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Recommendations Resulting From the SPDS Community-wide Workshop

June 1-3, 1993, Houston, Texas

SwRI Project 15-5659
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Recommendations of Policy Panel

Should there be an SPDS?

Making space physics data broadly and readily accessible for scientific inquiry is an activity in which the space physics community is currently engaged and which is a necessary component of a viable, modern research activity. Recognizing these activities collectively as the "Space Physics Data System" (SPDS) is most appropriate.

What should the Philosophy of the SPDS be?

The SPDS should be a distributed data system designed, developed and operated by scientific users of space physics data. SPDS should make maximum use of existing facilities including data centers, project data management units, and principal investigators. SPDS should be implemented through existing computer networks using appropriate standards and software.

What is the appropriate funding level and how should SPDS funding be related to funding levels of other SPD activities?

The workshop feels strongly that the entire data analysis effort within the Space Physics Division (SPD) is seriously underfunded, and total resources within this area should be significantly increased. We believe that the SPDS should serve to enhance the data analysis environment for researchers in the field, and that therefore, significant future funding for SPDS should represent new resources, made available to the Division to support the Division Data System in a move toward achieving parity with other Divisions, which already have been given large Data System resources. The need for an SPDS is real and urgent. Therefore, we urge the Division to initiate the SPDS now, with existing (albeit limited) funding. As the utility of the SPDS grows and is recognized, funding should grow appropriately. The ultimate funding level should be determined by the value of the user-evolved SPDS to the community, and may well turn out to be of the same level as now exists in the Solar System Exploration and Astrophysics Divisions.

If there is funding, how should it be distributed to the community?

Funding should be awarded competitively through peer review. In the initial stage, this could be through an augmentation or supplement to scientific investigations selected under existing peer review programs. In anticipation of future increases in funding, support could then be distributed through a separate Announcement of Opportunity.

In the current austere funding environment, what should the SPDS look like?

The paucity of funds make it impossible to incorporate the diverse data sets into a comprehensive system. The current paradigm must therefore be reliant on the Master Directory to indicate what data are available and where they are located, the use of existing software and human systems to retrieve data, and the use of data format translators to import data into an investigator's own analysis system.

What are the important objectives of an SPDS, and in what priority?

Access to quality data is the most important objective, with curation and information about the data being integral parts of any accessible data set. As pointed out in the Concept Document on NASA's SPDS, support for dissemination of data analysis tools is important but of secondary priority to the above three objectives. Awareness of recent developments in data management technologies is important but of lowest priority of the five objectives.

What next? How should an embryonic SPDS be structured to continue the activity, in the current climate?

We expect the management structure to evolve as the SPDS becomes better defined. Initially there should be a volunteer Discipline Coordinator from the user community for each of the four SPD branches and a Project Coordinator. The coordinators will survey and inform their communities and begin SPDS activities. A follow-on users community workshop should be planned for about one year from now.

What should be the relationship between SPDS and Network services?

The success of SPDS depends upon the existence of a reliable, highspeed, worldwide, multi-protocol communications network.

What should be the relationship of SPDS to new projects and proprietary data?

Participation in SPDS by all current and future division-related investigations, and their Principal Investigators during the active phase of missions should be facilitated. This requires recognition of and adequate safeguards for the protection of data as long as they remain proprietary. The SPDS should be structured so as to permit the dissemination of proprietary data to team members and guest investigators, and to allow for easy migration of data into the public domain.

Should SPDS support the software library?

A software library catalog that indexes into software distributed across the network should be an integral part of SPDS. Software should include data processing, translation, analysis, and visualization routines, and could include ancillary software such as models, simulation results, etc.

What should be the relationship between the SPDS and existing information services activities (e.g. NSSDC & SPDF) within Space Physics?

Existing NASA data services provide for deep archiving (a permanent repository), access for international collaborators, broad cataloging and directory services, and Division-wide coordination (e.g. Satellite Situation Center) through the NSSDC. We see these activities as an important part of SPDS and recommend the continuation of these activities by inclusion of NSSDC as one of the SPDS nodes.

Recommendations of Data Issues Panel

The Data Issues Panel started with a set of assumptions that were generally held by the members but not specifically debated. These general assumptions formed a framework upon which the discussions of specific issues were based.

