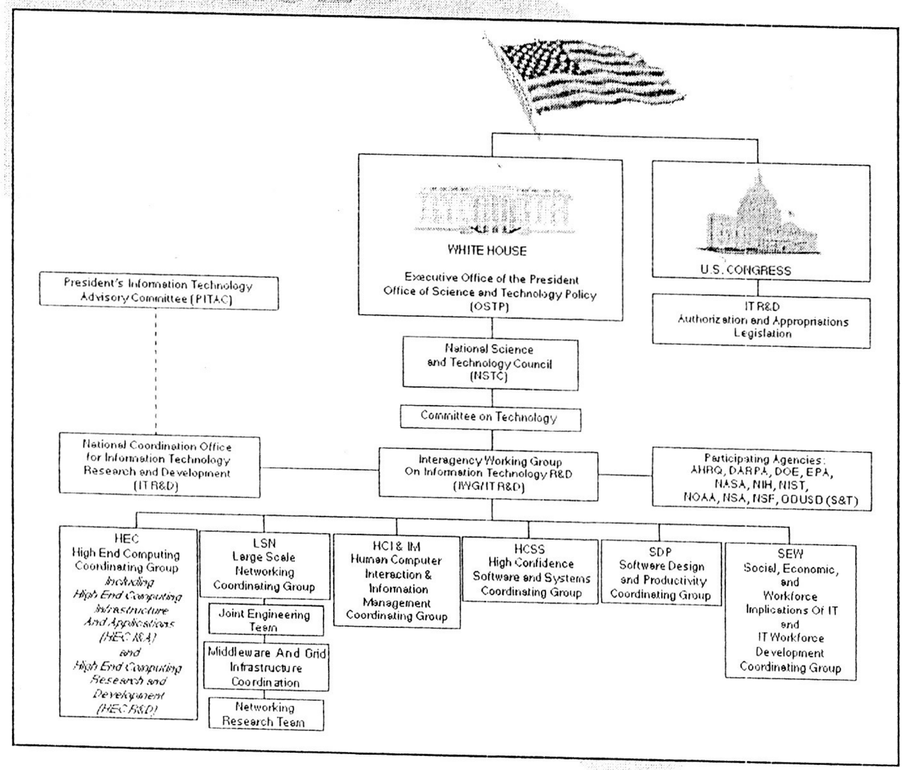




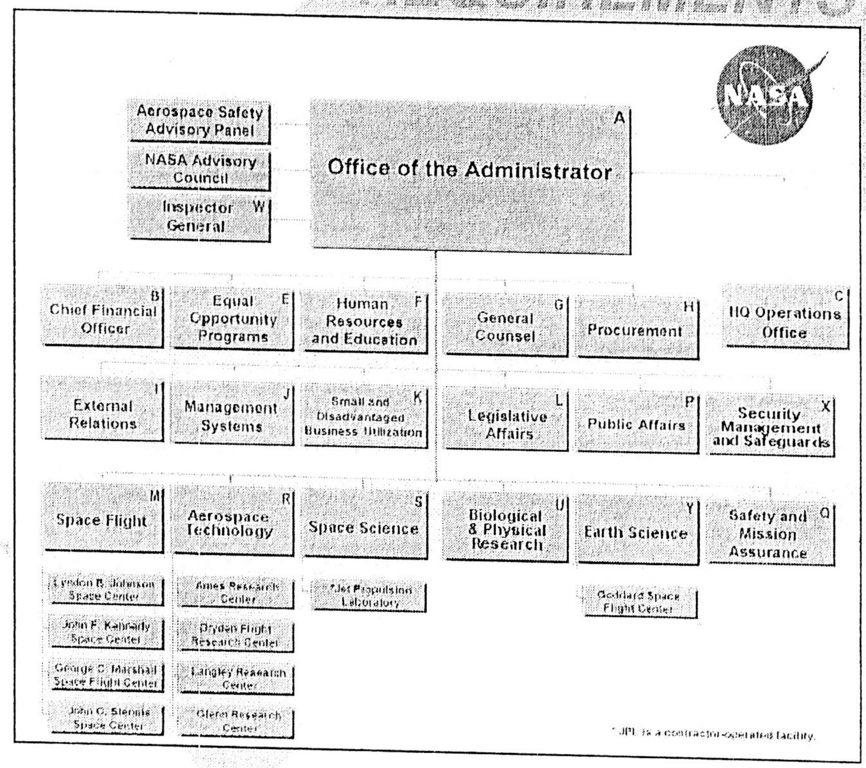
NASA CICT Goal

- From Guidance and Requirements to Goal -

GUIDANCE



REQUIREMENTS



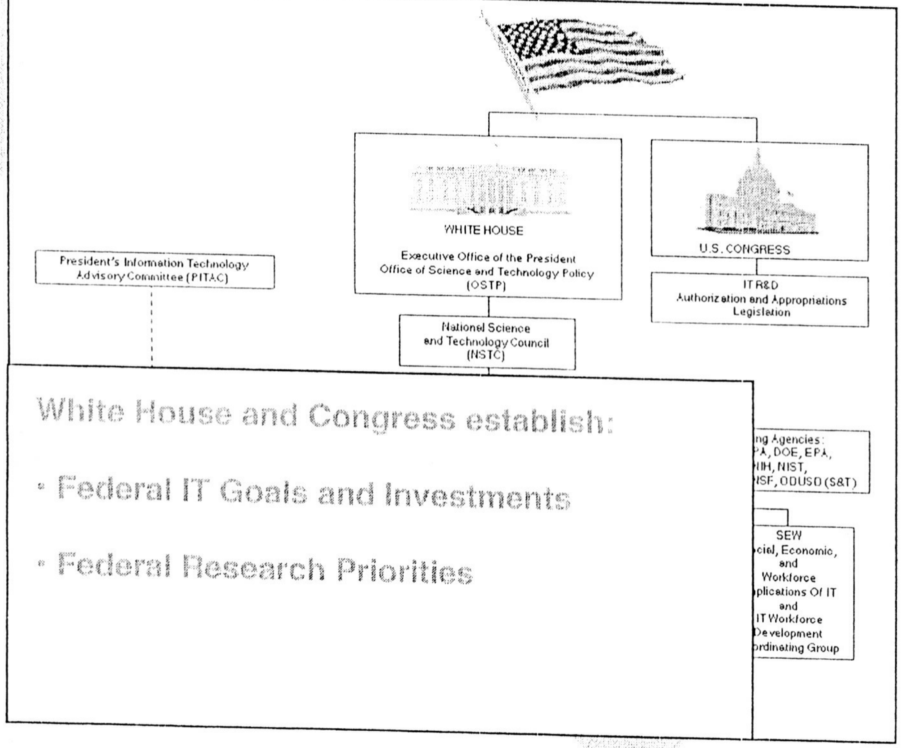
NASA CICT Goal

Enable NASA's Scientific Research, Space Exploration, and Aerospace Technology Missions with greater mission assurance, for less cost, with increased science return through the development and use of advanced computing, information and communications technologies.

NASA CICT Goal

- From Guidance and Requirements to Goal -

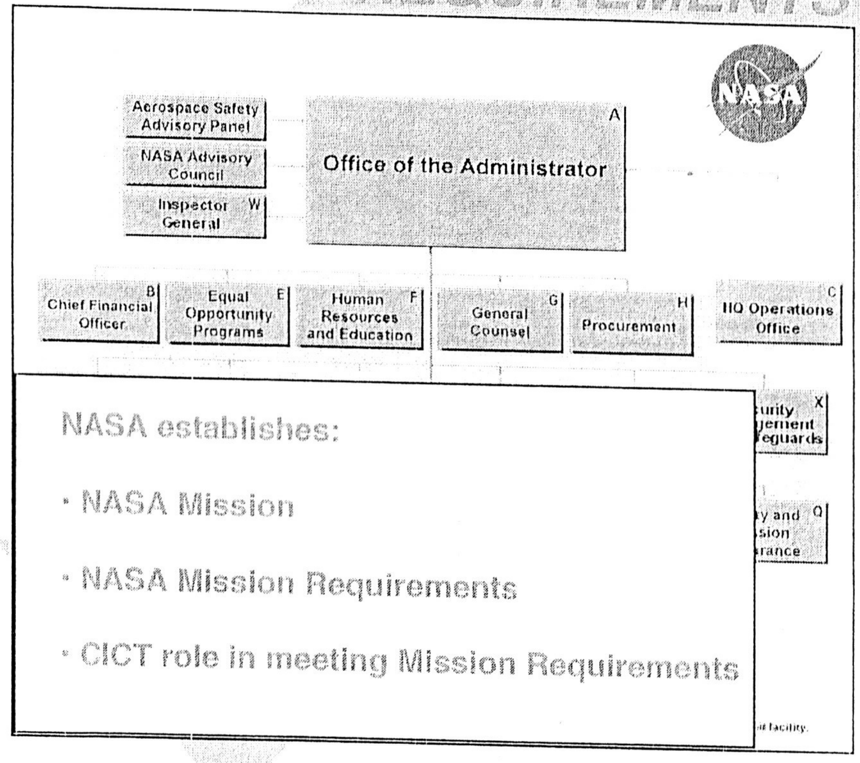
GUIDANCE



White House and Congress establish:

- Federal IT Goals and Investments
- Federal Research Priorities

REQUIREMENTS



NASA establishes:

- NASA Mission
- NASA Mission Requirements
- CICT role in meeting Mission Requirements

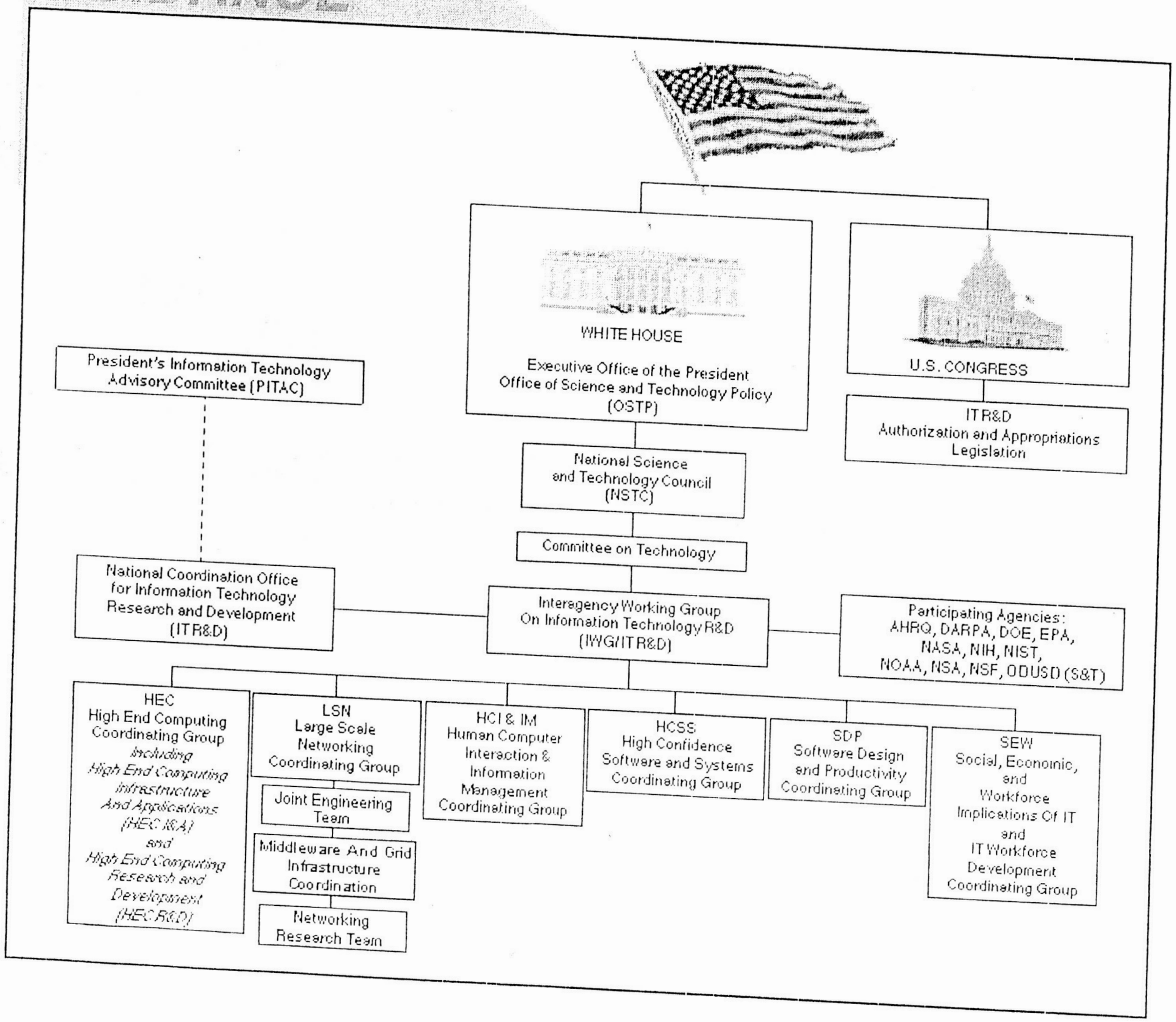
NASA CICT Goal

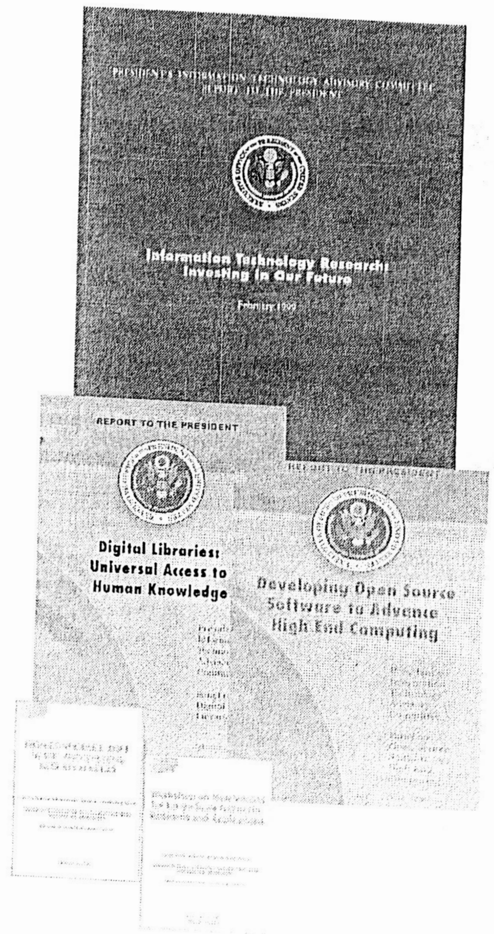
Enable NASA's Scientific Research, Space Exploration, and Aerospace Technology Missions with greater mission assurance, for less cost, with increased science return through the development and use of advanced computing, information and communications technologies.

