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EARTH OBSERVING SYSTEM

NASA Needs to Reassess Its EOSDIS Development Strategy

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here to testify on the National Aeronautics and Space Administration's (NASA) development strategy for the Earth Observing System Data and Information System. EOSDIS, as it is called, will be a critical element in the overall EOS program. Without the extensive processing, archiving, and distribution functions that EOSDIS will perform, the data collected by EOS' satellite-based instruments will be of little use to researchers or policy-makers. Our testimony today is based on our recently issued report entitled Earth Observing System: NASA's EOSDIS Development Approach Is Risky[1].

Developing EOSDIS will be a massive undertaking, both in terms of the system's scope as well as its cost. NASA estimates that it will spend about $3 billion to develop EOSDIS through fiscal year 2000. The sheer size of EOSDIS is staggering; its intended scope far exceeds that of any previous civilian data management system. Over its lifetime, the system could accumulate a mass of data equivalent to more than 1,000 times the amount of text currently stored in the Library of Congress.

Based on our review of EOSDIS, we believe that NASA's development strategy does not adequately identify and mitigate the significant technological risks inherent in a project of this size, scope, and technical complexity. NASA's near-term EOSDIS prototype projects do not address critical areas where technical feasibility is in question nor are they substantial enough to allow users to assess key EOSDIS functions. Furthermore, certain key technologies, including new data-base search techniques and data storage and retrieval methods, are not specifically addressed in NASA's official development strategy, even though they have been identified as critical to the long-term success of EOSDIS. Without specific plans to address these challenges, we believe NASA is taking an unnecessarily high risk that the system may not live up to its ultimate goal of providing the global change research community with fast, efficient access to earth science data.

Therefore, we are recommending that the NASA Administrator not award the planned EOSDIS Core System contract until specific plans have been developed and resources identified for (1) prototyping the full range of critical system elements and (2) guiding and accelerating research into key advanced technologies that will be essential for the system's ultimate success.

NASA's EOSDIS STRATEGY

NASA bills EOSDIS as a comprehensive system that will bring together data from many sources to serve the needs of scientists performing integrated, interdisciplinary studies of the earth.

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[1] GAO/IMTEC-92-24, Feb. 25, 1992.

In addition to data from the EOS satellites, EOSDIS will include previously archived data, new measurements from other non-EOS spacecraft, various ground-, ocean-, and air-based measurements, and data-processing software developed by the scientific user community. As such, EOSDIS will be the one system responsible for archiving and distributing all NASA earth science data. The goal of EOSDIS is to make this vast wealth of data easily accessible to a broad range of researchers and to aid these researchers in producing useful global change data products and models.

NASA's development of EOSDIS has two major components. First is a relatively small-scale, in-house program to pilot-test certain aspects of the future EOSDIS on existing NASA data systems. This program is budgeted at roughly $19 million per year through fiscal year 1996. The second major component is the large-scale procurement of an operational EOSDIS through a single, comprehensive contract, known as the EOSDIS Core System contract. NASA plans to choose a Core System contractor this May.

The Core System contractor will be responsible chiefly for building and integrating the major elements of EOSDIS, including hardware and software to be installed at seven locations around the country. The system the contractor builds will need to be fully operational in 1997 to process and distribute data from the EOS satellites beginning in 1998. NASA intends to rely on this contractor to initiate prototyping projects and to identify and develop new technologies as they are needed.

EARLY PROTOTYPING DOES NOT ADDRESS MAJOR RISKS

Prototyping is an engineering technique in which partial, experimental versions of computer-based systems are rapidly and inexpensively built to validate requirements and test the feasibility of key functions before production. NASA has initiated a number of early EOSDIS prototyping projects. However, these projects do not address critical areas where technical feasibility is in question, nor are they substantial enough to allow users to assess key EOSDIS functions. In view of NASA's plan to spend some $3 billion on EOSDIS' overall development, its $19 million investment in this early effort appears disproportionately small.

Three major prototype projects are being directed by the EOSDIS project office at Goddard Space Flight Center in Maryland. One of these projects, a prototype of a common user interface, involves developing a set of interconnected translation routines that will automate connections among the existing data systems at the seven EOSDIS data centers. This prototype will help reduce the number of separate computer systems a researcher needs to check to find earth science data. However, it will not provide any major qualitative advances in how a researcher searches for

data once access to the system as a whole has been obtained. In short, this prototype addresses the relatively easy problem of providing connections between data systems; it does not take on the harder problem of improving fundamental methods of data access within large systems.

A second major effort--the network prototype--will not be able to prove the feasibility of using current networking technology because it will provide connections to existing data systems only, which require neither the high data volumes nor the fast transfer rates anticipated for the full-scale system.

The third major prototype--the project to study data format standards--addresses an important and complex issue. Earth science data currently exists in many different incompatible formats, with no clear choice available for an overall standard. However, the project is receiving just a modest commitment of resources: only one quarter of a staff person's time at each of the seven data centers is dedicated to pursuing this problem.

Since rigorous prototyping results will not be available any time soon, NASA's planned EOSDIS procurement decision later this year will likely be made with scant feedback on the technical feasibility or user acceptance of major design concepts. This is clearly unwise, because it significantly and unnecessarily increases the risk that EOSDIS will not meet scientific needs and expectations and will result in excessive, uncontrolled development costs.

NEW TECHNOLOGY WILL BE NEEDED

For certain key functions, new technologies will be needed for EOSDIS that are beyond the state of the art. Current data management technology is simply not adequate to efficiently handle the vast amounts of EOS and other earth science data that global change researchers will need.

Current data-base search techniques, which were generally designed to meet the needs of transaction-based business applications, are inadequate to support the work of interdisciplinary earth scientists. A new kind of data base management system is needed, a system designed specifically for scientific purposes that will handle complex earth science images as nimbly as a business-oriented data-base system handles payroll records. Such a system needs to allow scientists to search and sort electronic images by the natural features they depict; without such a feature, the huge mass of data in the system will likely be prohibitively difficult to access and correlate. In addition to better data-base management systems, advances must be made in the way scientific data are organized and characterized within an information system. Again, because of the amount of

data involved, manual classification of the data will be impractical. Instead, new automated methods will be needed.

Better methods of displaying the data will also be needed. To find broad-based correlations within all of these data, scientists must have ways of displaying dense, complex interrelationships on computer terminals so they can sort out their significance. While some research has been done in this area, more work is needed to make flexible visualization of large amounts of data practical. These are just a couple of examples where technological advances will be needed before EOSDIS can reach its goals.

Although NASA has allowed for future incorporation of advanced technology by endorsing an evolutionary approach to EOSDIS development, the program, as currently structured, gives no specific direction in these areas. Further, EOS program officials have not supported proposals by NASA's research organization, the Office of Aeronautics and Space Technology, to begin doing research in these technologies in the near term.

CURRENT DEVELOPMENT STRATEGY IS INADEQUATE

EOSDIS has been initiated on the premise that it will offer substantial improvements over existing earth science data systems, which are limited in their ability to support global change research. Yet unless specific plans are developed and resources directed toward research into key advanced technology areas in the context of EOSDIS, NASA risks developing a system that is little better than these current systems. As a result, global change researchers will be unable to fully analyze the vast wealth of data stored in the system and interpret its significance.

Mr. Chairman, this concludes our testimony. We will be happy to answer your questions regarding our work.

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