1. SPDS is a good idea and should exist.

2. It should not be ambitious but rather should start by formalizing the informal system that already exists.

3. The first goal of SPDS should be to facilitate the exchange of useful data between scientists with greater ease.

    (a) This will maximize scientific output

    (b) The effort would be voluntary

4. The SPDS should be accessible and usable by as many people as possible.

    (a) SPDS should include non-NASA data sets such as those funded by NSF, DoE, other federal institutions, and universities. Both US and non-US data suppliers and users should be included. The needs of developing nations should be considered.

    (b) To include a maximum number of participants, the use of the SPDS should require only widely available technology and hardware and should need minimal technical knowledge of computer systems.

    (c) To encourage wide participation, there should be no undue burdens on data suppliers or system users. There should be few "requirements" to which data suppliers or users would need to conform. However, there should be many "suggestions" which can be used to guide those who wish to participate.

5. There should be "rules of the road" that allow PI's or curators to both control and facilitate access to and use of the data. These rules may vary for different data sets.

6. Documentation should be available for all data and should be as thorough as possible. The level and completeness of documentation will also vary among data sets.

The Panel considered the first steps toward a Space Physics Data System. The Panel envision that an early incarnation could begin to develop even in the absence of any funds through voluntary effort. Thus, one guiding principle for including data sets was that beggars can be choosers.

Minimum Requirements for a Space Physics Data System (SPDS)

1. There must be a centralized listing of all data sets that are a part of the SPDS. This listing should include data sets that exist at host

institutions but are off-line. The listing should be kept current. It should include the following items, at a minimum:

> (a) Source of data (e.g. S/C, ground station, etc.)
>
> (b) Type(s) of measurement (e.g. magnetometer, particle telescope, etc.) and parameters available (e.g. flux, moments, etc.) and their units.
>
> (c) Time span of data, plus information on nature of data coverage (e.g. complete polar passes only, etc.)
>
> (d) Volume of data set
>
> (e) Ephemeris data location (if not contained in data set)
>
> (f) Cognizant Personnel (PI., curator)
>
> (g) Means of access/delivery (e.g. on-line, CD-ROM near-line, magnetic tape, [punched cards?], etc.)
>
> (h) Restrictions
>
> (i) Format
>
> - Abstract of data description
>
> - Available software to read and/or display data set
>
> - Software to translate the data set into a "standard" format, if necessary
>
> - Detailed format description.

2. It will be the curator's responsibility to maintain and extend the data set, notifying the SPDS Project Coordinator of any and all changes to the data set, including new data, re-calibrated data, etc. These changes will be passed on to the user community.

3. In the event that a data set is "endangered", either through loss of funding, lack of cognizant personnel, deterioration of media, etc., the SPDS Project Coordinator shall communicate this to the entire

SPDS community, and identify means of "saving" it, if possible and determining whether the data set is considered "important."

4. A means of controlled access must be established so that a PI's proprietary rights to a data set are respected.

The Structure and Layers of SPDS

The SPDS is a grass-roots effort defined by the following structure. Each layer of the SPDS is described by that element's functions, responsibilities, and requirements:

Figure TBD

1. Project Coordinator(s) (PCs) and staff:

   - The Project Coordinators charges are:

     - To advertise to the appropriate community the existence, mission, and operation of the SPDS

     - To compile information provided by SPDS data nodes regarding data and generic software, availability, points of contact, access, etc., at their institutions, and to disseminate these inventories to the community

     - To establish rules of the road for data exchange and SPDS participation

   - Ideally, Project Coordinators are scientists within the community who are presently engaged in proto-SPDS activities.

   - A possible structure would be one overall Project Coordinator, assisted by four "Branch" Coordinators. Initially, these might be voluntary, rotating positions.

   - Project Coordinators should encourage similar SPDS-like activities within non-NASA agencies and the international community.

   - Coordinators should be the sounding board of the community and should play an active advisory role in data systems requirements for future missions.

   - Coordinator should monitor system use and track data distribution (retain log of "users" as well as nodes)

   - Coordinators should identify possible duplication of effort (provide information on the "official" approved repository in the event of discrepancy)

- Coordinators should notify users about data set additions (subtractions), system changes, etc. as needed

- Coordinators should encourage, but not require, community involvement toward developing "standards" and community-shared efforts

- Coordinators should identify and support "endangered" data sets

- Coordinators should promote communication with other non-traditional agents for data archival/curation (e.g., university libraries).