NASA CICT Goal

- From Guidance and Requirements to Goal -

GUIDANCE





NASA CICT Goal

- From Guidance and Requirements to Goal -

GUIDANCE

National Coordination Office for Information Technology Research and Development

PITAC Report Research Priorities:

- Software

"…special emphasis should be placed … on managing large amounts of information, making computers easier, to use making software easier to create and maintain, and and improve the ways humans interact with computers"

- Scalable Information Infrastructure

"…research to learn how to build and use large, complex, high-reliable, and secure systems…"

- High-End Computing

"Funding should focus on …. overcoming the limitations of today's systems…"

REQUIREMENTS

NASA Mission:

To understand and protect our home planet
To explore the Universe and search for life
To inspire the next generation of explorers

NASA Enterprises execute missions:

- Earth Science
- Space Science
- Biological and Physical Research
- Human Exploration and Development of Space
- Aerospace Technology

NASA CICT Role:

- Develop computing, information, and communication technologies in support of NASA mission requirements

NASA CICT Goal

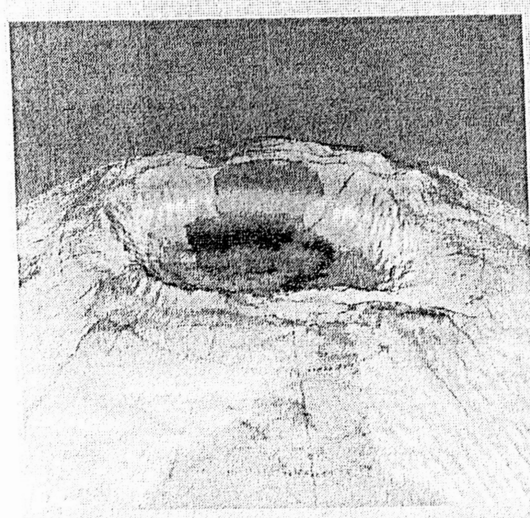
Enable NASA's Scientific Research, Space Exploration, and Aerospace Technology Missions with greater mission assurance, for less cost, with increased science return through the development and use of advanced computing, information and communications technologies.

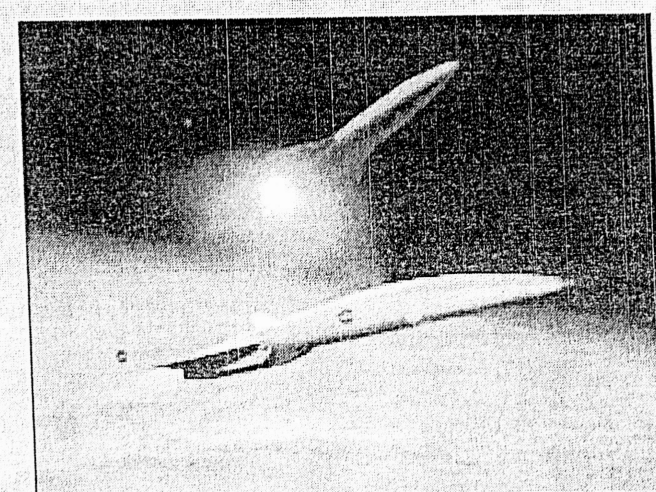
The NASA Mission

To understand and protect our home planet
To explore the Universe and search for life
To inspire the next generation of explorers

... as only NASA can.

Sean O'Keefe
NASA Administrator
April 12, 2002

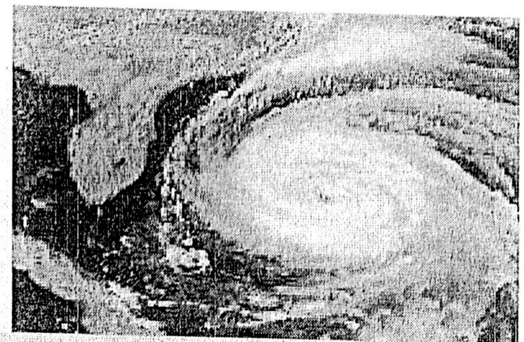
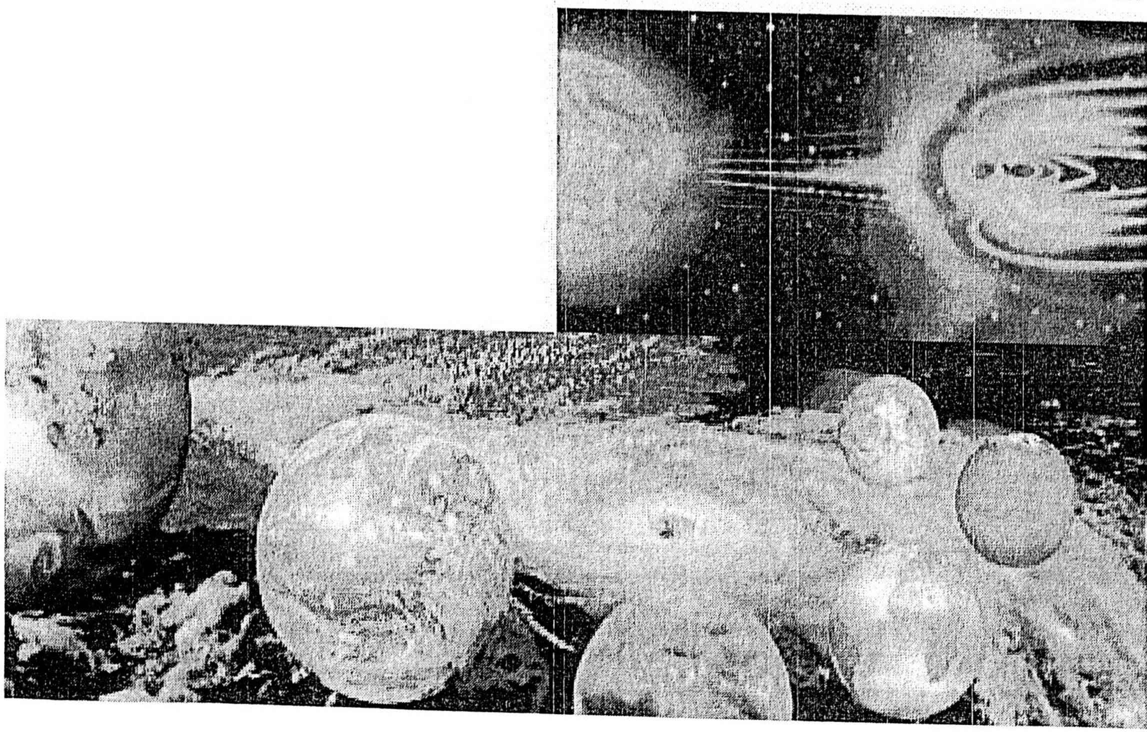
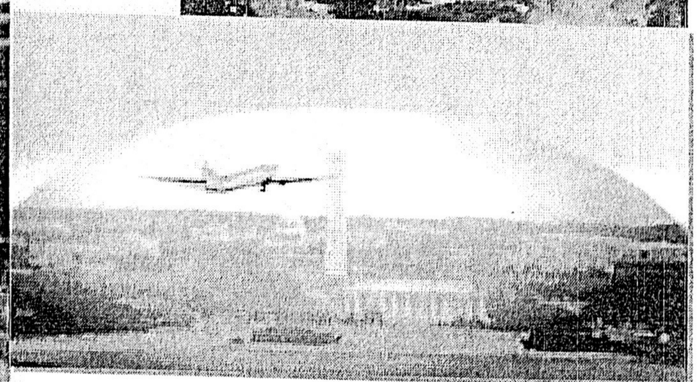




The NASA Mission

- To Understand and Protect Our Home Planet -

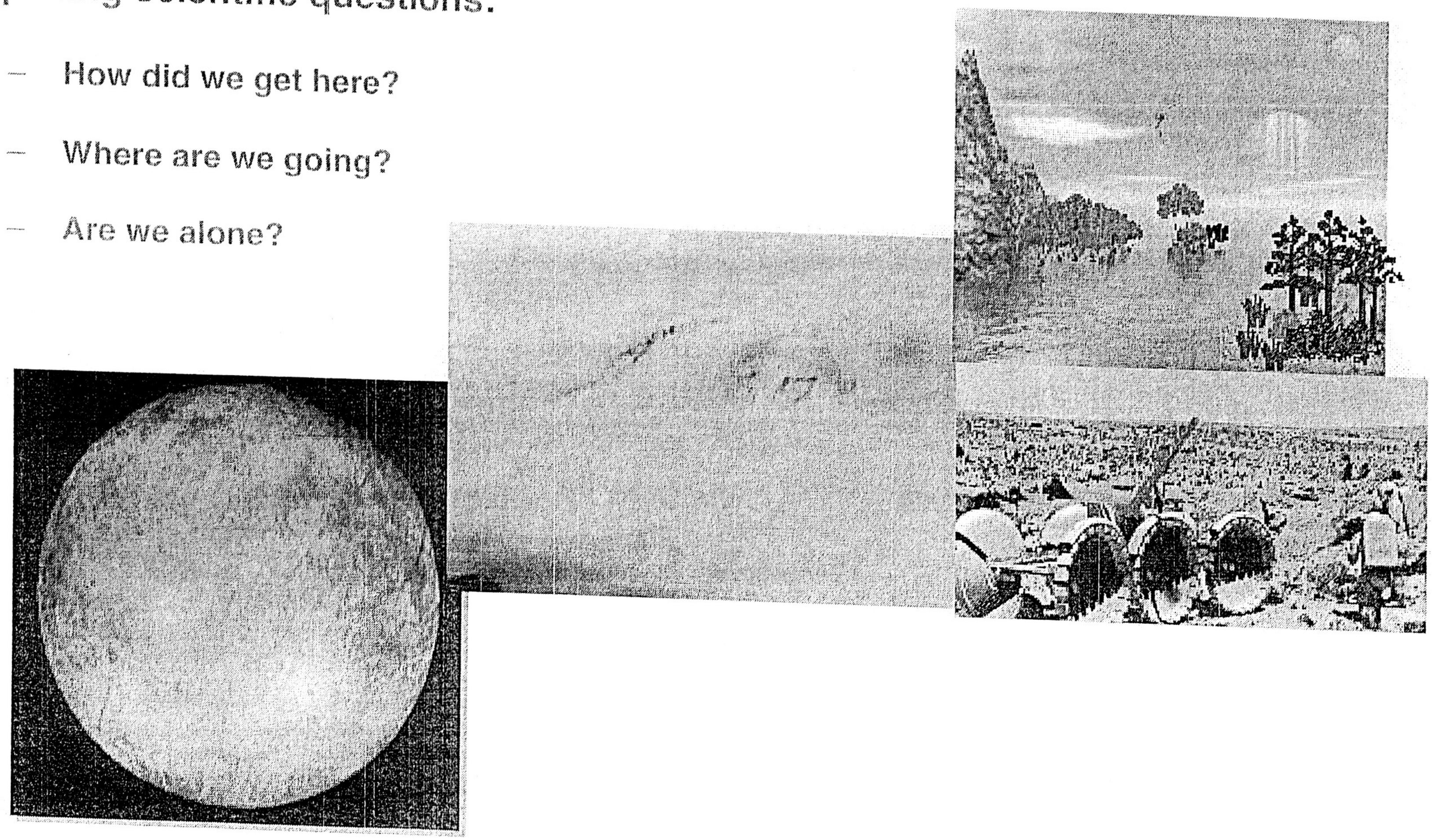
- Understanding the Earth's system and its response to natural and human-induced changes
- Enabling a safe, secure, efficient, and environmentally friendly air transportation system
- Investing in technologies and collaborating with others to improve the quality of life and to create a more secure world

The NASA Mission

- To Explore the Universe and Search for Life -

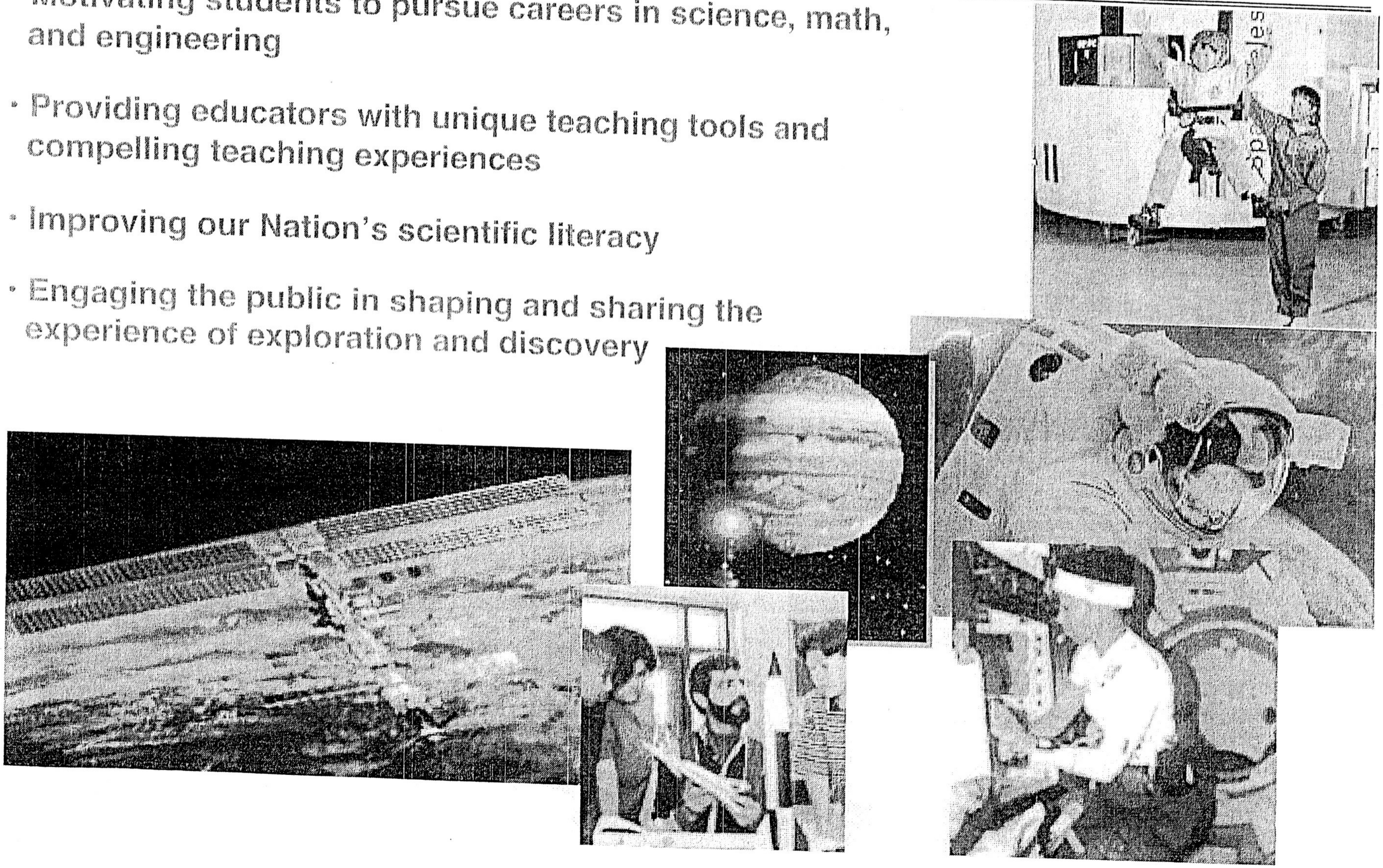
- Exploring the Universe and the life within it... enabled by technology, first with robotic trailblazers, and eventually humans... as driven by these compelling scientific questions:
  - How did we get here?
  - Where are we going?
  - Are we alone?



The NASA Mission

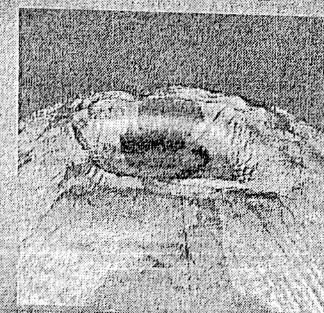
- To Inspire the Next Generation of Explorers -

- Motivating students to pursue careers in science, math, and engineering
- Providing educators with unique teaching tools and compelling teaching experiences
- Improving our Nation's scientific literacy
- Engaging the public in shaping and sharing the experience of exploration and discovery



NASA Mission: Scientific Research

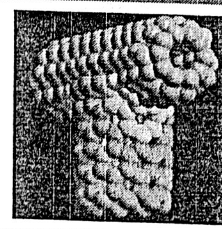
To advance and communicate scientific knowledge and understanding of the Earth, the solar system, and the universe



Space Science Enterprise:

"...reap benefits of technology investments, including biological, information, and nanotechnology systems"

"...enable a virtual presence for autonomous scientific discovery"

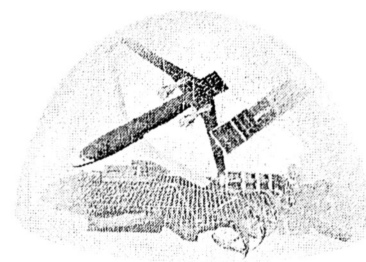


Earth Science Enterprise:

"...implement autonomous satellite control..."

