Overview of the Planetary Data System

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ABSTRACT

The NASA Planetary Data System is an active archive that provides high quality, usable planetary science data products to the science community. This system evolved in response to scientists' requests for improved availability of planetary data from NASA missions, with increased scientific involvement and oversight. It is sponsored by the NASA Solar System Exploration Division, and includes seven university/research center science teams, called discipline nodes, as well as a central node at the Jet Propulsion Laboratory, PDS today is a leader in archive technology, providing a basic resource for scientists and educators. Operational since **1989,** PDS distributes more than 11,000 orders annually. Current master holdings include 283 unique CD-ROM titles, 695 CD-Write Once titles, and 54,000 tapes.

Major data additions to the PDS archives are now in process, including more than 350 new CD-ROM titles over the next two years. Deliveries are expected from the Clementine, Shoemaker-Levy 9, Galileo, Ulysses, and Giotto Extended projects. Additional archive products are planned in future years from Galileo, Mars Surveyor, Discovery, Cassini, Near Earth Asteroid Rendezvous, and the Mars Pathfinder projects. PDS is also restoring data from the following previous missions to improve data descriptions, formats, and quality of the data so that scientists have better access: Voyager, Viking, Pioneer, Pioneer Venus Orbiter, Magellan, and Mariner 9 and 10. Many restorations still remain. PDS produces several hundred copies per title in initial distributions, with additional distributions to users via the National Space Science Data Center, and soon online orders will be available via the World Wide Web.

This article describes why there is a PDS, what PDS has accomplished, how it is organized, what innovations it has added, and what it plans for the future. Terms are defined which are used in this article and in the related articles. In addition, the functions of the Central Node at JPL are described. The functions and holdings at the Discipline Nodes are described in separate articles within this journal.

INTRODUCTION: WHY IS THERE A PDS?

In 1982, the National Academy of Sciences chartered the Committee on Data Management and Computation (CODMAC), which identified serious problems in the way data was managed by NASA. Historically, much planetary data was not delivered to any archive facility. Frequently, data that was stored was difficult to locate or use because the documentation was inadequate for scientists outside the original investigation teams. In addition, in the years since early planetary missions, their tapes containing data were becoming physically unreadable.

CODMAC I [Bernstein, 1982] offered these principles to result in more scientific return from the data: 1) scientific involvement; 2) scientific oversight; 3) data availability including usable formats, ancillary data, timely distribution, validated data, and proposer documentation; 4) proper facilities; 5) structured, transportable, adequately documented software; 6) data storage in permanent and retrievable form; and 7) adequate data system funding.

CODMAC II [Arvidson, 1986] and the Planetary Data Workshop [Keiffer, 1984] provided further science rationale for a PDS.

Under CODMAC 111 [RUSSELL, 1988], the committee reviewed the NASA progress in addressing the issues previously defined. Its report included these recommendations: implement the principles of CODMAC I; write explicit data management plans for all missions; provide sufficient resources for data archiving; enforce proper archiving requirements on projects and principle investigators; build a secure archive; manage scientific data management units by discipline, with NSSDC as the deep archive; establish catalogs and directories; assess storage media and develop guidelines for their use; establish data advisory committees on data retention and preservation; promote and support use of data archives.

In response to the CODMAC request, the NASA Solar System Exploration Division established the Planetary Data System as an active archive. PDS became operational in 1989, It currently satisfies all the CODMAC recommendations for those tasks within its responsibility. Data management plans are the responsibility of each flight project, although PDS provides help in the definition of archive products. Enforcement of proper archiving requirements on projects and investigators rests with the NASA sponsoring organization. Funding remains a challenge.

All major Congressional concerns on planetary data archiving expressed in a Government Accounting Office audit [GAO, March 1990 and GAO, November 1990] have been resolved with the emergence of a strong PDS. Continuing GAO audits of NASA archiving reinforce the need for high quality data archive systems [GAO, April 1991 and Draft GAO Report, September 1993].

PDS SUCCESS

PDS Goal and Functions

The goal of PDS is to enable science by providing high quality, usable planetary data products to the science community. Our shorthand motto is, "provide the BEST planetary data to 'the MOST users FOREVER." We are committed to providing quality products, not just warehousing items, and we distribute them to a wide audience while ensuring that the media and the system itself are long-lived, operating beyond the existence of any one planetary project.

PDS meets the NASA requirement to archive in a cost effective approach. Within PDS, there are four major tasks. The first task is to "publish" quality, well-engineered data sets. While the media of the published data varies, all PDS-produced products have been peer reviewed by a group of scientists to ensure that the data and the related descriptions are appropriate and usable. PDS provides easy access to these data products by a system of online catalogs sorted by planetary disciplines.

