NSSDC news

NASA's National Space Science Data Center

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Popular Space and Earth Science Data Are Stored on CD-ROM

Displayed is a selection of CD-ROM data discs currently available from NSSDC.

The task of acquiring, archiving, and disseminating space and Earth science data has become increasingly complex. Different data formats, analysis tools, and the sheer volume of data from recent missions have limited the potential user communities to those who have access to expensive computer systems. It is often impossible for a small university or independent research group to acquire and analyze data, for example, on thousands of magnetic tapes.

The personal computer has given more researchers than ever before access to the newest data analysis, graphics, and storage technologies. The combination of the PC and Compact Disc Read-Only-Memory (CD-ROM) technology has revolutionized the storage and distribution of space and Earth science data. This medium is only 12 centimeters in diameter and yet can hold up to 700 megabytes of data. The disc itself is very durable and has an extremely long shelf life. It requires a minimum investment in hardware and software to use on IBM, Macintosh, VAX, and SUN computers. CD-ROMs are ideally suited for distribution because they are very inexpensive both to produce in mass quantity and to mail through the postal system. Scientific data in bulk volume previously accessible only to government agencies or large research organizations are now available to any researchers at nominal prices. Data on CD-ROM are even being used in high school classrooms as instructional tools. The end result is that more effort can now be spent on actual research than on data acquisition and processing.

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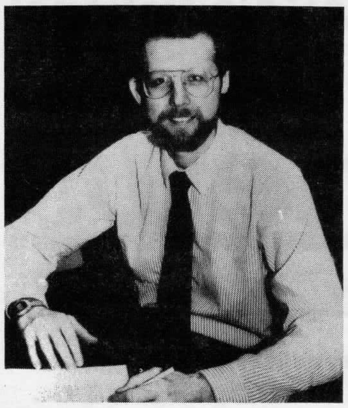
Dedicated to providing multidisciplinary data and information for the worldwide science community



Director's Message:

A Look at Our 1990 Report Card

Enclosed with this newsletter you will find the *1990 Annual Statistics and Highlights Report.* I am delighted to provide this report on the highlights and distribution statistics for most of the basic NSSDC operational services for fiscal year 1990. It is my intention to provide this report to the science user community on an annual basis. Call it the "NSSDC report card," if you will. This report will tell users how well we are doing in supporting the space and Earth science communities. I have tried to pick out the key systems and statistics from those systems that would be of most interest to the science community. I am particularly proud of the NSSDC publications list, which has over 70 catalogs, newsletters, documents, and reports that have been completed by the staff in 1990.

Over the last five years there have been some tremendous changes in the way NSSDC has supported the space and Earth science user community. The science user community needs rapid access to archival data and information about data, and NSSDC has been set on the course to provide just that. Five years ago NSSDC came "on line," becoming easily reachable for thousands of scientists around the world through the electronic networks it managed as well as through other international electronic networks to which it connected. Since then, the data center has developed and implemented more than 15 interactive systems that are operational nearly 24 hours per day; NSSDC is reachable with DECnet, TCP/IP, X.25, and BITnet communication protocols.

The first major "on-line" thrusts of NSSDC were designed to provide users with information about the data in our archive and the ability to electronically request data. NSSDC has torn down its walls by becoming a clearing-house through which the science user can use the Master Directory system to find data needed—whether those data are located at NSSDC or at one of the other 50 archives and data management facilities around the world.

Within the last two years, NSSDC has been able to place on line more and more data in the archive for remote user access and browsing. Response from the international science community to this new "on-line thrust" has been tremendous, with more than 13,000 user accesses to NSSDC electronic systems last year alone. Thousands of requests for data have been satisfied, resulting in NSSDC's sending out a volume of data last year that nearly exceeded a quarter of its holdings. We sent out more data in CD-ROMs in 1990 than we did on magnetic tape. In addition, a significant fraction of data also was distributed over the wide area computer networks.

It has taken NSSDC nearly 25 years to accumulate over 6 terabytes of space and Earth science data. NSSDC is entering a new era as NASA aggressively whittles away at its space flight backlog. Our projection for the volume of incoming data from future NASA missions indicates that NSSDC's holdings will nearly double every two to three years.

In a similar manner, I expect that a massive amount of data will be delivered to the science community for further analysis from the archive. We are currently taking steps to accommodate the large amount of data coming in and the large amount of data going back out to scientists. It is important to note that NSSDC will only physically archive a part of the science data coming from NASA missions.

Our intention is to continue to provide rapid access to larger volumes of data held at NSSDC by improving our on-line and off-line services and to point to the other important data holdings elsewhere. Managing an ever-increasing volume of data in the archive while making it more accessible is a challenge that we are getting ready to meet. I hope you will agree with that assessment after reviewing the *1990 Annual Statistics and Highlights Report* from NSSDC. I invite your suggestions for further enhancing NSSDC's user services.

James L. Green

CD-ROM, *from p.1*

About two years ago, NSSDC started distributing a variety of NASA data sets on CD-ROM, ranging from astronomy to planetary and Earth remote sensing. Many of these data sets are distributed with detailed documentation and display software, either on the CD-ROM itself or on an accompanying floppy disk.

1. Astronomical Catalog Library for stellar and nonstellar sources from the Astronomical Data Center (ADC). One test disc was released with star catalogs in Flexible Image Transport System (FITS) and ASCII formats. A new version is in preparation and may be available later this year.

2. Comets Giacobini-Zinner (GZ) and Halley data from the International Halley Watch. One test disc of the GZ is available in Compressed Flexible Image Transport System (FITS) and Planetary Data System (PDS) formats along with ASCII text. Twenty-four archival discs will be released in the summer.

3. Magellan mission to Venus data from the Magellan Project and the Planetary Data System (PDS). One radar mosaic image disc is available in VICAR2 and PDS format. More than 50 discs containing images, altimetry and radiometry composite data, and global maps are being prepared. Limited copies of the pre-Magellan disc are available. The disc contains radar data for Venus, Mercury, Mars, Earth, and the Moon, together with gravity data obtained through the Pioneer-Venus Orbiter and the Viking Orbiters.

4. Nimbus 7 Scanning Multichannel Microwave Radiometer (SMMR) Irradiance and Sea Ice parameters in the Special Sensor Microwave/Imager Grid from the Principal Investigator. One test disc is available with tables and documentation, including the *Polar Regions User's Guide*. Contact Dr. Per Gloerson, Code 971, NASA/GSFC; Telephone: (301) 286-6362.

5. Nimbus 7 Total Ozone Mapping Spectrometer (TOMS) data from the Nimbus Project. One disc containing ten years of recalibrated Version 6 total column ozone data is available in ASCII format. A second disc with graphics is in preparation.

6. Viking Orbiter Images of Mars from the Planetary Data System (PDS). One Infrared Thermal Mapper (IRTM) disc (non-imaging) was available in VAX and PDS format. Because of a manufacturing problem, the availability of additional copies of the IRTM disc is uncertain. Potential users should contact NSSDC periodically for updates. One image disc is available with compressed and browse images. More will be available in 1992.