2. SPDS Data Suppliers (Nodes):

- Nodes shall:

  - Provide to the PC's a list of data sets available at the Nodes institution

  - Provide description of how to access available data

  - Provide data descriptions Provide PI/curator supervision and assistance to users if possible, and if desired

  - Provide translation code to access data A Node must be connected to Internet.

3. SPDS Data Users:

  (a) Should have an Internet connection Must abide by the "rules of the road" Must notify the PI/curator about intentions for data and provide preprints of publications.

  (b) The curatorial role of the original institution where the PI is (was) affiliated should be recognized and developed. Since one of the obligations of an archiving system must be to make data available to future generations of researchers, the SPDS should investigate the use of universities and institutions which have mechanisms that are designed to provide long-term curation of scholarly data bases and raw research materials in other disciplines: to wit, libraries, and museums. A low-cost program that the SPDS office might undertake would entail:

    1) Selling the concept of scientific data curation responsibility to the libraries and museums at institutions.

    2) Provide guidelines, documents, software, and other tools to assist libraries, etc. in fulfilling this responsibility.

The Panel discussed the 10 questions listed in the Data Issues Panel Charge and arrived at the following responses:

1. The SPDS can supply encouragement, guidelines, and ultimately provide a mechanism for financial support for data archiving, restoration, and curation. NSSDC is a recognized repository for data archiving. However, where applicable, the PI for the mission, and his current institution should retain his or her data and be responsible for its restoration and curation. Ideally, all data should be archived.

However, the restoration and curation of archived data sets will be undertaken by those who have an interest, and the finances, to do so.

Orphaned data sets, i.e. data which are no longer supportable by either the PI or his/her institution and are not wanted by any other organization, should be repossessed by the NSSDC which would act as a library for old data sets. Prudence strongly suggests that longterm archiving should include duplicated archives at widely separated sites.

2. The SPDS should be sufficiently attractive to induce PI's of new missions to join and obtain correlative data sets. PI's may hold proprietary rights over their data sets for periods defined by NASA.

3. Some criteria for determining which data sets should be restored include: uniqueness, the difficulty with which they were obtained, and their potential for being lost. However, the primary criterion must be heavy use, or the possibility of heavy use.

4. Files should be self-documenting with enough information to enable scientific use.

5. There should be an option for users to add comments upon problems they have encountered.

6. An expert infrastructure is very helpful in interpreting data sets.

However, we must recognize that the PI and Co-I's won't always be available. The SPDS nodes should therefore maintain records of related papers and recent data requests to assist future researchers.

7. Archiving and documenting data sets must generally assume priority over improving formats or placing data sets on-line. The Panel recognized that formats change and the technological advances will make it possible to place large amounts of data on-line in the near future.

8. Archiving Level 0 data is highly desirable and should be recommended in order to economically allow for changes in processing routines. It is recognized that such data will be accessed in conjunction with a set of processing routines which both culturize the data and put it in suitable units with the minimum loss of time resolution. Lower resolution data along with derived data products may be appropriate in many instances. These will require no additional connections and generally can be used as is.

9. We cannot afford to place all data (particularly older data sets) in a standard format. We expect a gradual evolution to a preferred one or two formats. For the foreseeable future, we will need format translators.

10. Catalogues should contain information concerning the instrument, satellite, format of the data, a timeline of the instrument/satellite events, and the location of the ephemeris.

11. We had two additional points:

    • If SPDS proves cost-effective, it will be in a position to suggest guidelines to NASA for requirements it might impose upon future missions and data sets.

    • We reiterated our interest in including non-NASA data sets in the SPDS system, i.e. NOAA, ESA, ground-based, and DoD data sets.

Recommendations of Data Systems Panel

Given the lack of prospects for any near-term funding sufficient to allow significant enhancements in SPDS capabilities beyond those currently in place, the Data Systems Panel concentrated on maximizing the scientific usefulness of a lean data system.

Critical Functionalities

The Panel identified three critical functionalities of a Space Physics Data System: the delivery of self-documenting data, the existence of a matrix of translators between various standard formats (IDFS, CDF, netCDF, HDF, TENNIS, UCLA flat file, and FITS), and a network-based capability for browsing and examining inventory records for the system's data holdings. The translators, as well as useful data reduction and analysis tools, should be made available via anonymous File Transfer Protocol (FTP) from central sites. The inventory system would have both central and distributed entry points (with the central node pointing to the latter), with the inventory records at each node or subnode transmitted in a standard format. (This could be a simple ASCII flat file with certain required and optional fields describing the data holdings, data access methods, and points of contact for expert advice on analysis of the data.)

