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NASA'S INFORMATION TECHNOLOGY ACTIVITIES FOR THE 90'S

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INTRODUCTION

I would like to discuss briefly NASA's plans in information systems technologies for the 1990's. Let me begin by outlining the approach and philosophy which the Office of Aeronautics, Exploration and Technology (OAET) uses in deciding what technologies to address and how far to take these technologies. I would then like to describe the current and planned research and technology development programs in informations systems and close with some thought on what I feel are the key information technology problems for astrophysical missions in the twenty-first century.

NASA, over the years, has adopted a standard model for technology maturity, rating developing technologies on a readiness scale from one to seven. While the definitions are sometimes difficult to apply, they do give a good starting point for coordinated planning between technology developers and technology users. OAET generally develops technologies through readiness level five which is the demonstration of components or breadboards in the relevant environment.

In recent years, OAET has engaged in a number of processes to try to insure that we are developing the right technologies, and that we are developing them right. Our technology development resources are scarce. We want to develop those technologies which will be most beneficial to NASA missions and support requirements and that our advanced development addresses the key risk issues which would otherwise tend to preclude the technology's use.

CURRENT AND PROPOSED OAET PROGRAM

OAET is just completing an extensive assessment of its nearly five hundred million dollars of proposed space technology development work. The budget is divided into four segments which I will describe later when I talk about the current program. Let me first describe the thrust areas which we have been using to sort our way through this assessment from a user's perspective. The areas are Exploration, Transportation, Space Station, Space Sciences and Basic Research. The thrust area that has received the most attention lately is the exploration thrust. Into this category, we have put most of the technologies which are designed to contribute to fulfilling the President's vision of returning to the moon, this time to stay, and proceeding to Mars in the second decade of the next century. We have separated out space station and transportation technologies. Transportation technologies would include rovers as well as launch vehicle technologies, for example. Space Science which includes technologies for Earth Science, Astrophysics, Space Physics, and Planetary Science is our second largest thrust area. Finally, we have a small number of efforts in high risk, high payoff breakthrough technologies which, if successful, could contribute significantly in many of NASA's application areas.

In addition to the NASA in-house technologies development, we also take advantage of technologies that can be done better by others. We guide independent industry research and

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development through participation in reviews, exchange of information with colleagues through workshops, symposia and conferences, engaging in active joint planning with other agencies through activities such as the NASA-Air Force Space Technology Interdependency Group, and stimulating private industry by using Small Business Innovative Research grants.

It is not part of OAET's mission to work on technologies which are needed for very near term applications. The major emphasis of our program is on technologies for medium term missions, say three to ten years away.

Enough of the generalities; let us get down to the specifics of the information systems technology programs and plans. I mentioned that the OAET space budget is divided into four segments. One of those segments, in-space technology experiments, has little information systems technology at this time. On the other hand, the High Performance Computing Initiative (HPCI), which is in the aeronautics budget, may have a significant impact on space missions, so I would like to describe that to you along with the space program elements. I will discuss the goals and technology areas of each of four programs. As I do so, I will give some examples of specific efforts in these areas.

THE BASE RESEARCH AND TECHNOLOGY PROGRAM

This program is the foundation of our technology developments. It provides fundamental technologies with broad applicability. It generally is concerned with demonstrating concepts and feasibility. I shall cite a few examples relevant to this Workshop. For example, we are currently conducting work in Information Management, Neural Networks, and Space to Earth communications. One of our tasks, called Distributed Access View Integrated Database or DAVID, is building an intermediate interface to give users a coherent view of data access across multiple remote data bases. Typically, data from science instruments are stored at the principal investigation's home site in a format and with an access method chosen by the instrument team based on their experience and need. Multidisciplinary investigators have been faced with the problem of learning a different access method to obtain data from each instrument of interest. DAVID can alleviate that problem, giving the investigators more time to concentrate on their science.

THE CIVIL SPACE TECHNOLOGY INITIATIVE (CSTI)

This initiative began in 1988 and is focused on technology development for application in medium term missions such as the Eos platforms. In this program, the emphasis is on breadboard and engineering module demonstrations. Developments are proceeding on a Spaceflight Optical Disk Recorder, an Advanced Image Processor, a Configurable High Rate Processing System, Spaceborne Multi-Computers, and Automated Mission Planning and Operations.

The Spaceflight Optical Disk Recorder effort has delivered a prototype Gallium Arsenide 10-element laser array and a prototype 14-inch formatted magneto-optical disc platter. It has developed a system design which will allow terabyte systems composed of several drive units, each with two counter-rotating platters. Unlike tape drives, such systems will be capable of block access and simultaneous read and write.

The Configurable High Rate Processing System (CHRPS) is an architectural approach for connecting processors, mass storage, high data rate instruments and telemetry channels on board a spacecraft. The CHIRPS architecture would allow sharing of storage and processing resources among instruments producing data at up to gigabit rates. Test bed implementations of this architecture will be demonstrated with other data systems technologies such as the Advanced Image Processor and the Spaceflight Optical Disk Recorder.

Automated mission planning and operations have the potential to reduce operations costs, enable more complex missions, reduce planning errors, and allow speedier recovery from anomalies. The Real Time Data System (RTDS) Project has been demonstrating automation in parallel with the existing Mission Control Center in Houston. Many of the operations concepts demonstrated by the RTDS have been converted to production status.

Automation is also helping science analysis. By applying cluster analysis on Infrared Astronomical Satellite (IRAS) data, the AutoClass system has distinguished two subgroups of stars previously thought to be one.