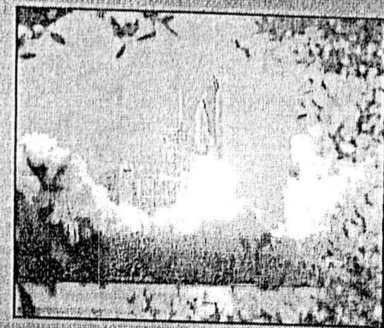
"...deploy cooperative satellite constellations, intelligent sensor webs..."

"...employ distributed computing and data mining techniques for Earth system modeling"



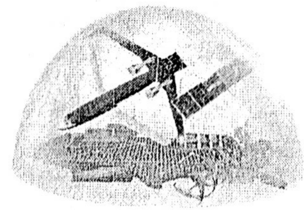
NASA Mission: Space Exploration

To advance human exploration, use, and development of space



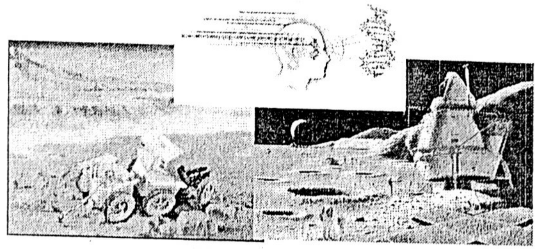
Biological and Physical Research Enterprise:

"…extend our understanding of chemical, biological, and physical systems"



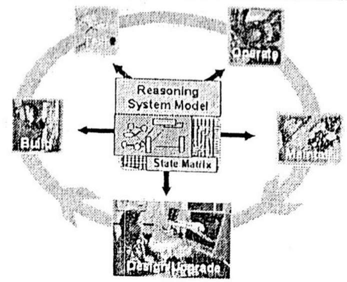
Human Exploration and Development of Space Enterprise:

"…establish robotic/engineering "outposts" at key sites…"



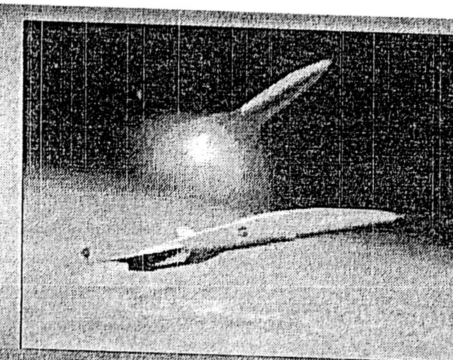
"…extend scientific discovery on missions of exploration through the integrated use of human and robotic explorers"

"Invest in the development of high-leverage technologies to enable safe, effective and affordable human/robotic exploration."



NASA Mission: Aerospace Technology Development

To research, develop, verify, and transfer advanced aeronautics and space technologies

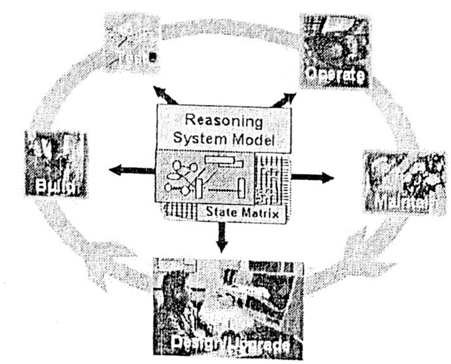


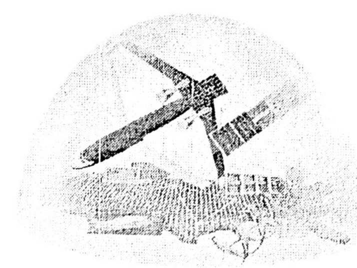
Aerospace Technology Enterprise:

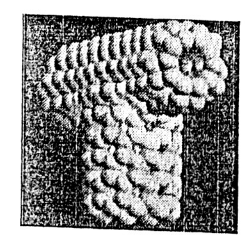
"... develop processes and technology improvements to support safer crewed launches..."

"... develop advanced engineering tools, processes, and design environments..."

"... pioneer basic research in revolutionary technologies such as nanotechnology, information technology, and biotechnology."

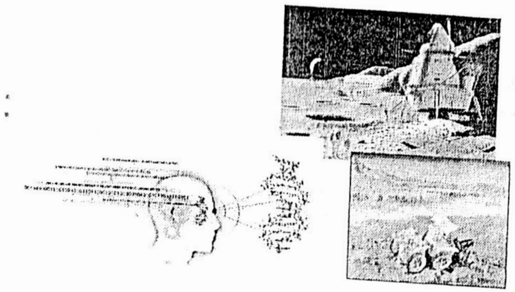




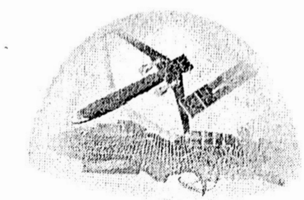


NASA Mission
CICT Technology Requirements

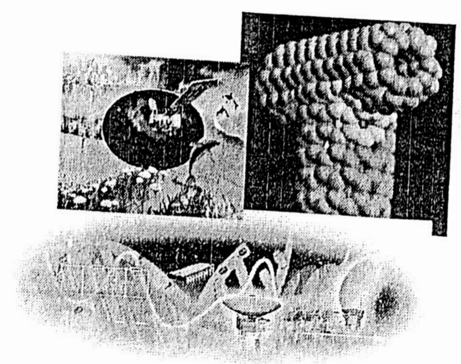
NASA Mid- and Long-Term Mission Plans are reliant on the availability of advanced information technologies:



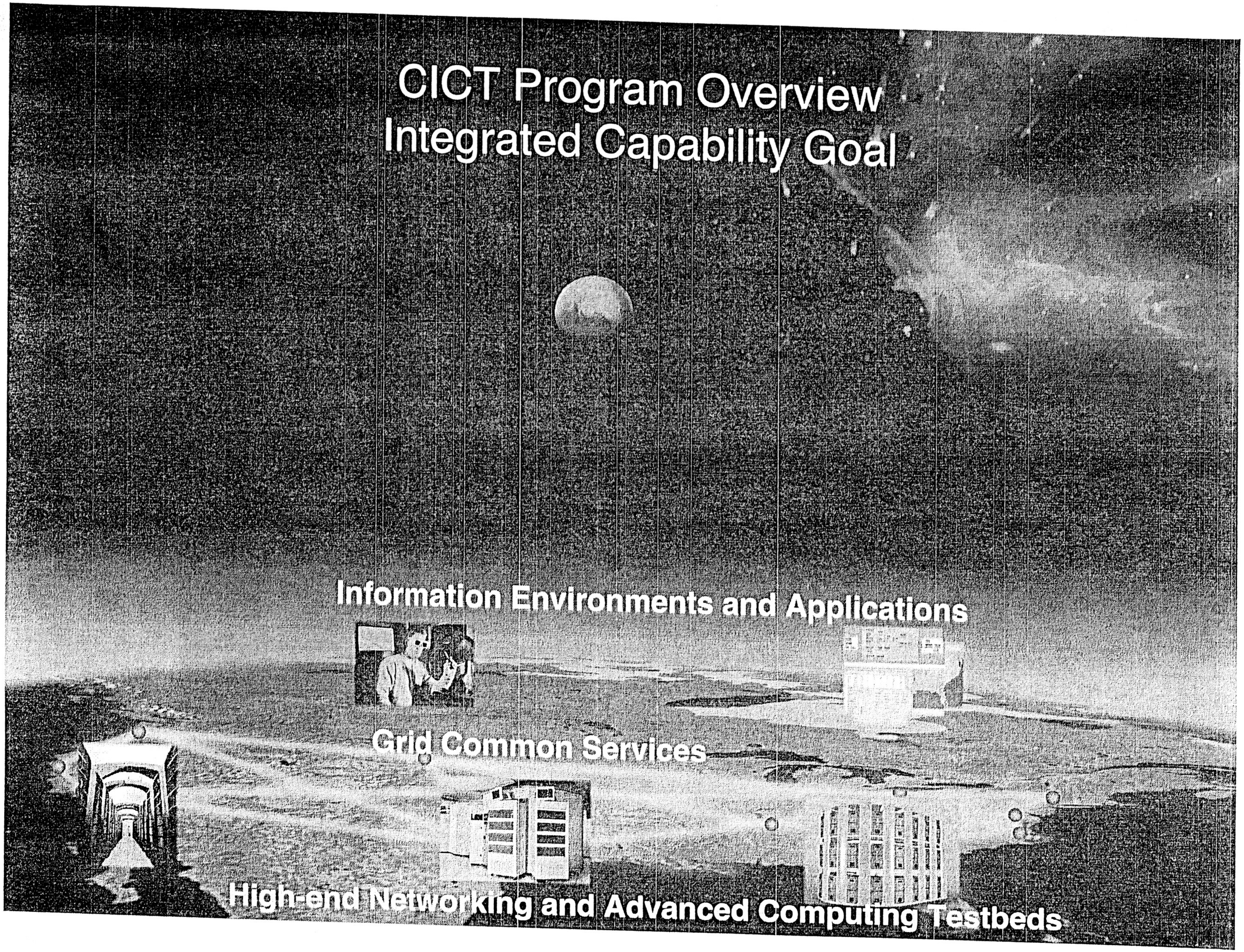
- Smarter more intelligent, collaborative systems including:
  - *Autonomous spacecraft control and scientific discovery*
  - *Intelligent sensorwebs and cooperating constellations*
  - *Integrated human/robotic explorers*



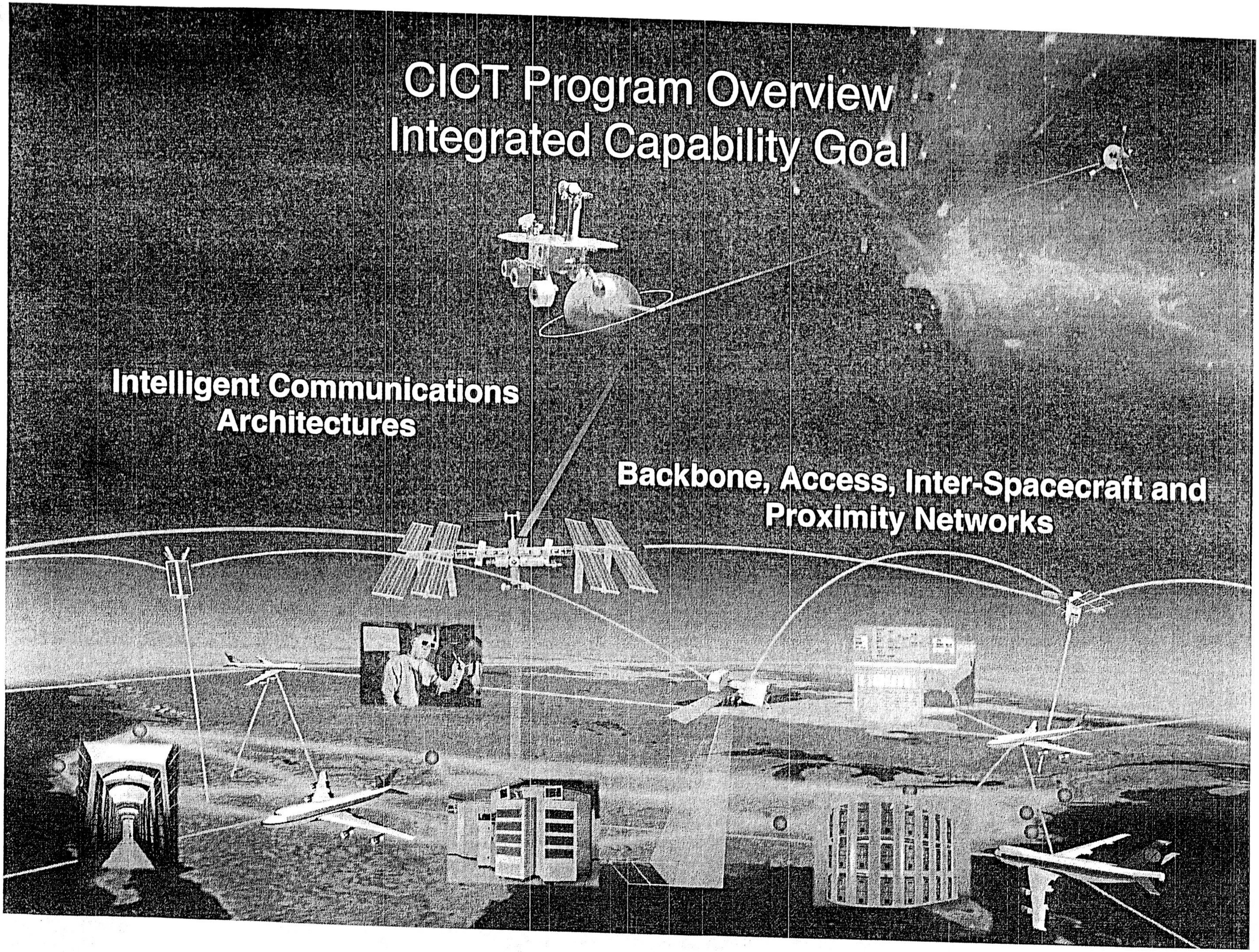
- Advanced computing and communication systems including:
  - *Breakthrough science and engineering simulation capabilities*
  - *Mobile, distributed analysis, data mining, and collaboration capabilities*
  - *Pervasive Earth-to-deep space communications technologies to support robotic and human exploration*