Desiderata

The Panel also enumerated additional, desirable capabilities of an SPDS that might be dependent on additional resources: a centralized bulletin board service and/or mailing list server for distribution of software update and data holding news, and data browse/display tools. A Usenet news group could be an effective method of keeping the community up to date with new data sets, software, and hardware available at the various nodes and end-user sites, and would not require moderation. A central FTP service could aid in the distribution of analysis and visualization software obvious desiderata in themselves as well as a source for other software and data (e.g., models, educational software, cross-sections, etc.). Whenever possible, such information should be shared with the Planetary Data System (PDS) and the Astrophysics Data System (ADS) communities.

The SPDS nodes should log the usage of various data holdings, and users of those data holdings should be informed of the appropriate wording for acknowledging the support of the node/P.I. providing the service.

System Level Standards

Once again considering the austere funding environment, as well as the diversity of systems in place at the nodes listed in the concept document and potential subnodes, the panel specified only TCP/IP network interfaces (Telenet, FTP, SMTP, and perhaps WAIS, gopher, and similar distributed data access facilities) and the seven file formats listed above as system-wide standards. There would be no impetus (from the SPDS alone) to reformat existing data sets if the matrix of translators existed.

Role of NSSDC

In addition to continuing its traditional roles as the Master Directory server, central data copying facility, and final, deep archive, the NSSDC can also serve the SPDS user community by providing a bulletin board and/or mailing list for announcements of general interest, and anonymous FTP service for data format translators, models, and other software tools of general interest. The NSSDC could also be used to help establish an e-mailing list (such as the Solarmail facility in use by solar physicists) for the space physics community. As an SPDS node, the NSSDC should provide access to orphaned data sets.

Functionality of Directories, Catalogs, and Inventories

As indicated in the critical functionalities section, the role of directories and inventories is to facilitate access to data holdings.

Directories should therefore serve as pointers to distributed inventories, in a standard format, that contain sufficient information to characterize the data holding sufficiently to allow the average researcher to decide whether the data are appropriate to the investigation under consideration, and if so, to identify the parts of the data holding that meet his/her particular requirements.

Distribution and Centralization

The Panel feels that a central facility could not only continue to provide the traditional services of Master Directory maintenance and facilities for copying large quantities of data, but could also provide a

bulletin board service, gopher, or mail exploder and anonymous FTP server for software and notices of community interest. All other roles should continue to be performed at the nodes or subnodes, including software development, updates of data inventories, translators for new formats or between platform-specific internal data representations, and so on. The Panel endorses the concept document's emphasis on a distributed system, based on the expertise of the PI group or node-resident, data center scientific staff. Systems

capable of accessing data at two or more nodes, and software distributions portable to a variety of end-user platforms, are particularly to be encouraged.

Commonality of Interfaces

The overriding consideration for any SPDS interface should be ease of use by a technically competent investigator. The only critical

interoperability requirement is network access, or if necessary, dial-in access to a central facility connected to the Internet.

SPDS as a Technology Clearing House

The SPDS should provide bulletin boards and/or news group(s) for exchanging information on new technology implemented by the node and user community. Such information should be given the widest possible distribution in the community, and communication should be established with communities with similar data technology interests, such as the Planetary and Astrophysics communities.

Support Priorities

The Panel feels the Space Physics Division should express its support for NASA's efforts to lead in the implementation technologies, such as ATM, that would significantly increase the bandwidth of data communications with currently bandwidth-limited sites. Any effort at accelerating NASA's transfer of this technology to the university community should likewise be supported.

Evaluation of Demo Systems

Comments on SwRI system: excellent data display and visualization facilities, but project-spacecraft-instrument-virtual instrument hierarchy can be misleading to inexperienced investigators looking for physical parameters. The multiplicity of IDFS file types necessary for a complete specification of a single data unit was also seen as a drawback for data ported to end-user systems. The IDFS file system is nonetheless a good example of forcing the data provider to make the data self-documenting.

Panel members were impressed as well with both the DITDOS systems capabilities for inventorying and browsing data, and the user interfaces developed at the SDAC.