EXPLORATION TECHNOLOGY PROGRAM (ETP)

This program focuses on the technologies needed for a lunar base, lunar based science and an eventual manned mission to Mars. These missions would benefit greatly from a family of evolvable flight computer systems and from high-rate communications. In 1989, the General Accounting Office recommended to Congress that NASA seek ways to shorten the development cycle for space qualified computers. In response, the Spacecraft Computer Technology Subcommittee of the Space Science and Technology Advisory Committee studied the spacecraft computer development environment. They recommended an ongoing computer development actively making maximum use of industry standards. They also noted that the spacecraft environment and the critical applications of flight computers would be key drivers for any such program. We hope to begin a program in Fiscal Year 1992.

HIGH PERFORMANCE COMPUTING INITIATIVE (HPCI)

This is a new program targeted for a start in Fiscal Year 1992. The HPCI is NASA's portion of the federal High Performance Computing Program. The federal program aims to retain the United States' lead in supercomputing by developing the technologies to effectively use highly parallel computing, scalable to teraflops (flop = a floating point operation) performance. The NASA program is driven by Grand Challenge applications in three areas of interest, Computational Aerosciences, Earth and Space Sciences, and Remote Exploration and Experimentation. By developing testbeds of massively parallel, scalable architectures and demonstrating algorithms and applications which could scale up to full performance, NASA will accelerate the development and application of high performance computing.

The national High Performance Computing Program involves many agencies. The four largest participants are NASA, DOD, NSF, and DOE. The President's Office of Science and Technology Policy has put a high priority on this program for a Fiscal 1992 budget start. An interagency task team, coordinated by the Federal Coordinating Council for Science, Engineering and Technology (FCCSET) is developing a "terms of reference" document for the Office of Management and Budget. NASA has been given the lead role in coordinating the software tools and algorithms efforts among the agencies and developing visualization and data management approaches.

Earth and Space Sciences applications include several of interest to the Astrophysics community. These include stellar dynamics, fluid dynamics, and inversion problems. The first two areas involve models with increased resolution, precision, and scope over those which can be run on today's supercomputers. Inversion problems involve the determination of physical parameters from high volumes of observable data.

Remote Exploration and Experimentation applications include space, lunar and planetary high performance computing for data reduction and automation. These applications also require three orders of magnitude performance increases, but since flight computers start from a lower base, this will bring us to gigaflops performance in space in the same era that we hope to achieve teraflops performance on the ground.

UNIQUE ASTROPHYSICS NEEDS

Now let us look more specifically at the key technology areas for Astrotech 21. Many of the ongoing and planned efforts in our current information systems programs will contribute solutions to anticipated astrophysics technology challenges. The attached chart sorts elements from our on-going development programs into five key technology areas for Astrotech 21. We should continue to identify and clarify Information System Technology needs for New Century Astronomy. We have the opportunity to bolster and guide on-going programs, and to initiate new efforts which will address key Astrotech 21 challenges.

The Astrophysics program shares with the other Space Science programs a challenging information explosion. By the turn of the century, we will have the capability to take more space-based data bits per day than would be required to store all of the text in the Library of Congress. Furthermore, we will have many scientists accessing multi-instrument data, whereas our old information systems were designed around a single PI per instrument model. We are in danger of having modern instruments which are under utilized because we cannot access, process, and correlate the data.

By the late 1990's, we can develop some pretty impressive capabilities. If we proceed along our current course we will have flight qualified computers which perform at 10-30 megaflops. Laboratory models of flight computers will ingest data at a gigabit per-second and process it at gigaflops speed. Flight qualified onboard optical disk storage will give block access to a terabyte of data. On the ground, teraflop computers with petabyte staging memories will begin to become available commercially. A 45 megabit per second National Research Network will be in place along with a small gigabit per second network being demonstrated. Ka-Band space communications will give us space communication rates of a gigabit per second with experimental optical links operating up to 5 gigabits. Operations will be more complex, but will be assisted by automation on the ground. Onboard automation capability will have been demonstrated.

While these goals may seem ambitious, I am convinced that they are achievable. It will be more difficult to balance priorities and to assure that the new technologies are configured for the greatest benefit to the users than it will be to accomplish the technical goals. That is where workshops such as this one contribute. We all need to project our needs in the future, with as much precision as we can, and to continue to do so as the need date for the new technologies approaches. In this way, we can maximize the benefit from our scarce technology development resources.

ASTROTECH 21
KEY TECHNOLOGY AREAS

CODE RC PROGRAMS	AUTOMATION IN MISSION PLANNING & OPERATIONS	SPACE-BORNE DATA PROCESSING	SPACE-TO-EARTH COMM.	DATA PROCESSING, TRANSPORT, & ARCHIVING	DATA ANALYSIS, INTEGRATION, & VISUALIZATION
BASE R&T		PHOTONICS	OPTICAL COMM. Ka BAND	DAVID INTELLIGENT DATA MANAGEMENT	- CESDIS - AUTONOMOUS EXPLORATION - OPT. PATTERN RECOGNITION
CSTI	ARTIFICAL INTELLIGENCE —SHARP —RTDS	HIGH RATE/ CAPACITY DATA SYSTEMS —MAX —CHRPS —VMS —SODR			
EXPLORATION		—ADV FLIGHT COMP & ARCH —NEURAL PROCESSING —STORAGE DEV	OPTICAL COMM. AND Ka BAND FOR DEEP SPACE		
HPCI		REMOTE EXPLORATION AND EXPERIMENT-ATION		EARTH & SPACE SCIENCE COMPUTING NREN	COMPUTATIONAL AEROSCIENCES