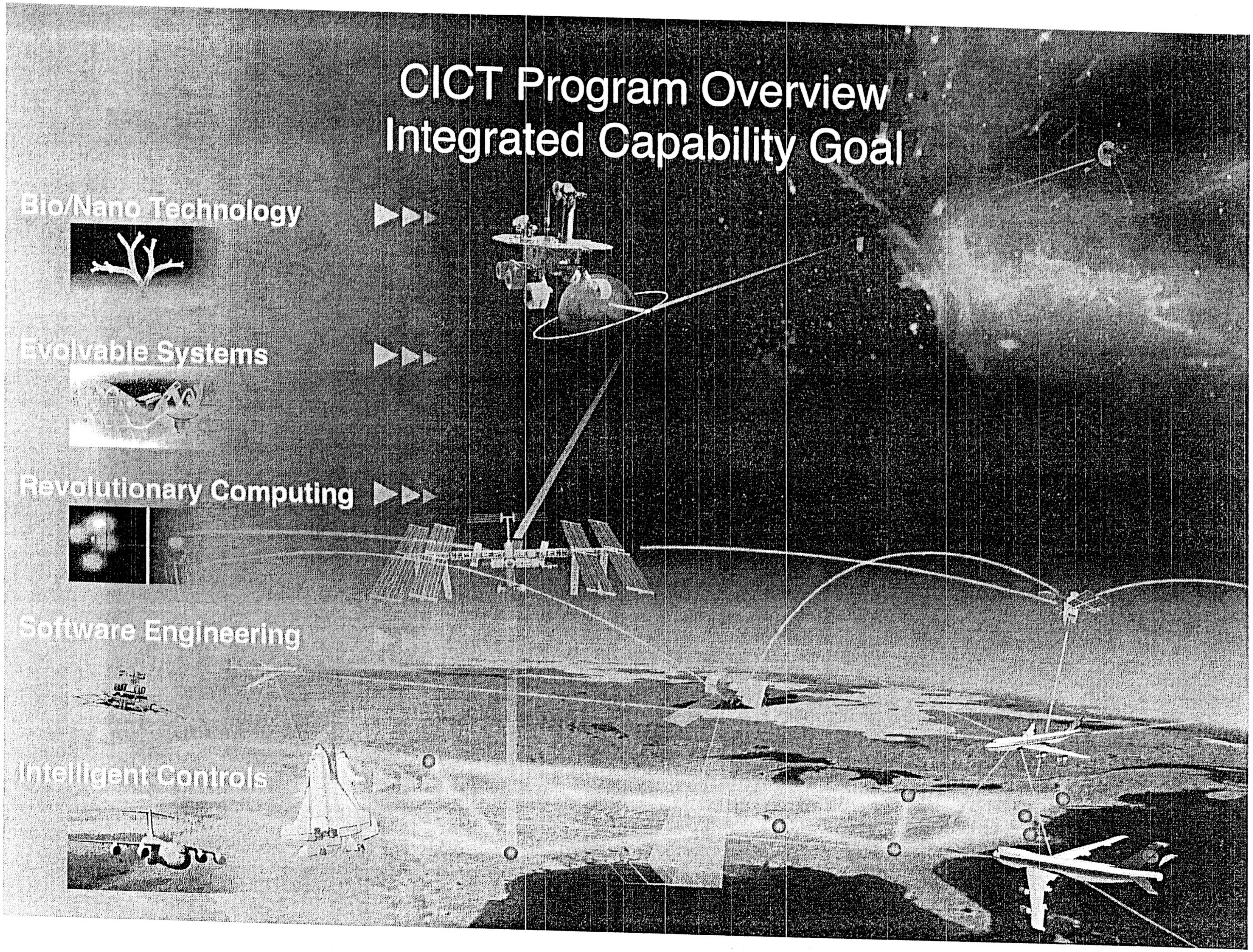


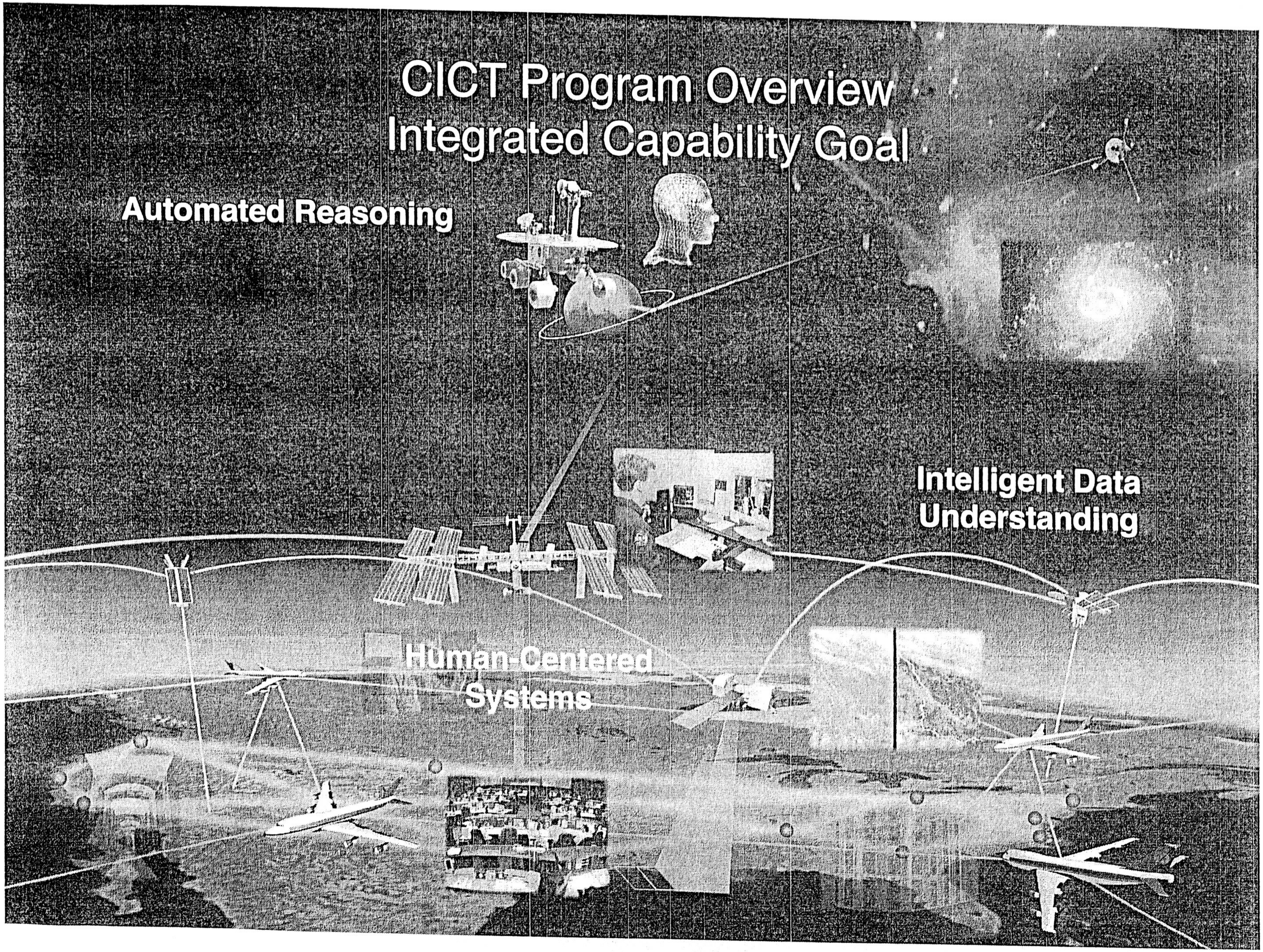
- Revolutionary technologies, including:
  - *Intelligent controls and diagnostics*
  - *Evolvable systems*
  - *Automated software engineering*
  - *Biotechnology and nanotechnology*
  - *Revolutionary computing concepts*


CICT Program Overview
Integrated Capability Goal
Information Environments and Applications
Grid Common Services
High-end Networking and Advanced Computing Testbeds

CICT Program Overview
Integrated Capability Goal




CICT Program Overview
Integrated Capability Goal
Bio/Nano Technology
Evolvable Systems
Revolutionary Computing
Software Engineering
Intelligent Controls

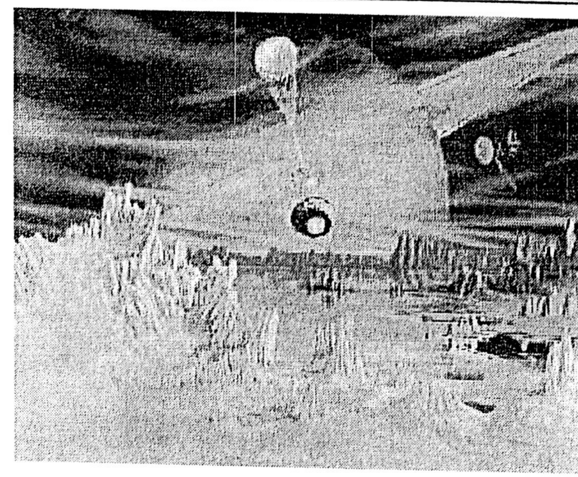

CICT Program Overview
Integrated Capability Goal
Automated Reasoning
Intelligent Data Understanding
Human-Centered Systems


CICT Program Overview
Integrated Capability Goal
IT Strategic
Research
Automated Reasoning
Space Communications
Intelligent Data
Understanding
Computing, Networking and Information Systems
ntered Systems

HORIZON SCENARIOS

"What CICT could enable...."

Planet Life Prospector
Autonomous, adaptive investigator looking for signs of life



Autonomous Vehicle Capabilities:
- "Understands" what to look for – signs of life, spectrographic signatures of key organic molecules, etc.
- "Knows" how to get to interesting locations
- "Knows" what measurements to take
- "Knows" when to notify Mission Control of findings
- "Knows" what to uplink/when, when to compress/how
- "Knows" how to keep itself safe/operational for long periods without assistance from earth

Integrated Systems Capabilities:
- Adaptive systems - use systems in novel
  - Reconfigure vehicle systems on the fly to adapt to science findings
    - Reconfigure sensors/sensor output-processing for on-the-fly adaptation to need science measurements
    - Adaptive utilization of surface "touch and go" vs. anchoring vs. micro-probes
  - Reconfigure vehicle systems to overcome component failures
    - Use all systems resources to best meet needs (utilization of secondary antenna, etc..)

Space Communication Capabilities:
- "Knows" how to pre-configure and dynamically configure itself to allow optimal vehicle to Earth up-linking
- Allows "science community - to - Prospector" link only limited by speed of light and celestial mechanics

Ground Communication Capabilities:
- Pre-notifies international scientific community of incoming data streams
- Allows "on-the-fly" analysis of incoming data, cross-correlating with existing data
- Support spontaneous and evolving scientific collaboration revolving around emerging data

Ground Computing System:
- Allow "during investigation" simulations and deep data-correlation

Solar Flare Detection and Response

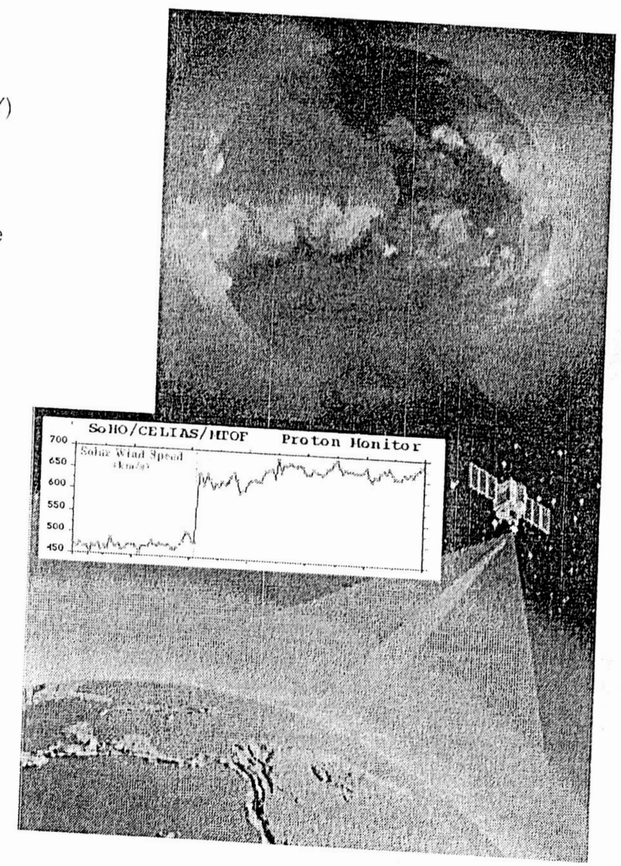
Scenario: A Code S Sun Observing satellite is gathering data on the Sun. A ground-based intelligent data understanding system mines the data in real-time, and detects a developing solar flare which may occur in the next 24 hours. A coordinated response to the flare is necessary.

Capabilities:

- Decision-making regarding astronaut safety for ISS and Libration Point human habitats (Code M)
- Earth Observing satellite retargeting to measure impact on Earth's atmosphere (Code Y)
- Rapid reconfiguration of Jupiter probes to measure the interaction of the flare with the Jovian magnetosphere (Code S)
- Other Deep Space probes are put into safe modes during the flare (Code S)
- Alerts are sent to terrestrial cell phone and satellite operators regarding possible service disruption
- NORAD alerted

Critical Technologies:

- Intelligent Data mining, trending, analysis, and prediction
- Distributed Decision-making by agent-based Human Centered Systems
- Spacecraft Autonomy
- Dynamic communications infrastructure



Libration Point Construction

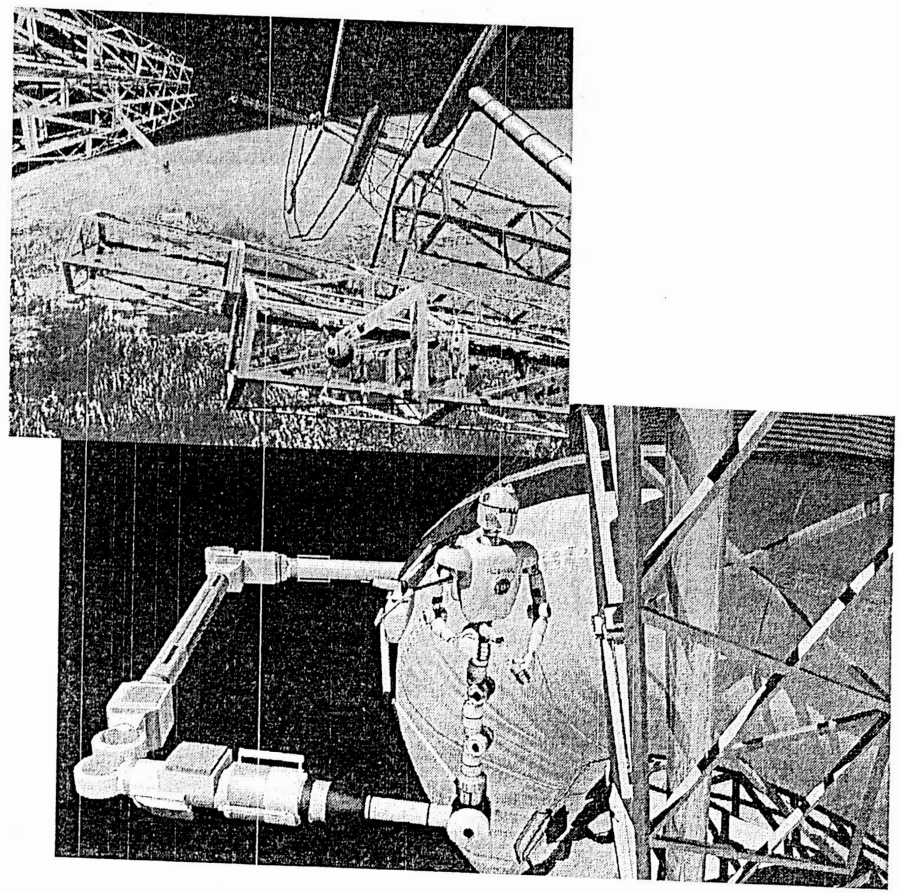
Scenario: A large astronomical telescope is being constructed at a Libration point by a mixed team of humans and robots. The multiple robotic construction assets are coordinated and controlled at a high-level by astronauts nearby as well as Ground Controllers. When problems occur, the astronauts need to either directly teleoperate the robots or perform an EVA.