A Suggestion for a Community Survey

As an aid to SPDS nodes developing appropriate software interfaces, the space physics community should be polled, preferably by e-mail, on such subjects as preferred interface (X windows, Microsoft Windows, VT terminal emulation, etc.), monitor display capabilities (bit depth, number of pixels, color capability), data analysis software of choice (IDL, other analysis packages), and available data communications (TCP/IP, DECnet, neither).

Recommendations of Software Panel

Overview

The Software Panel of the SPDS was convened to discuss and make recommendations on the software-related aspects of a future SPDS. The main focus of the Software Panel was to define the requirements and priorities for SPDS to support common data analysis and data visualization tools and packages.

It is hoped that through a combination of data and software collection of compatible systems will emerge which can exchange data and metadata with minimum overhead. There are many existing applications, both commercial and public domain, which can be enhanced or extended so that they are compatible. The development of data format translators appears to be the key in creating a confederation of compatible applications and data systems.

Recommendations

The Software Panel makes the following recommendations:

1. That SPDS through NASA funding begin an initiative to develop data format translators which will convert between specific data formats. The specific data formats are to be defined by the Data Systems Panel. It is believed that no one format can solve all data analysis and visualization requirements.

2. That SPDS develop a catalog to provide information to the community about the availability of all useful software that has been developed under NASA funding (hence in the public domain). This catalog should contain information about the programming language, available documentation, relative quality of the code, available support, and on the location of and contact point for the software.

3. That SPDS should not undertake a new development effort. Rather, NASA should provide funding to extend and enhance existing systems to meet the requirements and needs of an SPDS.

4. That SPDS encourage and NASA fund the porting of meritorious applications to platforms other than that on which the application was originally developed. The selection of which applications to port should be done using a peer review process.

5. That SPDS state as a policy that new application development should meet some minimum standards and that adherence to this policy become a contractual obligation. It is believed that NASA's current software development policy imposes too much overhead on software projects. The application development standard should include, but not be limited to, providing a Users Guide, providing an Installation Guide, coding in a standard language which is supported on multiple platforms, writing portable code (can run on multiple platforms), and internally documenting code with comments preceding each callable component (function, subroutine, et al.) of an application. These comments

should include a description of what the components do and the algorithm used. In addition, arguments, external variables, and any parameters which influence the operation of the component must be identified and described.

6. That SPDS encourage projects and groups that adopt Commercial off-the-Shelf (COTS) systems to be sensitive to data portability issues so that data can be used in other systems. Pathways to COTS which are widely used should be provided by NASA, users of the COTS, or suppliers of COTS.

7. That NASA should assume a capital equipment responsibility and provide funds to insure that the research community have a computing environment which does not act as a limiting factor in general distribution and use, as well as development, of software systems.

8. That SPDS identify as part of a Software Development Policy the platforms and environments on which software should run. The Software Panel recommends that the following hardware architectures be supported: SPARC, VAX, Alpha, Intel x86, Silicon Graphics (SGI), Hewlett-Packard (HP), and Mac. That the following operating systems be supported: DOS, SunOS, Solaris, VMS, MacOS, Utlrix, and AIX. That the following window systems be supported: X-windows (X11R5) with Motif and Open Look, MS-Windows, and Mac. It is acknowledged that this list is valid only at the time of this report and will undoubtedly change with time. NASA's policy should reflect this inevitability.

9. That SPDS select systems which have low maintenance overhead. For example, mail list servers, bulletin board services, Usenet news groups and data systems which are configurable and which determine data holdings each time they are run.

Discussion Summary

These recommendations were derived from discussions of a series of questions posed by the SPDS Steering Committee. In some cases the posed question required some interpretation in order to focus the discussion on software issues. The following are the questions and a summary of the discussions:

1. On-Line Library

   (a) Should SPDS provide an on-line library of existing software? A catalog of existing software should be implemented. Providing direct access to a central repository (library) of software is as not important as a catalog since the burden of maintaining current versions may not be cost effective. In addition the expertise on a specific piece of software typically resides with the provider, so software should be obtained from the original author. Furthermore, applications should be accompanied by test or example data sets so that the user can verify an installation and explore an applications capabilities.

   (b) How should this software be cataloged? By placing in a queriable system information about the programming language, available documentation, relative quality of the code, available support, and where to obtain the software.