7. Voyager Spacecraft to the Outer Planets images from the Planetary Data System (PDS). Compressed and browsed images accessible through the IMage DISPlay (IMDISP) retrieval program include

- Uranus (Vols. 1-3): 6538 images
- Saturn (Vols. 4-5): 4000 images
- Jupiter (Vols. 6-8): 6000 images
- Neptune (Vols. 9-12): 10,000 images

The Coordinated Request and User Support Office at NSSDC maintains a CD-ROM browse facility on a Macintosh computer. Reference copies of each of the CD-ROM data sets stored at NSSDC as well as at other NASA centers are available for browsing. The office staff will be happy to assist users in finding and reading the CD-ROM data sets of their choice.

In compliance to the data center's charge and service policy, requesters will be charged $20 per CD-ROM and $6 for each additional disc in the same data set. CD-ROM discs are normally sold by the set. If only one disc is requested from a set, NSSDC will randomly select a disc from the set. Shipping and handling fees are $2.50 for domestic orders and $10 for non-U.S. orders. However, as resources permit, the NSSDC director may waive the charge for modest amounts of data when they are to be used for scientific research or educational purposes. Requests should be addressed to CRUSO (see the back page of this newsletter).

Carolyn Ng
Jim Closs

Detailed statistics relating to NSSDC operations and services are furnished in the first *Annual Statistics and Highlights Report* accompanying this issue of *NSSDC News*.

International Reference Ionosphere 1990 Software and Handbook Are Now Available from NSSDC

The International Reference Ionosphere (IRI) 1990 is described in a new NSSDC document (*International Reference Ionosphere 1990*, NSSDC 90-22, November 1990, 155 pages) edited by Dieter Bilitza with contributions by K. Rawer (Germany), L. Bossy (Belgium), I. Kutiev (Bulgaria), K. Oyama (Japan), R. Leitinger (Austria), and E. Kazimirovsky (U.S.S.R.).

IRI is the standard ionospheric model developed and improved by a joint working group of the International Union of Radio Science (URSI) and the Committee on Space Research (COSPAR). Based on all reliable and accessible ground and space data, IRI describes monthly averages of the electron density, electron temperature, ion temperature, ion composition, and ion drift at ionospheric altitudes. IRI is used for a wide range of applications in science, engineering, and education; it is one of NSSDC's most frequently-requested software items.

The NSSDC document continues the series of IRI handbooks. The previous IRI handbook was published in 1981 by the World Data Center A for Solar-Terrestrial Physics (*IRI-79*, UAG-82, Boulder, Colorado, 1981). Since then, major improvements have been incorporated into the IRI models based on the data accumulated throughout the 1970s and 1980s by satellites, rockets, ionosondes, and incoherent scatter radars.

Proceeding from IRI-79 to IRI-86, the IRI group developed substantially better descriptions of the electron density in the equatorial topside and of the global and diurnal variations of electron and ion temperatures. IRI-86 was the first version to be released not only on tape but also on diskette for use on personal computers; it was also made accessible on line through computer networks.

IRI-90 includes new models for the E-F-region electron density and for the ion composition. These new model choices are offered in addition to the older versions, thus making the phasing in and out of new and old versions more transparent to the user community. The IRI-90 user can choose from a menu of new options including

- The URSI-1989 *foF2* model.
- The Gulyaeva-1987 model for the bottomside thickness.
- The analytical representation of the E-F-region with LAY functions.
- The Danilov-Yaichnikov-1985 ion composition model.

In addition, the *foE* nighttime variation was corrected to better represent incoherent scatter results. Feedback from IRI users has also led to several technical corrections and enhancements of the IRI software.

In publishing the IRI-90 book, NSSDC responds to the need of the IRI user community for a comprehensive information source that provides all of the mathematical and physical details of the model. The book is divided into the following six chapters:

(1) Introduction
(2) History and New Developments
(3) Formulas and Explanations
(4) Graphs
(5) Tables of Contents of IRI Reports
(6) References

The first two chapters provide an introduction to earlier IRI work and future plans. In the third and fourth chapters, the IRI-90 model is explained and illustrated in great detail. The list of titles and authors in the fifth chapter gives a brief summary of the agenda and discussion topics during the annual IRI workshops from 1980 to 1990.

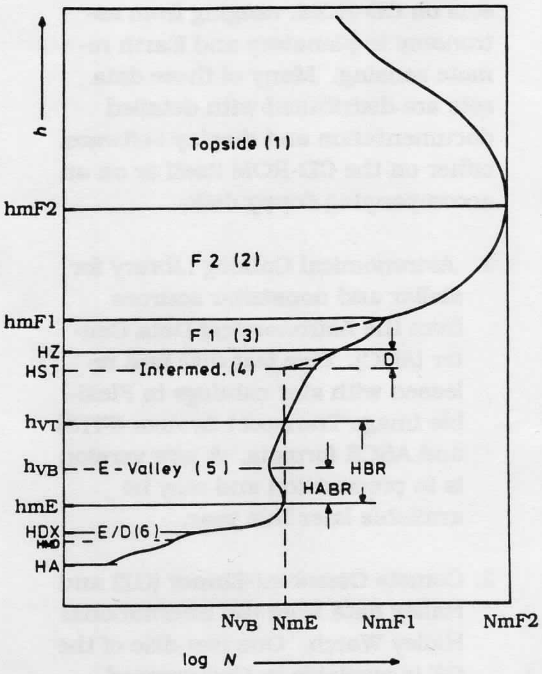


Figure from p. 51 in handbook shows IRI electron density profile divided into six subregions including topside, the F2-bottomside, the F1-layer, the intermediate region, the E-valley, and the E-bottomside and D-region.

IRI-90 software is being distributed by NSSDC on tape, on computer networks (NSSDC ID: MI-91H), and on diskette for use on PCs (MI-91I); it can also be accessed directly on NSSDC's Online Data and Information Service (NODIS) account.

The IRI-90 book can be obtained by contacting NSSDC's Request Coordination Office. The procedure for requesting information is explained on the back page of this newsletter.

Dieter Bilitza

Standards Office Surveys Physical and Logical Format Media Standards

As NASA's primary archive for scientific data obtained from spacecraft and ground-based observations, NSSDC is keenly interested in tracking and evaluating new mass storage and media technologies in order to ensure these data remain available for future use. Factors for evaluation have traditionally been cost, access time, storage capacity, transfer rate, archival life, and space requirements. However, the degree of standardization has become an increasingly important factor to help ensure long-term vendor support and the ability to exchange these media between heterogeneous systems.

Two key types of standards are being evaluated by both the American National Standards Institute (ANSI) and the International Standards Organization (ISO), but only for specified media. The first type of standard defines the physical format of the media and its cartridge, and the second defines the logical format, or its directory and file structure.

This article presents the status of the standardization efforts of these organizations for physical and logical formats of WORM and rewritable disks, CD-ROM, and tape optical media, and the physical format of 4mm and 8mm helical scan magnetic tape media. The table at right summarizes the findings described in this article.

Physical Format Standards

Physical format standards address the physical properties of the media, its cartridge (if any), and the method by which bits are identified. Media with physical formats include WORM optical disks, rewritable optical disks, and CD-ROMs. (Standards for optical tapes are not being worked on now.)