Capabilities:

- Multi-robot construction
- Operations through time-delay
- Fault Detection and Response

Critical Technologies:

- Multi-level autonomy
- Multi-robot control software
- High-level (goal-directed) operator interfaces
- Environment Sensing and Modeling
- Task planning
- Fault-tolerant execution
- Immersive teleoperator interfaces
- Distributed work collaboration tools
- Crew scheduling and task support tools
- EVA knowledge support systems

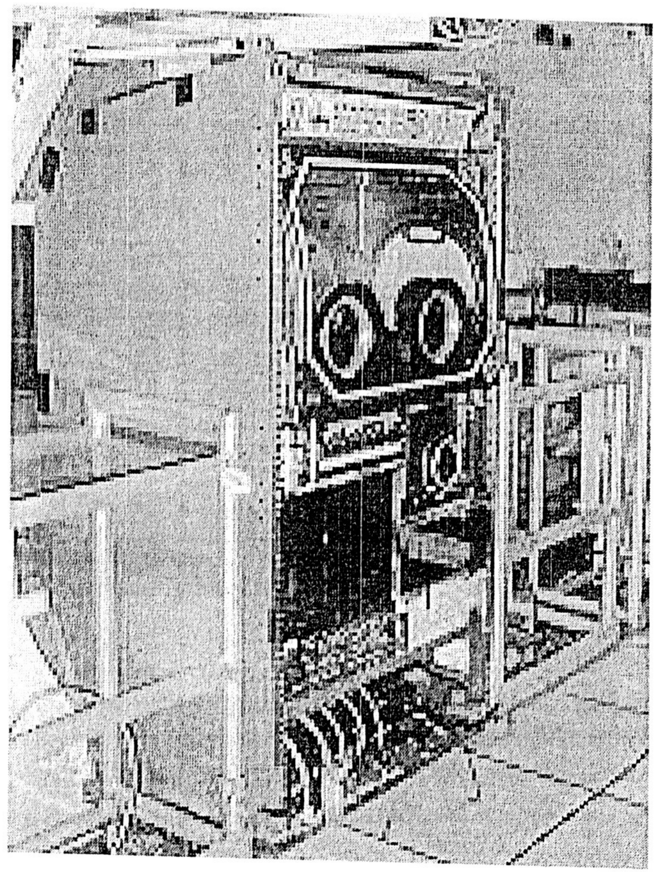


Remote Biological Science

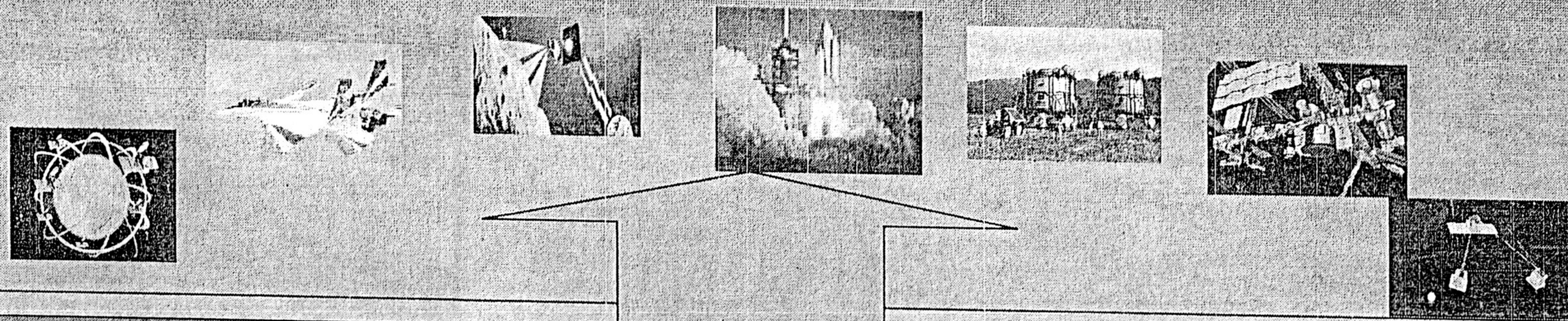
Scenario: A remote zero-G biological experiment (Code U) is operated by a distributed science team on Earth. A fault is detected, automatically diagnosed, and the fix allocated to the crew's schedule (Code M).

Capabilities:
- Sample preparation and handling
- Science Instrument Control
- Experiment Monitoring
- Data Analysis
- Fault Detection and Response
- Crew Scheduling and Task Support Tools

Critical Technologies:
- High-level (goal-directed) operator interfaces
- Environment sensing and modeling
- Distributed work collaboration tools
- Task planning
- Fault-tolerant execution
- Fault detection and diagnosis
- Problem resolution decision systems
- Dynamic scheduling



CICT Program Structure



Intelligent Systems

Enable smarter, more adaptive systems and tools that work collaboratively with humans in a goal-directed manner to achieve the mission/science goals.

Computing, Networking and Information Systems

Provide seamless access to ground-, air- and space-based distributed computing, information, and knowledge to enable NASA missions in aerospace, Earth science and space science.

Space Communications

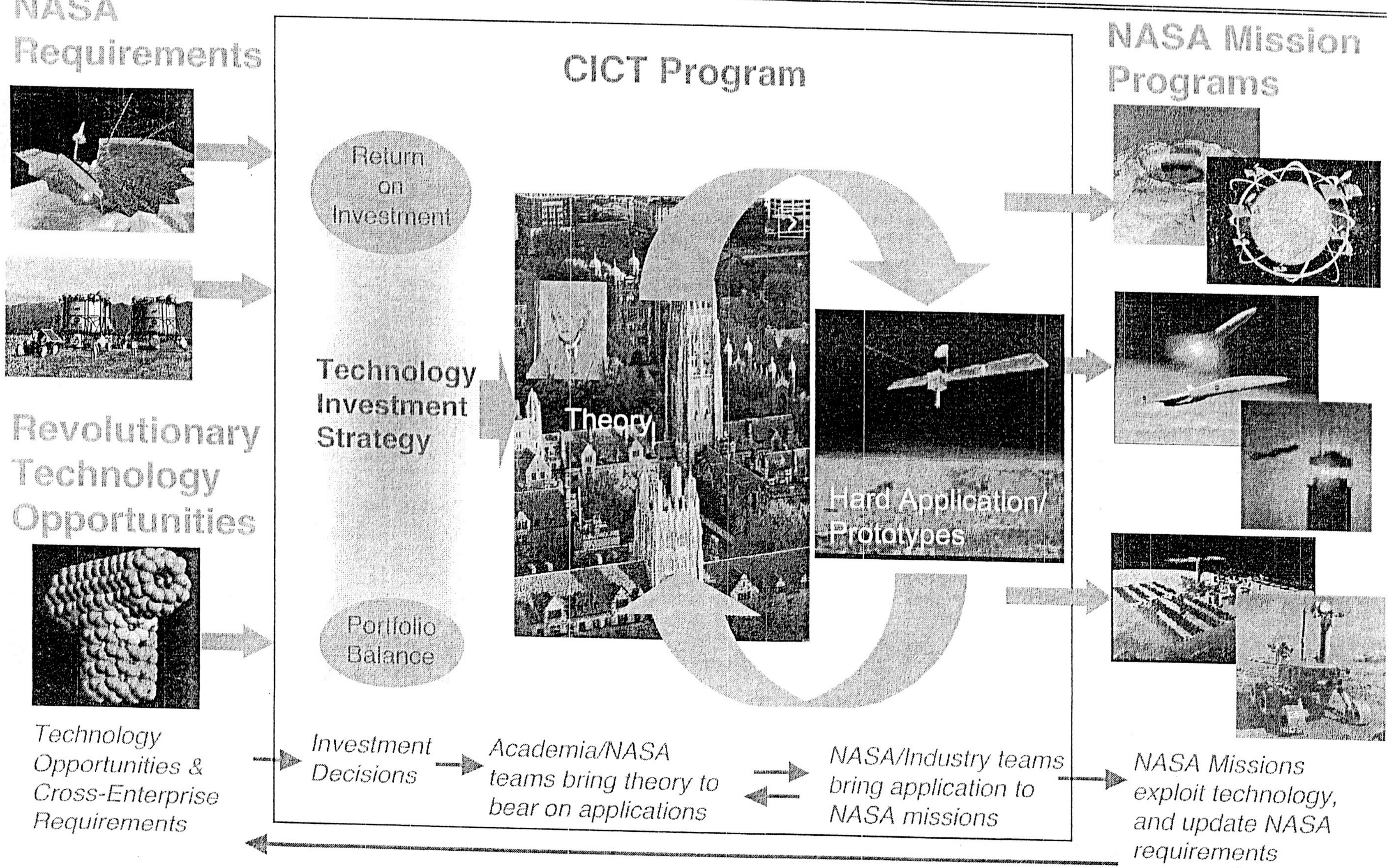
Provide revolutionary space communications technologies

IT Strategic Research

Research, develop and evaluate a broad portfolio of fundamental information and bio/nano technologies for infusion into NASA missions.

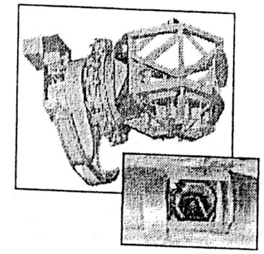
CICT Technology

- Requirements to Development to Infusion -

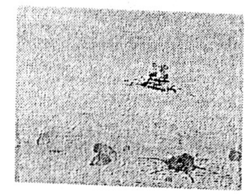


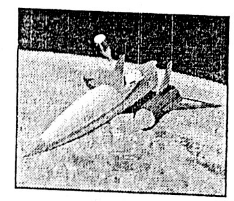
CICT Technology Infusion Activities
IT Strategic Research Project

- Space Science Applications
  - Advanced diagnostic system (SOFIA Secondary Mirror Assembly)
  - Health monitoring systems for gear-driven space systems (Planetary rovers, SOFIA Secondary Mirror Assembly)



- Aerospace Technologies Applications
  - Automated Software Model Checking Tool for Integrated Modular Avionics in support of NASA Aviation Safety Program and Honeywell
  - Intelligent flight control system incorporating hierarchical control surface allocation
  - C-17 advanced health monitoring for engine power transfer systems
  - 2nd Gen RLV IVHM architectures with hybrid diagnostic reasoning engines

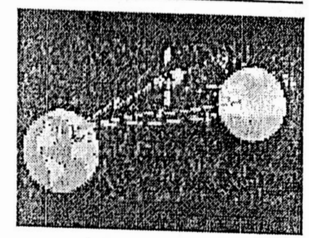




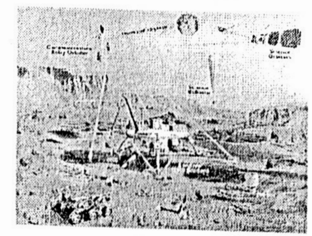
- Biological and Physical Research Applications
  - Carbon Nanotube Scanning Probes for High Resolution Imaging

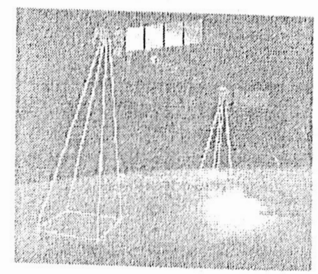
CICT Technology Infusion Activities
Space Communications Project

- **Advanced Space Communications Capability**
  - *Supports the Office of Space Science*
  - *100 watt traveling wave tube microwave sources for Mars missions*
  - *Transceiver chip for Mars 05 mission for Electra communication payload package for baseband signal processing*

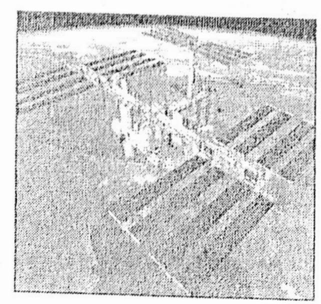


- **Space Communications for Earth Science Applications**
  - *Supports the Office of Earth Science*
  - *Inter-spacecraft communication architectures for Leonardo mission*
  - *Space Internet protocols based on TCP/IP for enabling spacecraft control directly by user*
  - *High data rate optical communication link*



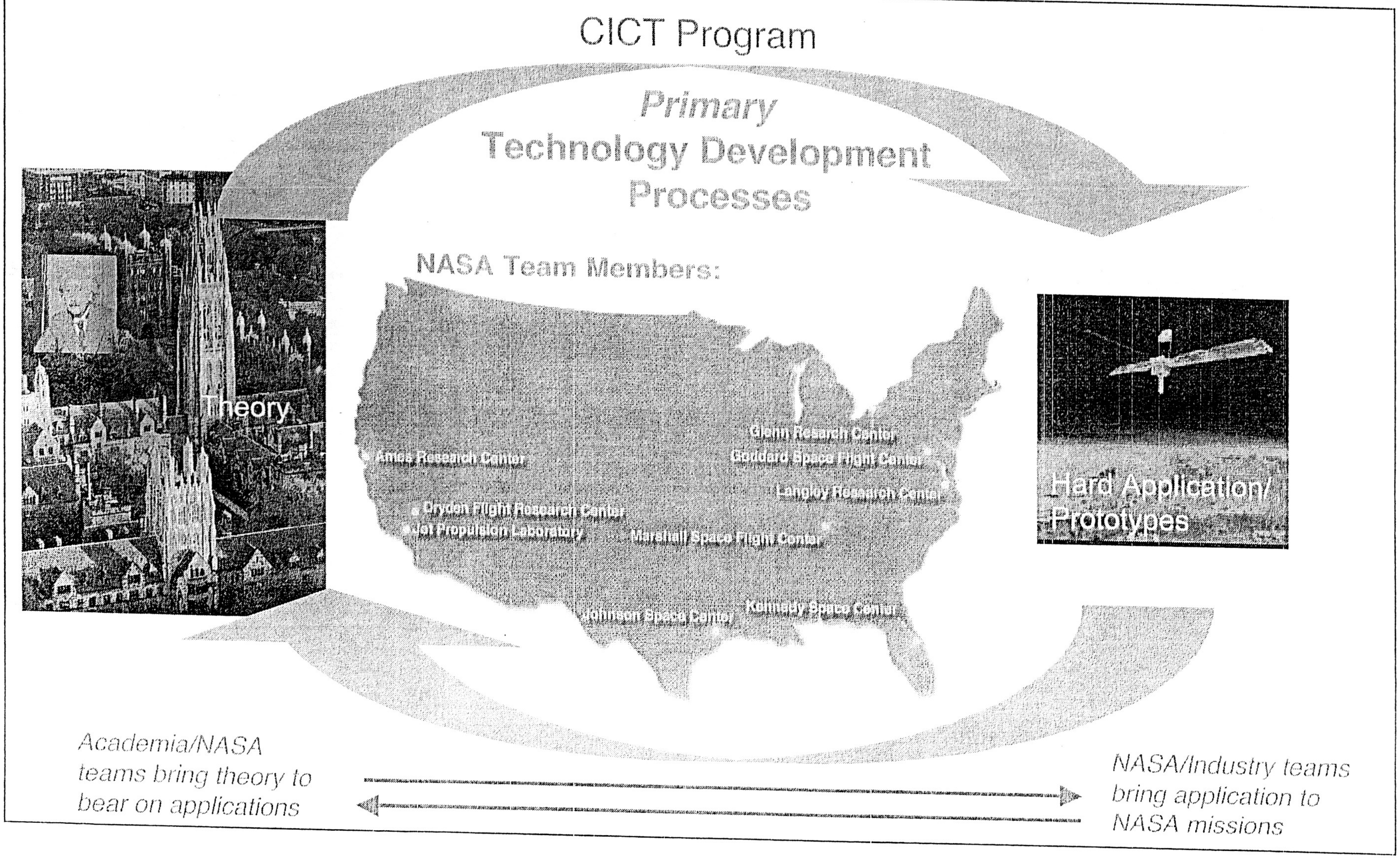


- **Communications for Human Space Flight Operations**
  - *Supports the Office of Space Flight*
  - *Wireless sensor networks for structural health monitoring for the International Space Station (ISS) and Space Shuttle orbiter*
  - *Communication technologies for human space suit/robotic testbed*
  - *Networking technologies (routing) to enable Internet-like communications for the Shuttle and ISS*