(c) What software documentation standards should apply? For applications, a minimal requirement would be providing a Users Guide and an Installation guide, coding in a standard language which is supported on multiple platforms, writing portable code (can run on multiple platforms), internally documenting code with comments preceding each callable component (function, subroutine, et al) of an application. These comments should include a description of the functions of the components and the algorithm used. In addition, arguments, external variables, and any parameters which influence the operation of the component must be identified and described.

2. New Software

   (a) Should SPDS develop new software to support data analysis and/or data visualization? No. Existing software should be enhanced or extended to meet SPDS needs. Enhancement should including porting of code which may exist on one platform to the platform where the need exits. If no software currently exists that can meet specific SPDS needs, then development of new software should funded.

   (b) What software documentation should apply? See 1c.

   (c) How should this software be distributed? See 1a.

   (d) What kinds of new software should be developed? Data format translators to provide bridges between existing data systems and applications including both public domain and major commercial software packages (i.e., IDL and AVS).

3. Software Toolbox

   (a) What should the software toolbox contain to support data providers? Data format translators and the software catalog.

   (b) What should the software toolbox contain to support data users? Data format translators and the software catalog.

4. Desirable Aspects

   (a) What are the desirable aspects of the surveyed data systems for SPDS to consider? It was decided that the Panel would not provide an itemized list. All of the systems demonstrated met at least one of the recommendations of the panel. In addition, this question seemed more appropriate for the Data System Panel to address.

   (b) What are the undesirable aspects of the surveyed data systems for SPDS to consider? It was decided that the panel would not provide an itemized list.

5. Development of Tools

   (a) Should SPDS sponsor development of tools that could be freely distributed? SPDS should encourage the sharing of existing software and actively work to make it easier to obtain existing software. No new development initiatives should be undertaken unless there are no

existing tools to address the problem. Freely distributed software was considered a high priority activity.

(b) Should SPDS define a framework that emphasizes increasing reliance on Commercial off-the-shelf (COTS) software? No, the choice of COTS software should be left up to the individual. However, SPDS should support activities that will provide data format translators that will permit data to be used by COTS. Hopefully, the supplier of the COTS could be encouraged to support data formats identified by SPDS and standard formats. It was also noted that no COTS technology assessment group should be a part of the SPDS.

(c) Is there a need for SPDS to act as a software clearing house? A software information clearing house (for COTS and public domain software) that utilizes community input should be pursued. Actual implementation could be a mail list server, or a moderated or unmoderated bulletin board service. Acting as a software repository is not considered as high a priority as dissemination of information, comments, and experiences.

6. Define Standard Platform(s)

(a) Is there a need to define a standard platform or platforms that will be the focus for any SPDS software support? If so, what should they be? In order to define a standard platform, a stable hardware and operating system market must exist. Since this is market influenced by communities outside of SPDS, choosing a standard platform does not appear to be viable. However, it is recognized that the current trend is towards UNIX systems that run X-windows on a variety of architectures and Windows-NT running on Intel architectures. The emphasis should be on developing portable code so that it may easily be migrated as new technologies are introduced. A survey of some of the attendees of the workshop indicated that the platforms used by the community are diverse, and changing to a standard platform is not feasible. The major platforms and environments in use today are:

Table TBD

(b) How important as a funding priority should it be to bring access to a standard platform to all active members of the space physics community? NASA should assume a capital equipment responsibility and provide funds to ensure that the research community have a computing environment that does not act as a limiting factor in the general distribution and use, as well as development of, software systems. The focus of such funding should be to insure that scientific research is accomplished without incurring additional costs due to redundant software development.

7. Common Formats

    (a) What should SPDS policy with respect to common formats be? Specific formats were left to the Data Panel to define, but the number of formats should be as low as possible.

    (b) What are the technical issues? There are no technical limitations to providing support for multiple standardized formats. The only limitations are resources. The fewer the formats the fewer resources must be brought to bear on providing support for the formats.

Some Efforts Resulting from the Workshop

Some participants at the workshop agreed to explore some of the recommendations of the Software Panel on a volunteer basis. The efforts to be undertaken are:

- Building a DITDOS server to work off the CEDAR inventory and provide a off-line data ordering service.

- Establishing an information server that will contain documentation on data formats which can be publicly accessed.

It should be stressed that all the recommendations of the Software Panel cannot be achieved on a volunteer basis. If NASA pursues an SPDS, it should provide sufficient funds to accomplish a fully functional and properly supported SPDS.