WORM Optical Disk

5.25" (130mm) WORM optical disk—The ISO 9171 standard was adopted in January 1990 on 5.25" WORM. ANSI's X3B11 committee has recommended that ISO 9171 become a joint ISO/ANSI standard, but ANSI has not yet adopted that suggestion. This standard document contains information on two incompatible formats; so in referring to this standard, one needs to clarify whether the reference is to the CCS (Continuous Composite Servo, 300 MB per side) or Sampled 4/15 (Sampled Servo with 4/15 Modulation, 320 MB per side) recording form. A third recording form, Sampled RZ (Sampled Servo with RZ Modulation, 450 MB per side) is not included in the above ISO standard because of its different hub size. X3B11 has produced draft document X3.191 *(Sampled Servo RZ Selectable Pitch Optical Disk Cartridge)*, which completed its balloting review by X3 in December 1990. This exclusively NSI standard will be published in the spring or summer of 1991.

12" (300mm) WORM optical disk—There are many 12" products on the market, and manufacturers have been unwilling to change their products to conform to any standards other than their own internal ones.

Therefore, there is no ANSI or ISO standard for 12" WORM. X3B11 reports that there is a project on a new generation of 12" worm optical disks with new hub diameters that will be incompatible with existing formats. Whether or not an ANSI or ISO standard will be established is uncertain, because each company has profited by using its own internal standards.

14" (356mm) WORM optical disk—These are built only by Kodak and Phillips Dupont. A draft standard identified as CD10885 is being circulated for ballot among the ISO SC 23 committee members. Balloting closed at the end of April 1991. ANSI has completed its review of this document and forwarded its vote to ISO this spring to stay on schedule.

see Standards Survey, *p. 6*

STATUS OF PHYSICAL FORMAT STANDARDS (Jan. 1991)

Underlying Technology	Media Type	Size	Bit Format	STANDARD ISO	STANDARD ANSI
Optical	WORM	5.25in	CCS, S 4/15	9171	To adopt ISO std
Optical	WORM	5.25in	S RZ	none	X3.191
Optical	WORM	12in		none	none
Optical	WORM	14in	yes	CD 10885	To adopt ISO std
Optical	Rewritable	5.25in	CCS, S 4/15	10089	X3B11/90-165†
Optical	Rewritable	3.50in	yes	CD 10090	To adopt ISO std
Optical	CD-ROM	4.72in	yes	ISO/IEC 10149	none
Optical	Tape	1.38in		none	none
Magnetic	Tape (HS)	4mm	DAT-DDS	10777	X3B5/90-231
Magnetic	Tape (HS)	4mm	DATADAT/Rec	11.18.02*	X3B5/90-293
Magnetic	Tape (HS)	4mm	DATADAT/UnR	none	X3B5/90-280
Magnetic	Tape (HS)	8mm	yes	11.19*	X3B5/90-192

* Working Paper
† Only addresses CCS standard

STATUS OF LOGICAL FORMAT STANDARDS (Jan. 1991)

Underlying Technology	Media Type	Size	File Structure	Directory Structure	STANDARD ISO	ANSI
Optical	WORM	5.25in	yes	yes	none	X3B11.1/90-039
Optical	WORM	12in	yes	yes	none	X3B11.1/90-039
Optical	WORM	14in	yes	yes	none	X3B11.1/90-039
Optical	Rewritable	5.25in			none	pending
Optical	Rewritable	3.50in			none	pending
Optical	CD-ROM	4.72in	yes	yes	9660	

Standards Survey, *from p. 5*

Rewritable Optical Disk

5.25" Rewritable optical disk—The term "Erasable" is no longer used because media can be erasable without being rewritable. ISO 10089 is the standard document approved by ISO in October 1990 and should be published in the spring of 1991. The 5.25" Rewritable has the same physical dimensions and appearance as the 5.25" WORM. Also like WORM, ISO 10089 contains only the CCS and Sampled 4/15 recording forms.

ANSI's standard document, X3B11/90-165, is the standard document for 5.25" Rewritable optical disk using the CCS format and is otherwise identical to ISO 10089. Its committee balloting period ended in December 1990 and began public review for a four-month period.

3.5" Rewritable optical disk—The same document, CD 10090, is being developed for ANSI and ISO for this medium. It is expected to go out for balloting in May 1991 with publication possibly this fall. This medium is being produced by IBM, SONY, and Nakamichi.

CD-ROM Optical Disk

The CD-ROM standard for physical characteristics, ISO/IEC 10149, is complete and published. Although there has been talk of a write-once CD-ROM, no proposals have been made to either ISO or ANSI technical committees.

Optical Tape

There is currently no ANSI or ISO standard committee working on optical tape standards.

Helical Scan Magnetic Tape Media

Helical Scan provides higher bit densities and longer life for both the tape and the read/write heads than traditional tape technologies. The 8mm tape was developed from video technology and was first used for data storage in 1987. The 4mm tape developed from audio technology and is new to the data storage function.

4mm Helical Scan Tape—Sony and HP developed and were the prime sponsors for the DDS (DAT) data format standard. DDS stores data contiguously and sequentially. The most current documents are shown below with their publishing standard organization.

Recorded DDS and unrecorded DDS (SONY/HP):

- ANSI X3B5/90-231—In public review as of September 1990.
- ISO/IEC DIS 10777—Draft International Standard.

1.2 Hitachi (and others) later proposed an alternative DAT format, the DataDAT data format, which is more disk-like than DDS in that, when preformatted, it can be updated in place and written randomly. DataDAT is incompatible with DDS.

Recorded DataDAT (Hitachi):

- ANSI X3B5/90-293—In committee review as of November 1990.
- ISO/IEC 11.18.02—Working paper.

Unrecorded DataDAT (Hitachi):

- ANSI X3B5/90-280—In committee review as of October 1990.

8mm Helical Scan Tape—The prime sponsor for 8mm is EXABYTE.

- ANSI X3B5/90-192—Standard is complete.
- SO/IEC 11.19—Working paper.

Logical Format Standards

Logical format standards address the specification of file and directory structures on the media, and they rely on the existence of physical format standards or specifications. File structure standards specify the arrangement of files on a medium's surface within the constraints of its bit field layout, identification of files with cross-media boundaries, conventions for time and date stamps, etc.

Directory structure standards support rapid identification and access to files. Standards in these areas provide recognition of files for transfer between different operating systems. They do not address file content, such as the representation of characters, reals, and integers.

see Standards Survey, *p. 7*

Standards Survey, *from p. 6*

WORM Optical Disks

Draft document ANSI X3B11.1/90-039 is the current working paper for volume and file structure for all WORM single- and double-sided optical disks. It also specifies a basic directory structure. Time estimates on balloting and publication are not definite enough to be available.

Rewritable Disks

No ISO or ANSI documents have been written to address logical format standards for rewritable disks.

CD-ROMs

The CD-ROM standard for file and directory structure, ISO 9660, is complete and published. However, there are user efforts under way to obtain updates to the standard.

Future Directions for Standards

It would be a mistake to assume that standards bodies plod through their deliberative processes in a preprogrammed fashion where no new developments are allowed to interfere. An article in the November 1990 issue of *BYTE* points out that there is some excitement as ISO gets ready to publish its ISO 10089 standard for 5.25" Rewritable optical disk technology; this enthusiasm results from the speed with which the standard was developed— so soon after Pioneer Communications and Laser Magnetic Storage announced that they have drives supporting both WORM and rewritable media using "a different format than other rewritables."