CICT Technology

- Technology Development Processes -

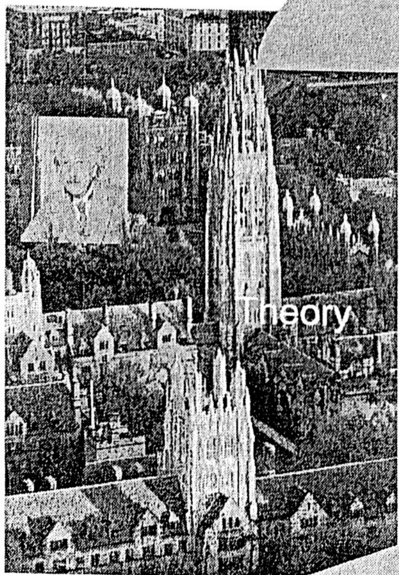


CICT Technology

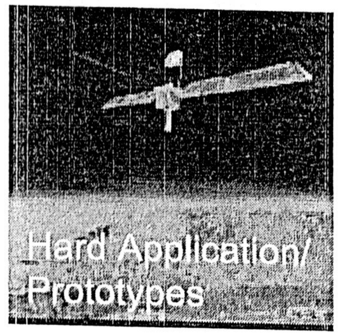
- Technology Development Processes -

CICT Program

Primary
Technology Development
Processes



Industry Team Members (Examples):
- Boeing Phantom Works
- CISCO
- General Electric
- Honeywell
- IBM
- Pratt & Whitney
- Qualtech
- Quasar Corporation
- SGI
- SRI International
- USRA-RIACS

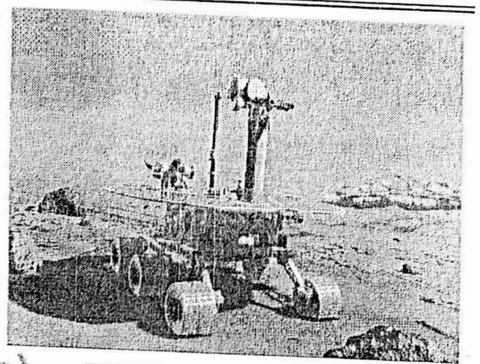


Academia/NASA teams bring theory to bear on applications

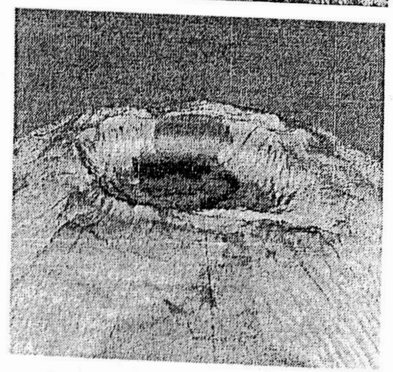
NASA/Industry teams bring application to NASA missions

CICT Technology Infusion Activities
Intelligent Systems Project

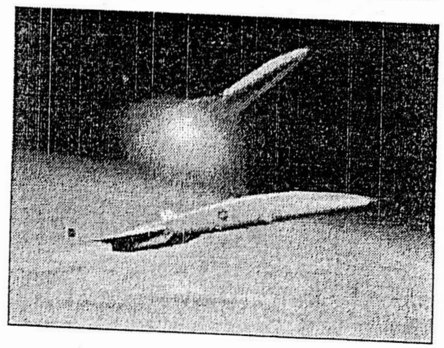
- Mars Exploration Rover (MER-Mars 03 Mission)
  - *Supports the Office of Space Science (Code S)*
  - *MER Operations Study*
  - *MER Board*
  - *MER Planning & Scheduling*



- Rover Autonomy Architecture (MSL-Mars 07 Mission)
  - *Supports the Office of Space Science (Code S)*
  - *Explores autonomy concepts for the Mars Smart Lander*



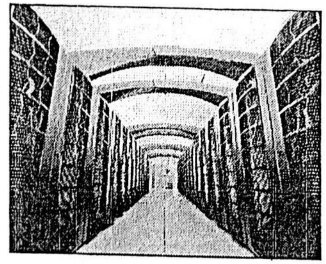
- NowCasting Project
  - *Supports the Office of Earth Science (Code Y)*
  - *Integrates Web-based and remote sensing data to provide real-time assessment of the environment*
- Integrated Launch & Range Operations
  - *Supports the Office of Space Flight (Code M)*
  - *Provides increased range safety via human-centered computing concepts*



CICT Technology Infusion Activities

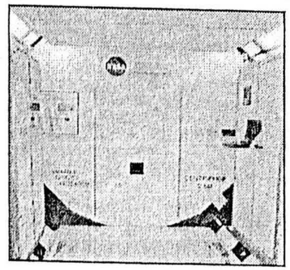
Computing, Networking, and Information Systems Project

- SGI 1024-processor Origin 3000 Testbed
  - *Supports the Office of Aerospace Technology (Code R) and the Office of Earth Science (Code Y)*
  - *Over 1 TeraFLOPS processing power*

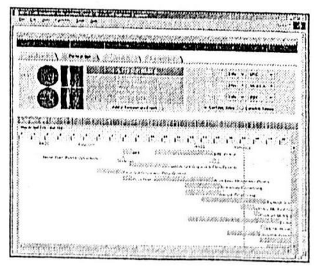


- Multi-Level Parallelism
  - *Supports the Office of Aerospace Technology (Code R) and the Office of Earth Science (Code Y)*
  - *Increases performance and usability of large-processor-count computing systems*
  - *40X improvement on FVCCM3 climate code*

- Virtual International Space Station
  - *Supports the Office of Space Flight (Code M)*
  - *Developed virtual model of Centrifuge Accommodation Module*
  - *Enables design simulation, astronaut training, and operations*

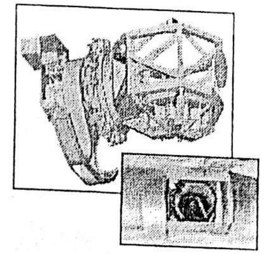


- Mars Exploration Rover Collaborative Information Portal (MER-Mars 03 Mission)
  - *Supports the Office of Space Science (Code S)*
  - *Provides insight into mission status and operations with time conversion, schedule information tools, and data product navigation*

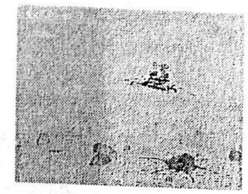


CICT Technology Infusion Activities
IT Strategic Research Project

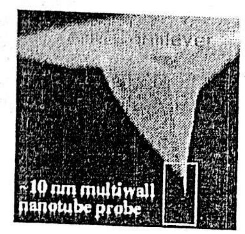
- Space Science Applications
  - Advanced diagnostic system (SOFIA Secondary Mirror Assembly)
  - Health monitoring systems for gear-driven space systems (Planetary rovers, SOFIA Secondary Mirror Assembly)



- Aerospace Technologies Applications
  - Automated Software Model Checking Tool for Integrated Modular Avionics in support of NASA Aviation Safety Program and Honeywell
  - Intelligent flight control system incorporating hierarchical control surface allocation
  - C-17 advanced health monitoring for engine power transfer systems
  - 2nd Gen RLV IVHM architectures with hybrid diagnostic reasoning engines

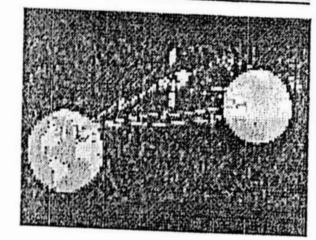


- Biological and Physical Research Applications
  - Carbon Nanotube Scanning Probes for High Resolution Imaging

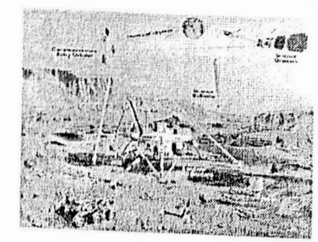


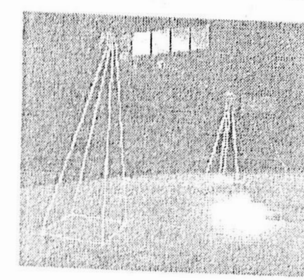
CICT Technology Infusion Activities
Space Communications Project

- **Advanced Space Communications Capability**
  - *Supports the Office of Space Science*
  - *100 watt traveling wave tube microwave sources for Mars missions*
  - *Transceiver chip for Mars 05 mission for Electra communication payload package for baseband signal processing*

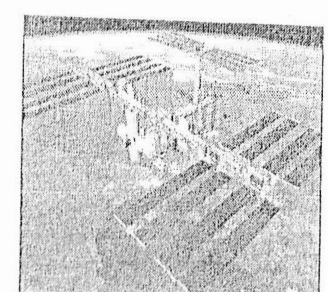


- **Space Communications for Earth Science Applications**
  - *Supports the Office of Earth Science*
  - *Inter-spacecraft communication architectures for Leonardo mission*
  - *Space Internet protocols based on TCP/IP for enabling spacecraft control directly by user*
  - *High data rate optical communication link*





- **Communications for Human Space Flight Operations**
  - *Supports the Office of Space Flight*
  - *Wireless sensor networks for structural health monitoring for the International Space Station (ISS) and Space Shuttle orbiter*
  - *Communication technologies for human space suit/robotic testbed*
  - *Networking technologies (routing) to enable Internet-like communications for the Shuttle and ISS*

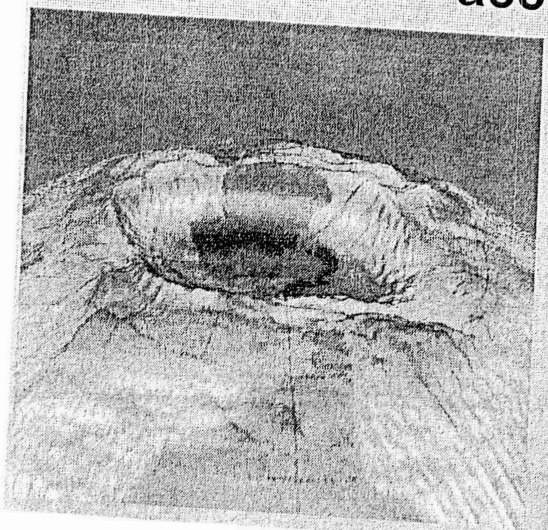


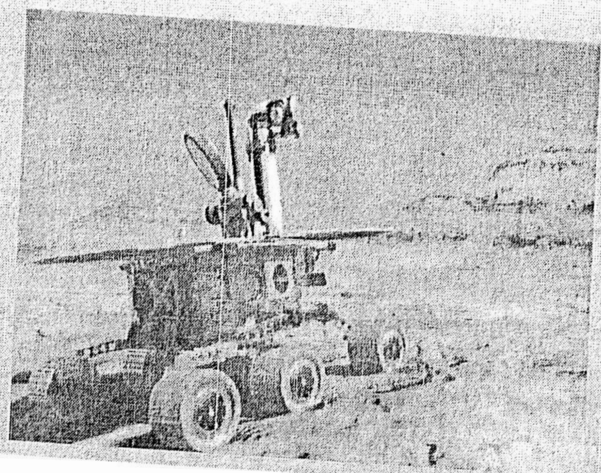
Summary

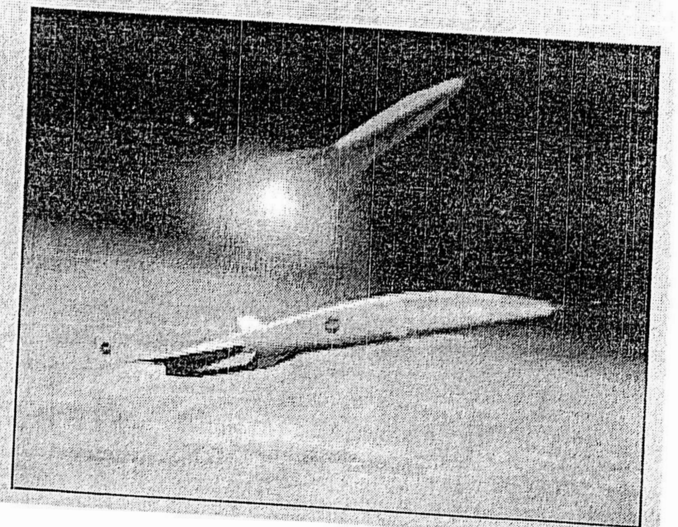
NASA has technically challenging missions...

CICT invest in advancing and testing computing, information, and communications technologies to support the accomplishment of NASA's challenging missions.

CICT looks for great ideas and hard work from everyone interested in helping NASA accomplish its missions







Supporting Materials

Milestone Status Report
(Example, FY02 2nd Quarter)

Program Milestone 2.1 Status (Slide 1/ 2)

Develop an exploratory Grid (IPG) environment

CNIS POC: Jerry Yan, NASA Ames

March 2002

Milestone: Develop an exploratory Grid (IPG) environment that supports location-independent use of heterogeneous data sets and high confidence tools. (CNIS, due 9/02): **On Schedule.**

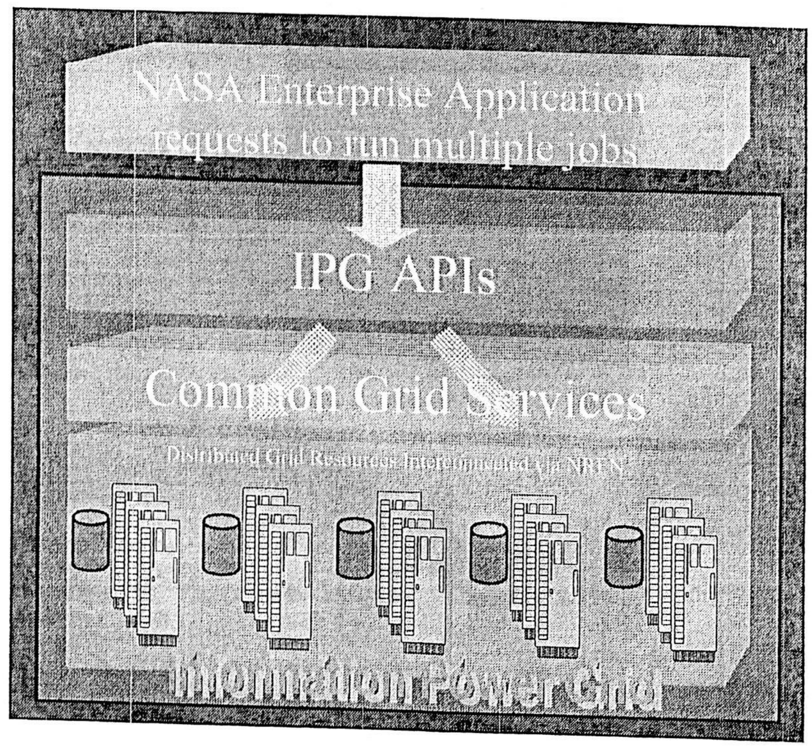
Metrics:

A. Prototype grid environment that provides: consistent application program interface for (1) directory service for resource discovery; (2) job queuing, tracking, monitoring and reporting; (3) interfaces to local schedulers for job management; (4) security services; and (5) access to 10 heterogeneous grid resources distributed over at least 4 locations.

B. New problem solving paradigm for 1 NASA Enterprise that: (1) executes job suites across multiple platforms; (2) accesses distributed data and high confidence tools; (3) determines execution locations based on published information about resources; (4) provides job status information; and (5) uses secure services.

Shown:

- To accomplish the milestone, a NASA Enterprise Application will be able to request that a problem be solved in a standard workflow language. From this point forward, the Information Power Grid (IPG) will communicate to the underlying abstraction layers (common grid services) to achieve the goal of using location-independent heterogeneous data sets and high confidence tools.



Accomplishments:

- Completed preliminary step towards meeting metrics A(3) and A(5) (see next slide).
- IPG has four NASA sites and ten resources accepting grid jobs.
- Two test cases have been completed using these resources.