SONY, HP, and others have produced a specification that may become a defacto standard. It would provide for rewritable drives to be used with media coded at the factory as being either write-once or rewritable.

Will ISO stop the presses and consider these developments? The standards office will let you know when it next publishes an update on the status of these and other optical and magnetic media standards. The standards office routinely purchases these copyrighted standards for local use at NSSDC. You may purchase your own copies of ANSI and ISO standards by contacting the ANSI Sales Office at (212) 642-4900.

Your comments and suggestions are welcome and may be addressed to

NSDSSO/NSSDC, Code 933
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If you would like to read an article about standards, try "Playing Catch-Up" by Andrew Reinhardt in *BYTE Magazine*, November 1990, p. 278.

Donald M. Sawyer
Alan M. Dwyer

NSSDC Contractor Moves into New Facility Near Goddard

About 60 NSSDC staff members who are employees of ST Systems (STX), the support contractor (formerly Science Applications Research [SAR]), moved to new office space February 15. The new space is off-site but close to Goddard Space Flight Center (GSFC) (two miles from Building 26). In fact, it is closer than the STX office in Lanham, where some staff members currently have their offices. STX invites you to come by and visit next time you're in the area.

Those in the new offices constitute about 45% of the NSSDC contract staff personnel. The logistics planning for the move was headed by Debbie Leckner, who, needless to say, has been very busy coordinating all the various requirements for office space, new furniture, communications planning, plus everything else, to ensure a smooth and painless transition. The actual move was centered around a weekend in order to minimize any impact on NSSDC operations and user services.

Electronic communications to the NSSDC computing facilities are in place at the new facility, so no changes are required in network addresses. For ordinary mail, the old address (Individual Name, NSSDC Code 933.9, NASA GSFC, Greenbelt, MD 20771) will still be correct. Please be sure that "NSSDC Code 933.9" is included, even if a different code (or only three digits) was used before.

The actual address of the new office is NSSDC Project, Suite 300, 7601 Ora Glen Drive, Greenbelt, MD 20770. Mail may be addressed to staff members there, also.

Although the old mail address will still work, the telephone numbers have all been changed. Below is a selection of often-used telephone numbers for employees in the new building, all with the area code of 301.

- Receptionist 513-1661
- FAX 513-1608
- Klenk, Dr. Kenneth 513-1601
- Beier, Dr. Joy 513-1662
- Hills, Dr. H. Kent 513-1670
- Stocker, Erich 513-1640
- Tighe, Dr. Richard 513-1660
- Wilson, Clayton (Ed) 513-1690

H. Kent Hills

Newly-Created Composite IMP 8 Data Set Archived at NSSDC

Much data relevant to magnetospheric and heliospheric magnetic fields, plasmas, and energetic particles have been collected by the IMP 8 spacecraft since 1973, and these data continue to be collected. Most of them have already been archived at NSSDC by individual Principal Investigators and their teams.

A new data set containing data from four of the IMP 8 instruments is now being created at Johns Hopkins University/Applied Physics Laboratory (JHU/APL) and archived at NSSDC. This data set contains the following:

- 20-s resolution fluxes of electrons, protons, alpha particles, and medium-Z nuclei, in several energy ranges above 300 keV/n, as measured by the Charged Particle Measurement Experiment (CPME) of S. M. Krimigis at JHU/APL.

- Similarly resolved lower energy electron (30 keV), proton (50 keV) and higher Z fluxes from the Energetic Particles Experiment (EPE) of D. J. Williams at JHU/APL (formerly NOAA/SEL).

- 15-s magnetic field data (Lepping, GSFC; formerly Ness).

- 1-min plasma parameters useful in the magnetosheath and solar wind (Lazarus, MIT; formerly Bridge).

Several of the CPME and EPE particle energy channels have azimuthal directional resolution, and a few actually have 10-s time resolution. The CPME and EPE data at these resolutions are held at NSSDC only on the tapes of this composite data set. The field and plasma data are also held on separate data sets at NSSDC. Approximately 60% of the bytes on the tapes are CPME data, and 20% are EPE data.

This data set is being transmitted to NSSDC on full 6250-bpi magnetic tapes. As of this writing, data for the period October 1973 to October 1985 have been provided to NSSDC on 155 magnetic tapes. Depending on user demand for these data, NSSDC may migrate them to higher capacity media and/or migrate them to near-online status for access and download of modest-sized chunks of data.

The data set has been created largely through the efforts of Pat Briggs (The Citadel, formerly University of Kansas), Tom Armstrong (University of Kansas), and Jack Gunther, Don Mitchell, and Joseph Milbourne, all of JHU/APL. A users' guide to this data set was created by Pat Briggs and is available from NSSDC with or without the data set.

To request any parts of the data or the *Users' Guide*, contact the NSSDC Request Coordination Office, whose addresses are given on the back page of this newsletter.

Joseph H. King

EOS Mission Data Volumes and Requirements Challenge Scientists

For the past three years, the Intelligent Data Management (IDM) Project has been tackling the intriguing problem of how to develop a computer system that can reliably characterize and catalog all of the images that are to be relayed back to Earth by the Earth Observing System (EOS). The first of two platforms defining EOS was launched late last year.

During its 15 years of operation, EOS will produce in a week more data than has been gathered at the National Space Science Data Center in its 25 years of operation. Whereas satellites such as Nimbus and LANDSAT contain one or two sensors that work in anywhere from one to seven channels, EOS will have roughly 30 instruments each sensing in a variety of bandwidths, including one instrument that can take measurements in excess of 150 channels.

The data volumes to be generated by EOS far exceed those handled by any existing civilian data management systems, and the interdisciplinary nature of the EOS mission means that whereas one physical scientist's meat is another physical scientist's morsel, each is a meal for computer scientists who must develop systems for archiving and accessing the data from all of the sensors. To handle the interdisciplinary call, the computer system must be able to facilitate scientists' needs to fuse data sets from disparate sensors into meaningful results.

At a minimum, computer scientists must develop an integrated system for solving the following problems: characterization of the satellite imagery; cataloging of the images; domain-specific user interfaces for the various scientific disciplines; efficient mass storage of the data; and evolution of the overall system during its lifetime (15 years of observations and umpteen years of usage thereafter). No commercial software exists for handling any of these issues when the size of the data sets is considered and the complexity of the potential scientific queries is understood. William J. Campbell, branch chief of Code 934, proposed to NASA Headquarters in 1985 to research the use of artificial

see EOS Challenge, *p. 9*

EOS Challenge, *from p. 8*

intelligence (AI) and advanced computer science techniques for approaching the increasingly difficult problem of data management. Since then the IDM group has pursued this research under continual Code R funding, augmenting its budget with occasional Goddard Space Flight Center Director's Discretionary Funding.

Computational problems for which there are clearly defined solutions, such as multiplying two numbers together or sorting names alphabetically, are said to be solved algorithmically. Artificial intelligence is the application of computers to problems that people do not solve algorithmically. It is concerned with issues such as automatic problem decomposition, knowledge representation, reasoning, and computer vision. All of these subdisciplines contribute to developing a system that can characterize satellite imagery.