Future Plans:

- Have first version of the NASA IPG Application Programming Interfaces (APIs) set for use by the Grand Challenge Application teams (mid May).

Supported NASA Offices: OAT, but applicable to other Enterprises

Program Milestone 2.1 Status (Slide 2/ 2)

Develop an exploratory Grid (IPG) environment

CNIS POC: Jerry Yan, NASA Ames

March 2002

Milestone: Develop an exploratory Grid (IPG) environment that supports location-independent use of heterogeneous data sets and high confidence tools. (CNIS, due 9/02): **On Schedule.**

Metrics:

A(3). Interfaces to local schedulers for job management;

A(5). Access to 10 heterogeneous grid resources distributed over at least 4 locations.

Shown:

- The table (top right) describes resources currently connected (except for the SGI 1024) to the Information Power Grid (IPG). Resources at Argonne National Laboratory (ANL) and National Center for Supercomputing Applications (NCSA) are pending NASA Research and Education Netowork (NREN) connections to StarTap.
- The diagram (bottom right) shows all the sites IPG is planning to have available on the NASA Grid for the 9/02 milestone.

Accomplishments:

- IPG has four NASA sites and ten resources accepting grid jobs.
- Two test cases have been completed using these resources.
- Test cases successfully demonstrated interfaces to local schedulers for job management.
- IPG has one NSF site interconnected with the NASA Grid, and NASA job submission is being tested.

Future Plans:

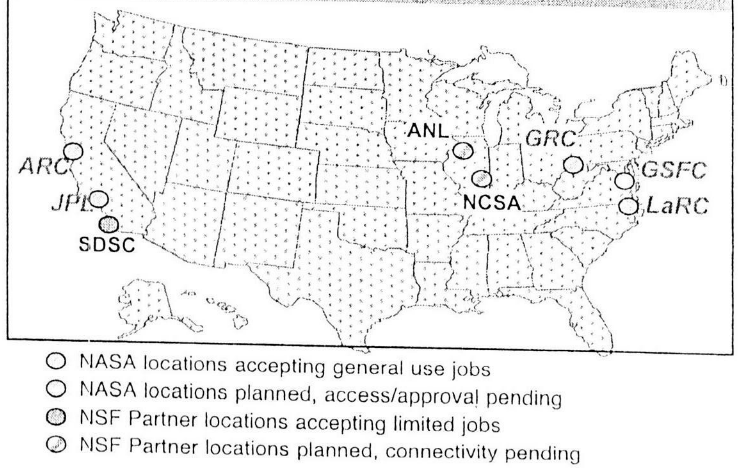
- Provide and test access to ANL and NCSA (June 02).
- Accomplish metrics using IPG resources planned for 9/02.

Supported NASA Offices: OAT, but applicable to other Enterprises

IPG Resources

System	Location	IPG Status	Model	# proc
Persistent:				
Computation:				
evelyn.nas.nasa.gov	NAS	General Use	SGI O2k	16
turing.nas.nasa.gov	NAS	General Use	SGI O2k	32
hopper.nas.nasa.gov	NAS	General Use	SGI O2k	64
steger.nas.nasa.gov	NAS	General Use	SGI O2k	128
chapman.nas.nasa.gov	NAS	TBD	SGI O3k	1024
lomax.nas.nasa.gov	NAS	General Use	SGI O2k	512
simak.nas.nasa.gov	NAS	General Use	Sun E10k	16
sharp.as.nren.nasa.gov	GRC	General Use	SGI O2k	24
aeroshark.as.nren.nasa.gov	GRC	General Use	Intel Cluster	128
rogallo.larc.nasa.gov	LaRC	General Use	SGI O2k	4
whitcomb.larc.nasa.gov	LaRC	General Use	SGI O2k	16
pollux.jpl.nasa.gov	JPL	Limited Use	SGI Onyx	4
horizon.sdsc.edu	SDSC	Limited Use	IBM SP	1152
Mass Storage:				
ariel.ipg.nasa.gov	NAS	General Use	SGI	8
lou.nas.nasa.gov	NAS	Genera Use	SGI	16

IPG Locations



Program Milestone 3.2: Status (Slide 1/2)

High-Level Autonomy Architecture

POC: Robert Morris, NASA Ames Research Center

March 2002

Milestone:

Develop conceptual high-level autonomy architecture for rovers collaboratively between Ames, JPL, CMU and other partners.

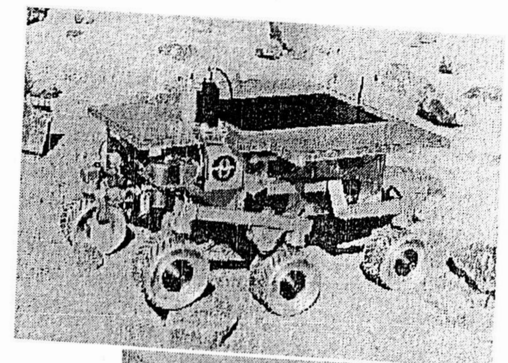
Metrics:

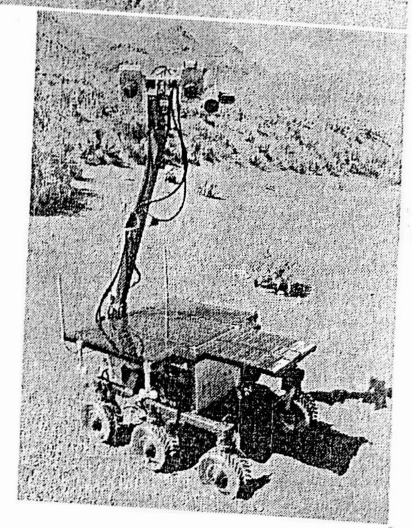
Demonstrate individual component technologies to be included in the larger, integrated demonstration.

Shown: Rocky 8 (top), K9 rovers

Accomplishments:

- Demonstrations of autonomous control of JPL rovers (Rocky 7, Rocky 8)
  - – CLARAty autonomy architecture
  - – Unified on-board planning and execution
    - > Integrates target selection, resources and path planning
- Rover infrastructure for autonomy technology demonstration using K9
  - – Design of science and robotic task APIs for autonomous rover control
  - – Based on Mars surface exploration science scenario (search for water, life)
  - – Applying autonomy technology for target approach and instrument placement
    - > Requires robust execution, planning, on-board analysis for rock finding and layer detection.





Future Plans:

- Work on integrating Ames, JPL and other IS funded efforts into a single plan for robust autonomy demonstration

Supported NASA Offices: OAT, OSS

Program Milestone 3.2: Status (Slide 2/2)

High-Level Autonomy Architecture

POC: Robert Morris, NASA Ames Research Center

March 2002

Milestone:

Develop conceptual high-level autonomy architecture for rovers collaboratively between Ames, JPL, CMU and other partners

Metrics:

Demonstrate individual component technologies to be included in the larger, integrated demonstration.

Shown: Mission Simulation Facility Architecture

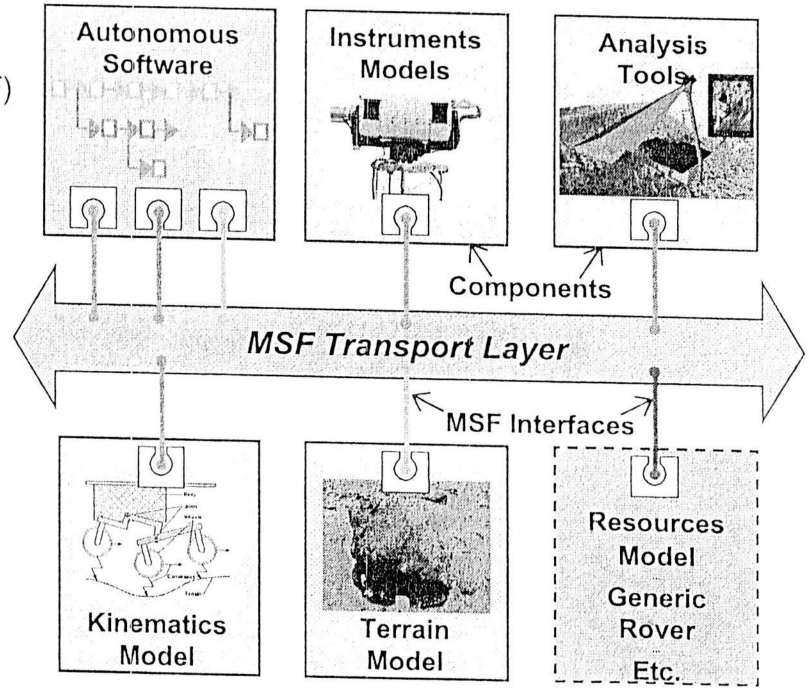
Accomplishments:

- An integration framework for a Mission Simulation Facility (MSF) supporting research in autonomy for remote exploration has been designed and prototyped.
- Initial integration of the framework involving 3 components has been demonstrated.
- Initial mission scenario derived from MER to exercise architectural framework and support autonomous robot controller.

Accomplishments:

- A collaboration with JPL to develop components and extended capabilities has been initiated.
- Integration of MSF with rover autonomy demonstration.

Supported NASA Offices: OAT, OSS



Program Milestone 4.1 Status (Slide 1/1)

Ad Hoc Networks in Space & Surface

SC POC: Kul Bhasin, NASA Glenn

March 2002

Milestone:

- Ad Hoc Networks in Space and Surface. (SC, due 9/03): **On Schedule.**

Metrics:

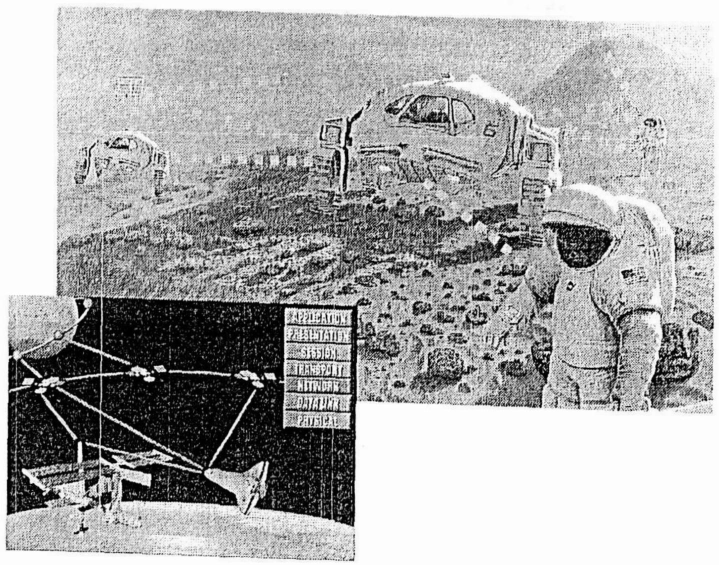
- **A.** Study of communication movements of NASA missions.
- **B.** Prototype protocol extensions and after testing develop final protocols.
- **C.** Simulation and emulation of ad hoc protocol suite for distributed network.

Shown:

- Application of Mobile Ad Hoc Networking Protocols on a planetary environment will allow flexible mobile wireless networking between nodes. The Ad Hoc Networking Protocol is a dynamic, self organizing, self configuring wireless network, in which network individual nodes cooperate to forward packets for each other to allow communication between nodes not directly within wireless transmission range of one another. This is a valuable feature for any planetary based communications system in which network nodes are in motion or randomly placed.

Accomplishments:

- Completed initial design of Quality of Service (QoS) ad hoc network routing protocol extensions.
- Designed, simulated and evaluated Adaptive Demand-Driven Multicast Routing (ADMR) multicast ad hoc network routing protocol.
- Designed and completed initial evaluation of robust security extensions to Dynamic Source Routing (DSR) ad hoc network routing protocol.
- Began initial meetings with NASA personnel to acquire necessary data to produce study of communications movements of NASA missions.



Future Plans:

- Complete remaining protocol extensions and simulation evaluation.
- Continue study on communication movements of NASA missions to address specific communication needs of space based applications.
- Design and implement testbed protocol demonstration using 10 nodes under a substantial networking traffic load.

Supported NASA Offices: OSS, OSF, OES, OAT

Program Milestone 5.2 Status (Slide 1/ 2)

Demonstrate reference implementations of integrated tool sets and collaborative information portals

CNIS POC: Jerry Yan, NASA Ames
March 2002

Milestone: Demonstrate reference implementations of (1) integrated tool sets for collaborative science and engineering, and (2) collaborative information portals featuring seamless information capture and knowledge management. (CNIS, due 3/04): **On Schedule.**

Metrics:

A. Integrated tool sets with: (1) architecture–supported component integration; (2) rapid assembly of distributed components into integrated processes; (3) 6-discipline, multi-fidelity interoperable tools; and (4) process status awareness.

B. Information capture and knowledge management systems with: (1) user-customizable interfaces to graphical displays; (2) automated interfaces to existing ground-based data systems; (3) integrated cross comparison of data from heterogeneous analysis systems; (4) location independent retrieval of data products; and (5) real time knowledge management.

Shown:

- Collaborative Information Portal (CIP) inserted into the Mars Exploration Rovers (MER) Mission Ground Data System (GDS). CIP is a web-based knowledge management system to provide management insight into mission status and operations during surface operations. The tool provides dynamic mission information content presented in a user customizable web portal.

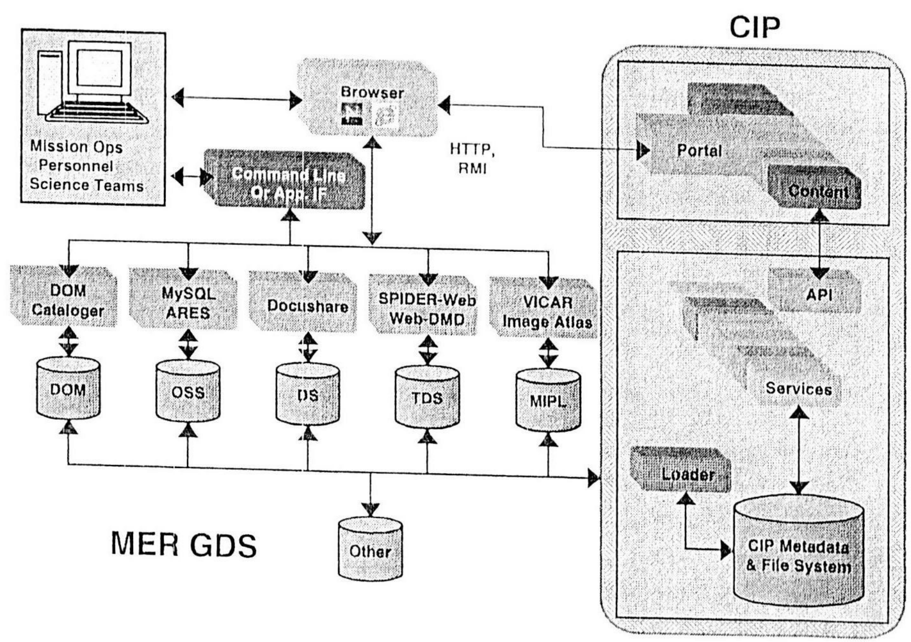
Accomplishments:

- Progress on metrics B (4) and B (5) (see next slide).

Future Plans:

- CIP Version 1.2 for deployment at the end of FY03

Supported NASA Offices: OSS, but applicable to other Enterprises.