The United States Geological Survey (USGS) has a standardized schema for categorizing land use and land cover for use with remote sensor data. At the highest level the categories are urban or built-up land, agricultural land, rangeland, forest land, water, wetland, barren land, tundra, and perennial snow or ice.

The IDM group began research into automatic data characterization in 1988. The idea is to take an image and produce a breakdown of the land use/land cover classes found within that image. Without any characterization of the content of an image, scientists must inspect a large number of images manually before a suitable scene is found. If a breakdown of the classes in an image is available, then a system can be built that allows direct access to images whose contents potentially match the scientists' needs. With EOS, there will be too much data to do an adequate job manually of selecting the best image. An automatic data characterization and cataloging system that can return a small set of candidate images for the scientist's manual perusal will not only save a lot of time, but perhaps also let scientist's choose from a small set of good images (which can be thoroughly checked), instead of a large set of images of varied quality (which can never be exhaustively reviewed).

In the late 1980s computer scientists were giving a lot of attention to a special model of computation known as artificial neural networks. Whereas most people think of computers as machines well-suited for numerical computation, artificial intelligence is predominantly concerned with symbolic manipulation. Neural networks are very good at mapping low-level signals into symbolic categories. In particular, the IDM group has been successful at implementing neural networks that accept the readings from the various channels of a sensor and output the land category to which those readings correspond.

It is not necessary to comprehend the mathematics underlying the functioning of a neural network to develop an understanding of this method of computation. Think of the neural network as a black box that receives input (such as sensor channel readings) and produces output (such as land use/land cover categories). The black box embodies a mathematical function that converts the input into the output. This mathematical function gradually takes shape as the neural network is taught to perform the characterization task.

The general technique for developing a neural network to do characterization can be compared with a student learning the same task from a teacher. The neural network is presented with sensor input and then outputs its selection as to what land use/land cover category the input should be mapped. At first, the choice is purely random. However, the network is then supplied with what the correct characterization for the given input should have been. This is compared with the network's generated output, a difference is computed, and this difference is used to modify the mathematical function in this neural network black box.

The modifications do not produce an exact mapping, but gradually they converge on a reliable configuration for doing the characterization. The neural network must be trained on a wide variety of possible sensor readings for each land use/land cover category because the underlying mathematical function is shaped from these examples. A larger number of varied inputs produces a more realistic mapping function.

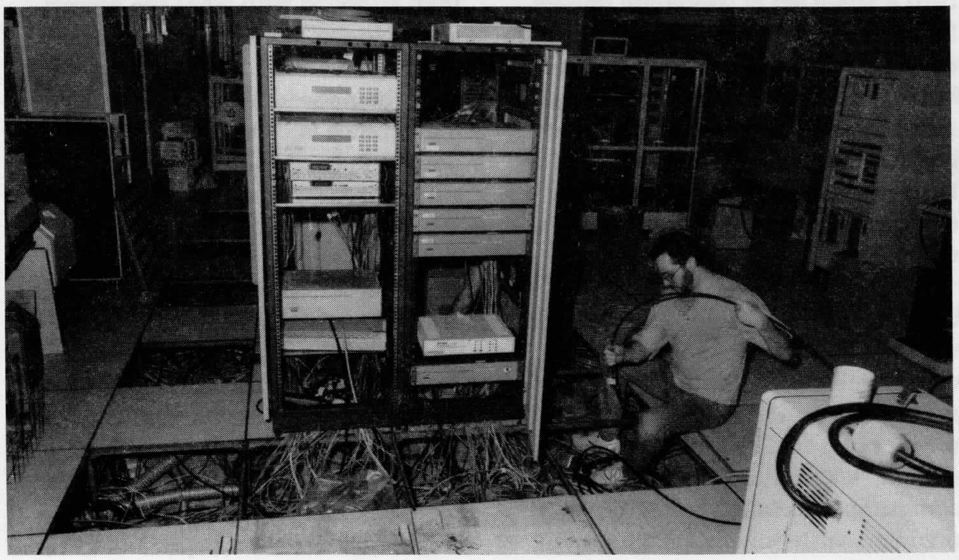
Though training of a neural network is slow, the application of a network to characterizing images is extremely fast. Once the mathematical function that defines the network exists, it can be evaluated in constant time for any given input. Computer scientists always strive to produce algorithms that run in constant time because they are the fastest possible.

The training of a neural network for this task requires both an image of some region and a ground truth file for that region. The ground truth file is obtained either from actual in-person site visits— a time-consuming, expensive task— or from inspection of aerial photos by a remote sensing specialist. Ground truth files of most of the United States are available through the USGS.

Once a satellite image file and a ground truth file for a given location are procured and assuming that the two files correspond to the same region down to the pixel level, the training can occur. A subset of the pixels

see EOS Challenge, *p. 13*

VAX Clusters Move from Building 26 to Building 28 . . .



Wayne Rosen pulls cable to disconnect VAX 8650 hardware in Building 26.

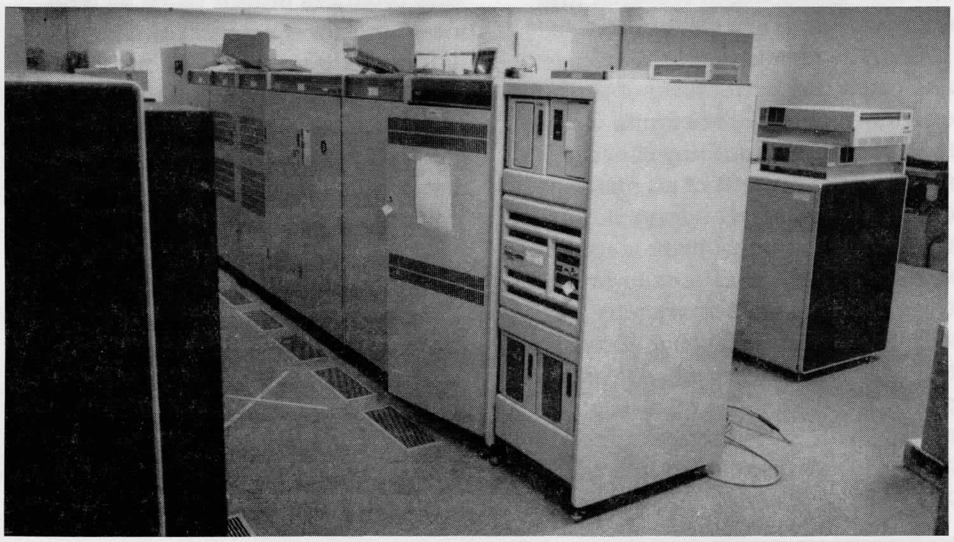
By the time you receive this newsletter, you already will be benefitting from the improved user services and three to four times increased processing power made possible by combining NSSDC's Building 26 VAX clusters with the VAX 9410 in Building 28 at Goddard Space Flight Center.

As mentioned in the Winter 1990 issue (Vol. 6, No. 4), beginning Friday, April 26, the VAX 8650 and the 6410 were both moved from the data center (Building 26) to Building 28, which now houses the VAX 9410 and a Cray supercomputer. The NSSDC Data Archive and Distribution Service (NDADS) was put back into service on Friday, May 3, and all equipment was in place, reconnected, and fully functional by Monday, May 6. Minimal inconvenience was incurred by users, who, in the interim, could access the NSSDCA node through a temporary account for E-mail purposes. Users requiring large scale computing capabilities had the International Solar-Terrestrial Physics (ISTP) system made available to them.

According to Ben Kobler, one of the principal NSSDC coordinators and organizers of the move, the computing configuration now in Building 28 is identical to that which was originally in Building 26, except that the 8650 unit is now clustered to the VAX 9410, and the 6410 will become clustered with the NDADS system. The Master Directory (MD) and NASA Climate Data System (NCDS) services are now on the 9410. Kobler said "NDADS, the NSSDC Cluster, and Cray are all in the same room." Access to the Cray computer through

see VAX Move, *p. 11*

The VAX 8650 unit (now in place in Building 28), seen shortly before finishing touches were applied.



Power Available to Users Increases Nearly Fourfold

Chuck Davis reconnects VAX equipment in Building 28.

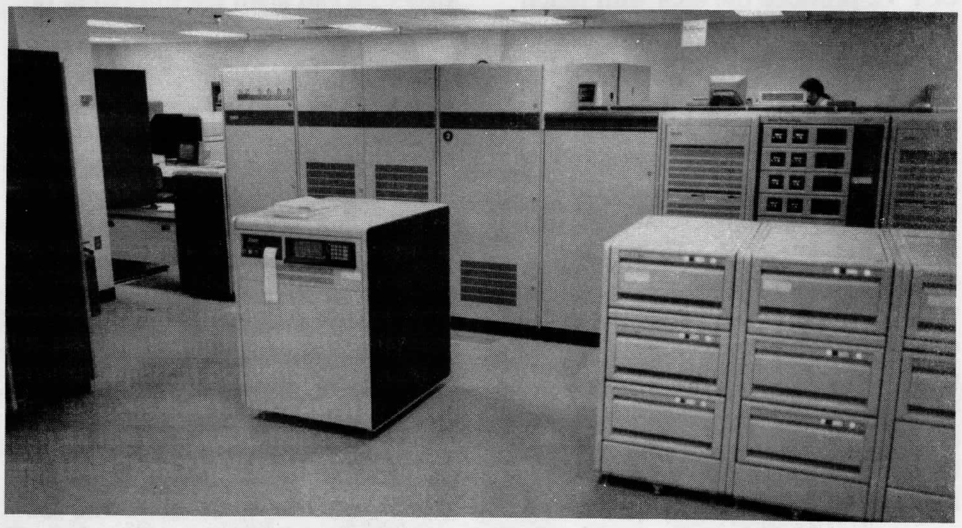
VAX Move, *from p. 10*

the 9410 is now possible, providing a dramatic increase in capabilities as well as better service to data center users. "Our goal is to have the full configuration ready in time for the CDAW Workshop on June first," said Kobler in a recent interview.

Approximately two months of planning preceded the move, and the actual task required the services of nearly a dozen individuals. Ben Kobler, acting as one of the major organizers, was responsible for planning, scheduling, and procurement. Ms. Valerie Thomas, assistant director of NSSDC, coordinated general procurements, while Ms. Jeanne Behnke coordinated procurements with Digital Equipment Corporation. Other key people involved included Ms. Terri Shaffer, who implemented the checklist; Ms. Dolores Parker, who coordinated user interactions and tape processing; Mr. Lee Foster, who coordinated and supported the ROLM lines move; and finally, Mr. Russ Dunlap, Mr. Wayne Rosen, Ms. Kelly Gygax, Mr. Chuck Davis, and Mr. Rick Payne, who were instrumental in doing the actual hardware disconnects, reconnects, and setting up of all the accounts. Kobler added that "the move was completed with the full cooperation of Mr. Hal Domchick and other Building 28 personnel who were most helpful."

Len Blasso

'Russ Dunlap, Wayne Rosen, and Rick Payne represented a critical component of this move and for that reason, they were awarded certificates." Ben Kobler



VAX 9410 standing in rear with power controller at center, hard disk drives in right foreground.

NSSDC Releases Version 2 of Its CDF

NSSDC recently released version 2 of its Common Data Format software (CDF V2). CDF V2 provides many new and improved features over version 1 of the CDF software (CDF V1).

CDF V2 is written to maintain backward computability with CDF V1. Unlike CDF V1, CDF V2 is written in C and is portable to a number of operating systems. When creating a version 2 CDF, users now have the option of creating the CDF in native or a machine-independent format.

Therefore, both software and CDF files themselves are portable. This portability is achieved transparently through the XDR software, which is imbedded within CDF V2. The XDR software converts the data to and from its native format into the IEEE 754 format. The IEEE 754 format is machine-independent, thus allowing it to be passed from machine to machine without the user's having to be concerned with the specific conversion factors that may be required.

A few of the most obvious enhancements of CDF V2 over CDF V1 are the handling of attributes, hyperplane access, and a substantial increase in performance. Contrary to the way attributes were handled in CDF V1, CDF V2 provides the user with much more flexibility in defining global and variable attributes. Variables are no longer restricted by the initial declaration of attributes; each variable can now be independently represented by an attribute. For example, in CDF V1, if the attribute was defined with having the data type of "INT," then every variable represented by that attribute would have to be an integer or converted from its existing type (CHAR, REAL, DOUBLE, BYTE, etc.) to an integer. This conversion is no longer necessary in CDF V2. Each attribute representing a variable will now inherit the variable's type or can be given any type the user desires. Another noteworthy change is that attributes are no longer restricted to representing only one data element—CDF V2 has extended this capability to support arrays.

The performance improvements in CDF Version 2 come from the inherently greater efficiency of C versus FORTRAN, including restructuring of the software to take advantage of C functionality, optimization of the software, and new access methods.
In addition to the capability in version 1 to provide random access to all elements within a data set stored as a CDF, version 2 extends the bindings to provide hyperplane access. The hyperplane technique provides random, aggregate access to subdimensional blocks within a multidimensional variable. In other words, a vector, plane, parallelpiped, etc., out of an equal or higher-dimensional structure can be accessed through a single call. The subdimensional structure can span the full extent of the multidimensional block or be smaller in size.

The hyperplane technique provides random, aggregate access to subdimensional blocks within a multi-dimensional variable.

We are currently supporting three interfaces for CDF V2: a C interface for CDF V2, a FORTRAN interface for CDF V2, and a FORTRAN interface for CDF V1. The reason that the data center decided to support three interfaces was to facilitate the existing and future requirements of its users. Many of its users, both within and outside the NSSDC, have a substantial investment in CDFs generated via CDF V1. Therefore, the center is obligated to provide an interface and the capability to read version 1 CDFs through CDF V2 without the modification of existing applications. The FORTRAN and C interfaces for CDF V2 will consist of approximately 10 more interface routines than the CDF V1 FORTRAN interface. These routines will allow the user to take advantage of all the new capabilities provided by CDF V2.

In addition to the CDF software, the CDF documentation, CDF Toolkit, and CDF Utilities have been updated to work with the CDF V2. The CDF Toolkit and Utilities are available on both the VAX/VMS and SUN/.OS systems. The center has also established anonymous FTP nodes on NSSDCA and NCGL for disseminating the CDF and related software via the network.