Program Milestone 5.2 Status (Slide 2/ 2)

Demonstrate reference implementations of integrated tool sets and collaborative information portals

CNIS POC: Jerry Yan, NASA Ames
March 2002

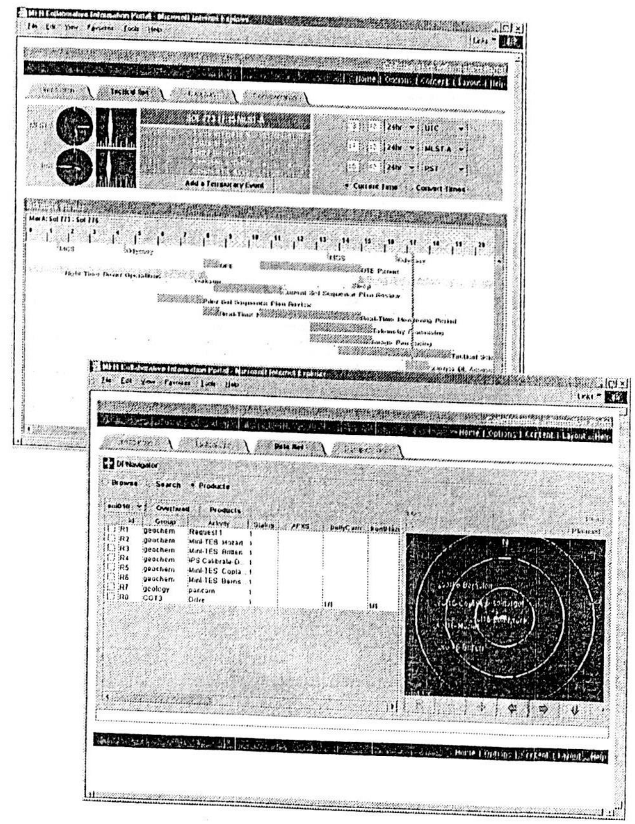
Milestone: Demonstrate reference implementations of (1) integrated tool sets for collaborative science and engineering, and (2) collaborative information portals featuring seamless information capture and knowledge management. (CNIS, due 3/04): **On Schedule.**

Metrics:

B. Information capture and knowledge management systems with ...
- (4) location independent retrieval of data products
- (5) real time knowledge management.

Shown:

- Sample screens from Alpha release of the Collaborative Information Portal (CIP)
- Front screen shows data product navigation.
- Rear screen shows time conversion, and schedule information tools.



Accomplishments:

- Completed delivery of first software release (Alpha) to JPL's Multi-Mission Office (MMO) Configuration Management (CM).
- Completed several demonstrations and presentations of this release using the server currently deployed at JPL on existing JPL workstations.
- Development of the next release of the CIP (Beta) is underway.

Future Plans:

- Expansion of current tools
- Linkages to existing mission systems
- Change awareness and notification
- User customization options
- Data comparison tools

Supported NASA Offices: OSS, but applicable to other Enterprises.

Program Milestone 8.1 Status (Slide 1/ 2)

Carbon Nanotube (CNT) Electronic Device
ITSR POC: Harry Partridge, NASA Ames
March 2002

Milestone: Design, fabricate and evaluate carbon nanotube electronic devices. (ITSR, due 9/02): **On Schedule.**

Metrics:
Demonstrate ability to build nontrivial molecular electronic devices and characterize performance.

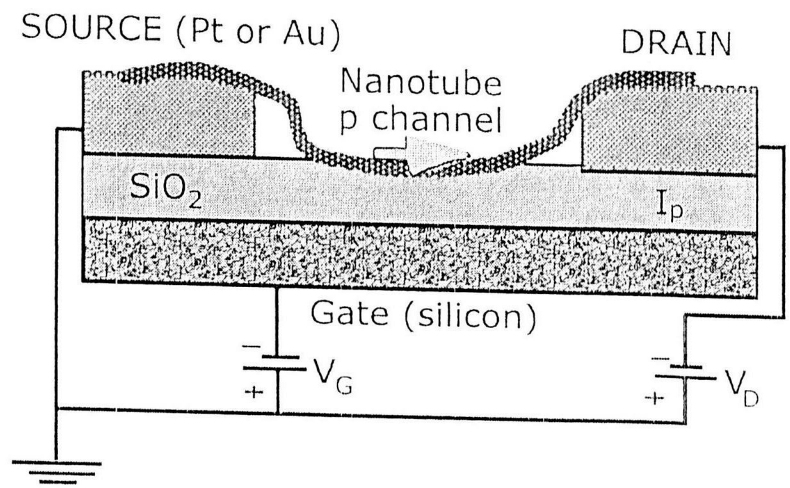
Shown (this slide): Carbon Nanotube Transistor Diagram

Shown (on next slide): Examples of CNT device integration and aligned CNT arrays

Accomplishments:
- Characterization of CNT field effect transistor and CNT electrical conduction
- Construction and characterization of CNT inverters (both PMOS and CMOS)
- Directed growth and growth of vertically aligned of carbon nanotubes.
- Functionalization of CNT ends

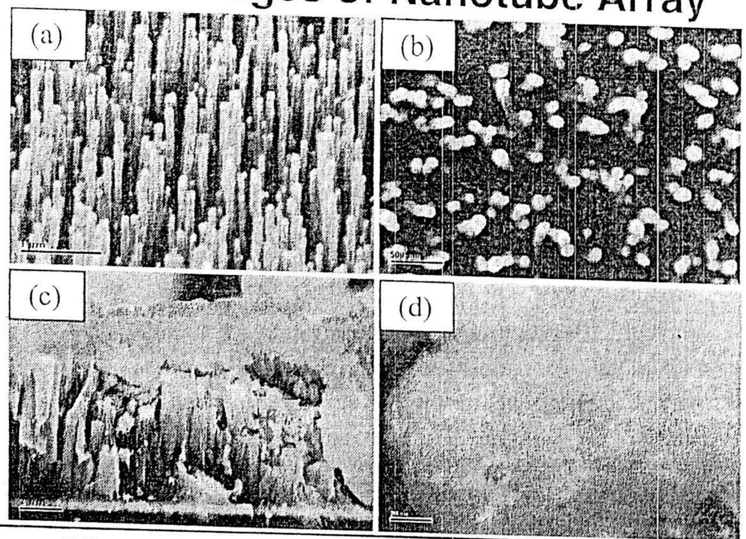
Future Plans:
- Construction of CNT based memory or adder
- Vertically aligned CNT integration
- Electrochemical detection of hybridization reactions.
- CNT based electronic chemical and bio-sensors
- Characterization of dendritic structures for electronic and sensing applications.
- Demonstration of CNT based field emission X-ray source.

Supported NASA Offices: OAT, but applicable to other Enterprises

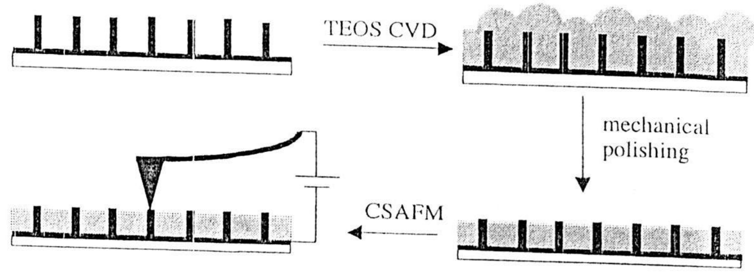


Program Milestone 8.1 Status (Slide 2/ 2)

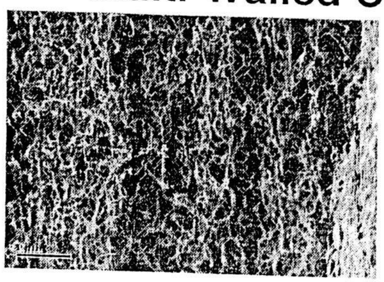
SEM Images of Nanotube Array

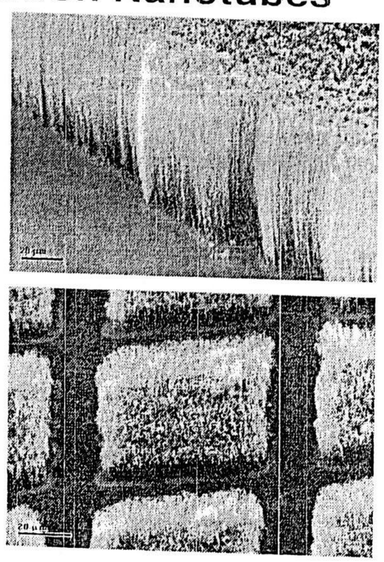


Schematic of CNT Vertical Array Fabrication Procedure



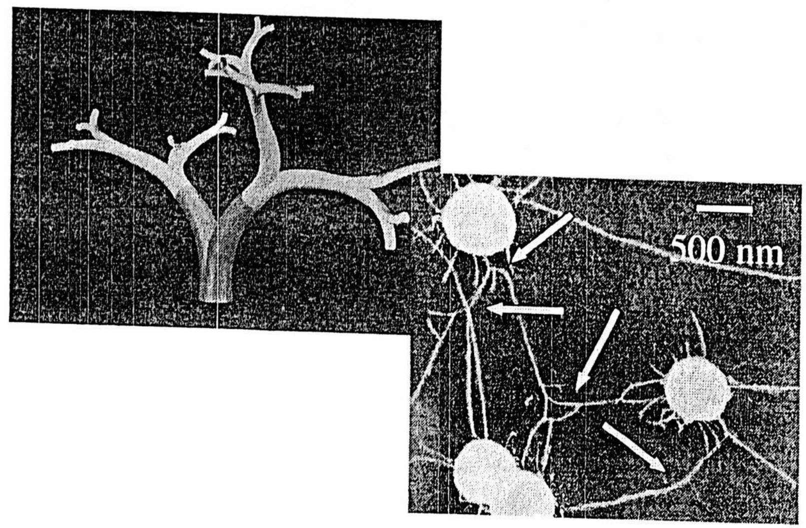
Multi-Walled Carbon Nanotubes





Ends not aligned for thermally grown MWCNT

Four Level CNT Dendritic Neural Tree



CICT/ITSR/Revolutionary Computing Algorithms

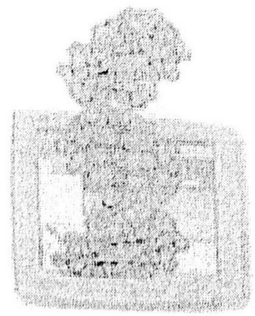
DNA Computing

ITSR POC: Benny Toomarian, JPL

March 2002

Accomplishment:

- DNA – the spiraling molecule that holds life's genetic code – has been used to carry out complex computations.
- A DNA-based computer has solved a logic problem that no person could complete by hand (20 variable Satisfiability problem), setting a new milestone for this infant technology that could someday surpass the electronic digital computer in certain areas.



Metrics:

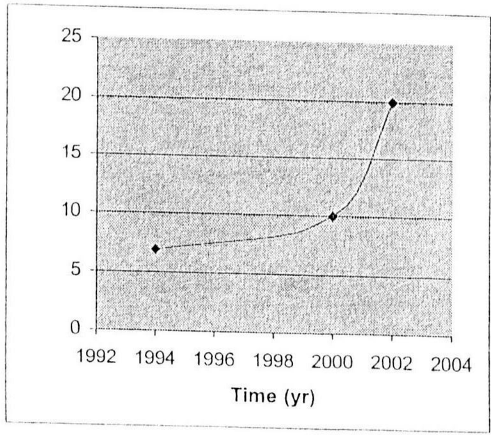
- The time to solve this type of problems (called "NP-complete") on classical computers increases exponentially with the size of the problem, while it increases only linearly for parallel DNA-based computers. Measurement of this activity is based on the size of the problem being solved (here a 20-variable satisfiability problem).

Significance:

- DNA-based computer runs in parallel, 10^{17} ops/sec, is very highly energy-efficient, 2×10^{19} ops/j and carries enormous information density, 1 bit/nm^3 (one gram of DNA ~ one trillion CDs).
- This will help us solve large complex problems such as planning and scheduling in a reasonable time with low amount of energy.

Shown:

- Illustration of computational problem size versus work year.



Future Plans:

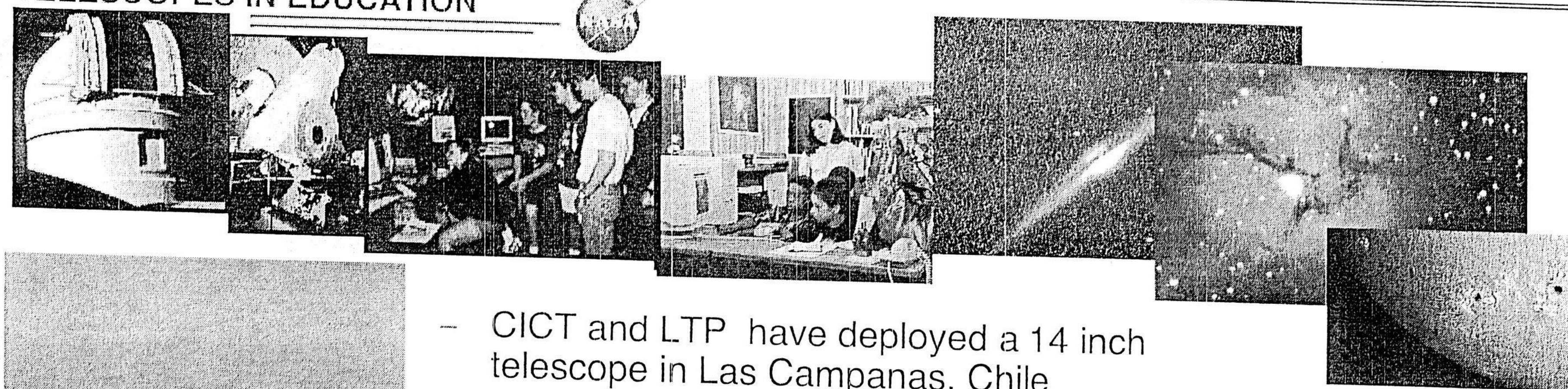
- The DNA computer currently gets too error-prone as the DNA strands go past a certain length. Hence the goal of finding error correcting approach.
- Implement an optimal solution for a 50-variable problem.
- Apply this novel computing paradigm to a computationally hard NASA problem.
- Develop a DNA based representation for a scheduling problem.

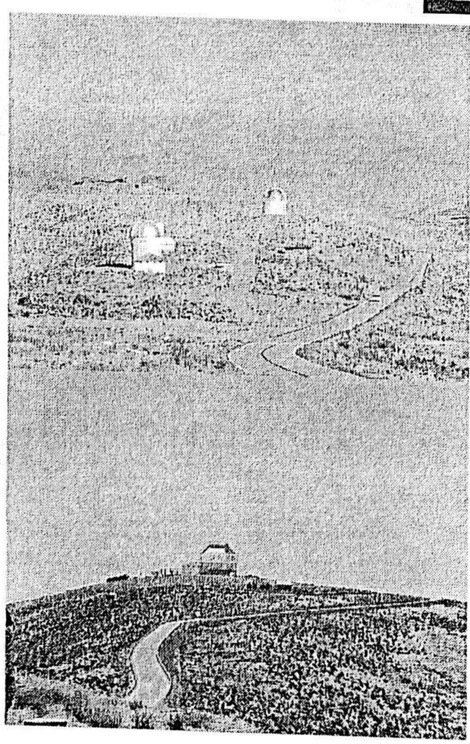
Supported NASA Offices: OAT, but applicable to other Enterprises

CICT Education

Chilean Telescope Online

TELESCOPES IN EDUCATION





- CICT and LTP have deployed a 14 inch telescope in Las Campanas, Chile
- CICT is implementing a 256up/56down Kbps link between telescope and the US in June, 2002
- Students have measured planetary orbit around a distant stars with the TIE project in California.
- Students discovered variable stars and worked with NASA scientists to recalculate the orbit of Pluto through stellar occultation.