Any additional information concerning CDF can be acquired through the CDF User Support Office at (301) 286-9506.

Gregory Goucher

SPACEWARN Now Accessible On Line

The World Data Center A for Rockets and Satellites (WDC-A-R&S) at the National Space Science Data Center now offers its bulletin, *SPACEWARN*, electronically for public access. The bulletins contain announcements on all spacecraft launches in the world during that month, along with their WDC-A-approved international IDs and condensed descriptions of orbital parameters and payload contents.

Also included are other items such as actual and predicted decays of spacecraft, rocket bodies, and other

see SPACEWARN, *p. 13*

An Employee Shares His Special View

On Friday, November 9, 1990, the National Federation of the Blind held a Job Opportunities for the Blind (JOB) seminar in conjunction with the twenty-fourth annual convention of the National Federation of the Blind of Maryland in Annapolis. This seminar was directed toward both blind applicants and prospective employers. Speakers talked about conducting job searches, working for a blind supervisor, reasonable accommodation, and the blind and technology.

Many blind people described their professions, which ranged from secretaries to engineers to molecular biologists. I talked about my role with the National Space Science Data Center and described its mission (to archive and disseminate publicly all data obtained from NASA space flights, as well as some other spacecraft, and to develop computer systems that facilitate this job).

At the data center, my two primary tasks consist of providing customer support for the International Ultraviolet Explorer (IUE) and developing and managing a data base for the Infrared Astronomical Satellite (IRAS). These jobs require expertise in four areas: computer science, astronomy, writing, and management.

To fulfill NSSDC's requirements, my work experience, a Master's degree in aerospace engineering, a Bachelor's degree in astronomy, and my Federation experience serve me well. My Federation work has taught me about leadership, organization, and financial management. My service as a programmer with the Navy enabled me to sharpen my skills in computer science to a razor's edge. While a graduate student at Cornell University, I enjoyed a wide variety of experiences and studied everything from physics to folklore. Upon examining my combined education, real-world experience, and service as a programmer with the Navy, it becomes apparent why NSSDC found me to be the right person for the job.

Employers, being part of the general public, must come to understand that blindness is simply a characteristic, a mere physical nuisance, and it limits us only to that extent—no more and no less. Once people understand this simple truth, blind people will have finally freed themselves from the bonds of discrimination and prejudice. The array of talented blind people speaking last fall on the seminar's panels clearly demonstrates the reality of this philosophy. The blind in America are changing what it means to be blind through a vehicle for collective action. For the past half century, that vehicle has been, and continues to be, the National Federation of the Blind.

Kenneth Silberman

SPACEWARN, *from p. 12*

About 800 copies are distributed around the world each month.

Since December, NSSDC personnel have been loading these bulletins into electronic files for anyone's access. The *SPACEWARN Bulletin* may be accessed by entering COPYNSSDC:: ANON_DIR:[ACTIVE.SPX]FILE.NAME.

The FILE.NAME for the January issue was SPX.447. Subsequent monthly issues will be denoted in ascending numerical order (February's was SPX.448; April's was SPX.450; etc.).

Those who are able to access the *SPACEWARN Bulletin* electronically are asked to inform the WDC-A-R&S so that their names can be deleted from the mailing list.

Sardi Parthasarathy

EOS Challenge, *from p. 9*

are chosen so that each class identified in the ground truth is equally represented. From the 262,144 pixels available, perhaps 100 from each class found in the region are randomly selected for training purposes.

Generally, this set is passed through the neural net about 10,000 times, meaning that in this case the internal parameters of the network are modified one million times per class. This type of program takes almost a day to run on a conventional workstation, such as a SUN computer. Since this is research, it is not uncommon to wait a day for the experiment to run only to look at the results and decide after a brief moment that some adjustment should be made to the network architecture and the whole process should be started over again.

A successfully trained neural network can be used to characterize images for which no ground truth is available. The IDM group is currently evaluating the accuracy of the performance of neural networks on this task. Data from Washington, D.C., the Black Hills, South Dakota, and Monterey, California, have been used. Preliminary results indicate that the networks perform just as well as existing statistical approaches, except the networks are much faster. Additional research is being undertaken to perform change detection and to measure the robustness of these networks when they are applied to other regions or when they are used on images taken in different seasons.

A variety of research reports on all phases of this work are available through Code 934 of the National Space Science Data Center.

Robert F. Cromp

NEWSBRIEFS NEWS-

Planning Continues for the Space Physics Data System

To continue planning the form and direction of the NASA Space Physics Data System (SPDS), the SPDS Steering Committee (SPDS/SC) held its third meeting on March 13-15, 1991, in Boulder, Colorado.

NSSDC reported on the status of its action items from the last SPDS/SC meeting (December 1990, Palo Alto, California). These items included a report on known NASA (mainly NSSDC) data holdings related to space physics grouped by instrument and subdiscipline, a test application of the committee's data evaluation criteria to some selected data sets, and the definition of requirements for a proposed Interim Space Physics Directory (ISPD) to be derived primarily from the existing Master Directory software system. Others presenting to the committee included representatives from the National Oceanographic and Atmospheric Administration (NOAA) Space Environment Laboratory (SEL), the National Geophysical Data Center (NGDC), the Planetary Data System (PDS), the Astrophysics Data System (ADS), and the NASA Science Internet (NSI) project. Subcommittee reports on Data Screening/Priority for Data Archive and Restoration, Elements of a SPDS, and Future Data Archiving were also made.

SPDS/SC planning continues. The committee strongly suggested that all of the resources for both system development and operation, for what is being termed a "massively distributed" system, be expended at sites within the scientific community. The committee stated that the focus of the SPDS should be productive science, with a critical issue within this community being the preservation of the existing expert infrastructure to support that science. Plans for the NSSDC to fulfill the role of the system's "central node" remains, and the continuation and more adequate funding of NSSDC's current primary NASA archival role was endorsed. The possibility of forming a small "project office" at NSSDC to coordinate and administer the upcoming effort was received favorably.

The SPDS/SC suggested that NASA Headquarters now proceed to form a data evaluation group to initially prioritize data for ingest into the SPDS, and to define a pilot SPDS program based on the general guidance above. NSSDC expects to assist Headquarters with these tasks. The SPDS/SC also requested that the NSSDC proceed with the ISPD effort if the required resources could be sufficiently reduced from the initial proposal. NSSDC will also proceed to further complete and validate the data census results as tabulated for the committee and will continue to support committee activities.

Robert McGuire, H. Kent Hills

NASA Science Internet User Working Group Meeting Highlights

The NASA Science Internet User Working Group (NSIUWG) held its annual meeting February 11-14, 1991, in San Mateo, California. The meeting included plenary sessions, exhibits of advanced networking applications, and subgroup meetings (mostly user-led) on NSI policy, networking, security, and user services and applications. One of the key reasons for organizing and convening the NSIUWG has been, and continues to be, to enable direct assessment and critique of NSI Project status and plans by the NSI user community through direct interaction between the NSI user community and NSI Project personnel. Contributing to that objective, the meeting attracted over 100 scientists and data systems personnel from NASA, other U.S. government agencies, universities, private research labs and industry, and France.

Members and/or contractors of GSFC's Advanced Data Flow Technology Office (ADFTO)/930.4 who are part of the NSI Project and participated in this meeting included Pat Gary/930.4, who presented "NSI User Services and Network Applications Development — An Overview" in the opening plenary and "The Internet Resources Guide and the Automatic Login Executor (ALEX)" in the User Services Subgroup meetings; Ron Tencati (ST Systems Corporation)/930.4, who presented "NSI Security Overview" in the opening plenary and chaired the Security Subgroup meeting; Lenore Jackson (ST Systems Corporation)/930.4 and Brian Lev (ST Systems Corporation)/930.4, who, respectively, presented "Overview of the NSI User Support Office" and "The NSINIC (NASA Science Internet Network Information Center) On-Line System" in the User Services Subgroup meetings; and Dave Stern (ST Systems Corporation)/930.4, who attended a special meeting of NSI Routing Center Managers/Site Liaisons and represented GSFC in the Networking Subgroup meetings.

While the NSI Project overall received both commendation as well as constructive criticisms of its status and plans, the ADFTO-presented material was very well received. In particular, the User Services Office for which the ADFTO is responsible was credited with having no evident shortcomings; and the NSINIC, which had its first public debut at the NSIUWG, was

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praised as a breakthrough in unified support for NSI's DECnet and TCP/IP-based computer networking community.

A complete copy of all of the meeting's presentations, as well as discussion summaries and findings from each of the subgroup meetings, will be compiled over the next few weeks by the ADFTO, printed as a NASA Conference Proceedings document, and distributed to all attendees and other interested individuals.

Patrick Gary

NSSDC Advises SOHO Science Working Group

NSSDC representatives Robert McGuire, Donald Sawyer, and David Batchelor met with Solar and Heliospheric Observatory (SOHO) scientists and support staff February 13–14, 1991, to discuss planned roles in the project's data capture, distribution, and archiving center to be located at Goddard Space Flight Center (GSFC). To be launched in 1995, SOHO is a joint NASA/European Space Agency (ESA) mission to investigate the solar corona, the expanding solar wind, and the interior of the Sun.

The use of format standards is an important issue in SOHO data management planning, not only within the SOHO science effort, but also to ensure compatibility with the larger International Solar-Terrestrial Program (ISTP) of which SOHO is a part and with other parts of the solar physics science community. Donald Sawyer and Robert McGuire presented and distributed an explanation of Standard Formatted Data Units (SFDUs), their use within the Global Science (GGS), also part of ISTP, and their possible application to SOHO data products.

The meeting also covered the progress on data base development to culminate in a transparent interface between SOHO investigators and the data distribution center. The contents of summary data sets to be generated routinely were considered. Suggestions for parameters and searchable fields in these data bases were offered by Robert McGuire and David Batchelor.

A few special notes concerning the newest and fastest GSFCMAIL/Internet/SPAN internetwork mail capabilities were also distributed by Robert McGuire for both the SOHO scientists and GGS/ISTP project information.

David Batchelor, Robert McGuire
Donald Sawyer

Heliospheric Trajectory Document Issued

NSSDC has issued a new document containing graphical and numeric information of the trajectories of the fleet of spacecraft now exploring the vast reaches of the heliosphere. Spacecraft included are Ulysses, Galileo, Pioneers 10 and 11, Voyagers 1 and 2, ICE, Suisei, Sakigake, Giotto, Pioneer Venus, and the geocentric IMP 8. Trajectory information is given through 1999.

This document, entitled *Trajectories of Inner and Outer Heliospheric Spacecraft*, by Sardi Parthasarathy and Joseph King, is available by request
from NSSDC's Coordinated Request and User Support Office (Telephone: [301] 286-6695).

National Science Foundation Contributes to MU-SPIN

Goddard representatives V. Thomas, N. Wakim, and P. Sakimoto met with National Science Foundation (NSF) personnel Bryant York (director, Special Programs), Daniel Vanbellegehem (associate program manager for NSFnet), and David Staudt (staff associate for NSFnet) to discuss the Minority University-Space Interdisciplinary Network (MU-SPIN). The meeting identified Historically Black Colleges and Universities (HBCUs) which already have, or are in the process of having NSF wide area network connectivity. It was determined that only about eight of 34 HBCUs/MUs may require installation of circuits, with an additional five being added in Phase II of MU-SPIN. NSF has indicated a mechanism for providing grant money to those schools that need such circuits.

The NSFnet representatives were very excited about MU-SPIN and especially liked the program's human resources development aspects. They also liked the idea of putting their infrastructure development money into a program like MU-SPIN because it will help ensure that HBCUs and MUs move up the scientific networking learning curve more quickly.

Meeting attendees also discussed possible ways of instructing HBCUs to use the network once they are connected. The following three ideas resulted: The MU-SPIN program plans to develop a user's guide brochure; MU-SPIN Users Working Group meetings will be held; and video lectures will be broadcast to the HBCUs to support user activity. NSF is currently funding workshops and other activities to achieve increased network usage, including an enhancement program for faculty, to

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held at Michigan State University this summer, for intensive networking study.

NSF agreed to participate in the upcoming MU-SPIN Users Working Group meeting in September. To continue their work with the MU-SPIN coordination team, they will visit GSFC at the end of February.

Valerie Thomas

NDADS Update

The NASA Data Archive and Distribution System (NDADS), currently under development in Building 28, is turning out to be quite a successful operational system. At this writing, it has been moved and is being reassembled in the new computer room located on the first floor in Building 28 alongside the NCF cluster and the Cray supercomputer.

NDADS consists primarily of three 6410 VAX computers, a VAX 8250, an Aptec high-speed IO processing device, and two (sometimes three) Cygnet jukeboxes with a current available capacity of over 500 gigabytes near-on-line optical storage per jukebox. The original function of NDADS is to act as a prototype for the Hubble ST-DADS. In pursuing that end, NDADS has become more than just a testbed and has been used for archiving ROSAT, HEASARC, and IUE data. IUE alone has successfully written over 80 gigabytes of data.

The SOAR software, which is being used to write the NDADS data, has just undergone its latest (and possibly last) release. SOAR was developed by STX/SAR staff at the NSSDC and has been recently modified to run in conjunction with the NDADS jukebox. SOAR is currently being used at over 40 different sites and the list of users is growing. The software is used to make write-once optical disks look and act exactly like magnetic disks, as far as VMS is concerned.

Chuck Davis

CALENDAR

June 1-3, 1991
CDAW Conference at NSSDC
Goddard Space Flight Center
Greenbelt, MD

July 23-25, 1991
Conference on Mass Storage System and Technologies for Space and Earth Science Applications
National Space Science Data Center
Building 3 Auditorium
Goddard Space Flight Center
Greenbelt, MD

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NEWS

NSSDC Services

Researchers can obtain information about NSSDC's data archive– how to contribute to it or how to request data from it (including cost and availability concerns)– by addressing their questions as follows:

INSIDE UNITED STATES

Data Submissions

Dr. H. K. Hills
NSSDC/Code 933.8
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Greenbelt, MD 20771
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Telex: 248496 or 197640
TWX: 7108289716
NSI-DECnet: NCF::GREEN

Data Requests

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TWX: 7108289716
NSI-DECnet: NCF::REQUEST