The next task is to leverage with flight projects for PDS-compatible data sets. While PDS does not itself fund the production of archive data from active missions, we work closely with projects to help them design their data products. The great advantages of having projects deliver well-documented products are that the investigator expertise is available and those data can be then be used immediately by the general science community, If projects do not provide usable archive products, then PDS must try to re-publish them once data have been validated, documentation gathered, and remaining expertise found. Frequently these "restorations" require years, due to limited funds. In some high risk cases, the data may actually be lost due to loss of expertise or the media.

The third PDS task is to maintain the archive data standards to ensure future usability. Over the years of PDS experience, a set of standards have been evolved for describing and storing data so that future scientists unfamiliar with the original experiment can analyze the data using a variety of computer platforms with no additional support beyond the product. These standards [PDS Standards Reference, 1992 and Cribbs, et al, 1992] address structure of the data, description contents, media design, and a standard set of terms. The PDS challenge is to make the standards affordable to implement while preserving all information that future generations might require,

The final PDS task is to provide expert scientific help to the user community. PDS is an active archive, rather than a storehouse, which is staffed by engineers and scientists familiar with the data. While most of the archive products may be accessed or ordered automatically by users, PDS provides teams of scientists to work with users to select and understand data. Special processing can be done to generate user-specific products. In addition, these same scientists form a network into the science community to hear requests and advice for PDS.

Science Accomplishments

PDS has directly participated in science accomplishments, with these highlights:

SHOEMAKER-LEVY 9: Observational programs for Shoemaker-Levy 9 impacts into Jupiter were modified in real time on the basis of coordinated communications supported by PDS. PDS enabled a sociological change for scientists with rapid exchange of data. Support was organized early and users informed before the event, providing lessons for handling future NASA encounters.

GASPRA: Scientists at Cornell University have relied on PDS SPICE products to help analyze Gaspra light curves in modeling the size, shape, rotation, rate, and albedo of this asteroid.

JUPITER: New thinking on structure and dynamics of Jupiter's Great Red Spot resulted from correlative data analysis provided at the PDS Outer Planet Atmospheres Workshop.

SATURN: Through analysis of PDS-archived Voyager images, a new Saturnian moon, Pan, was discovered. If data had not been archived, the moon might not have been discovered, as the data was "buried. " A great deal of searching and analysis of the images were required to locate and verify the moon's existence.

MOON AND ASTEROIDS: PDS provides direct support to the new NASA Lunar and Asteroid Data Analysis Program by funding data publication and distribution costs according to the LADAP schedule. Also PDS developed software to provide access to data products and provided the full image processing/cartographic system for Clementine data that will be distributed to LADAP principle investigators.

Current Holdings and Distribution

PDS currently provides major data collections of data from Voyager, Viking Orbiter, Magellan, Galileo, Geological Remote Sensing Field Experiment, Pioneer Venus Orbiter, and International Halley Watch [Figure 1]. The archived 212 data sets reflect 283 unique CD-ROM titles, over 54,000 data tapes, and 695 CD-Write Once volumes. Copies of all PDS products are also put into the deep archive for long term storage at the Goddard Space Flight Center's National Space Science Data Center (NSSDC). Details of current holdings available from each discipline node are in the associated articles.

Through August 1994, PDS had distributed 29,000 orders, totaling more than 71,410,019 MB of data (see Figure 2). Users may order data by contacting any PDS node, using the seven online catalogs, or World Wide Web homepages. Ordered data may be provided on CD-ROM, CD-Write Once, tape, or online, depending on the user request and the type of data. Also, users may access PDS data products and catalogs via the NSSDC online Master Directory.

New Data Products

PDS will soon be receiving new deliveries to its archive from Clementine, Shoemaker-Levy 9, Galileo, Ulysses, and Giotto Extended Missions. In parallel, we are now coordinating with these missions for PDS-compatible future deliveries: Mars Pathfinder, Mars Surveyor, Near Earth Asteroid Rendezvous, Discovery, Cassini, Mars 96, and Pluto Fast Flyby.

PDS-published restorations are underway for Magellan, Pioneer, and Mariner 9 and 10. These products complement the multi-year effort to produce three series of data products for Voyager, Viking, and Pioneer Venus Orbiter, respectively.

PDS ORGANIZATION

Node and Task Structure

The Planetary Data System is a distributed system sponsored by the NASA Solar System Exploration Division and composed of eight teams, called nodes, The node structure, defined ten years ago, is organized primarily by subdiscipline within planetary science to focus expertise with archive data. Three nodes provide support or special capabilities to the science nodes. Many teams are consortiums of multiple universities. Specific node leads and members are determined through a NASA Research Announcement done every five years. The second NRA proposal selection will be completed in January 1995. Figure 3 identifies the current node and subnode affiliations. The science nodes include Atmospheres, Geosciences, Planetary Plasma Interactions, Rings, and Small Bodies Nodes. They each have an advisory group of discipline scientists to provide guidance and priorities for PDS. The support nodes are the Imaging Node, with expertise in sophisticated image processing, the JPL Navigation Ancillary Information (NAIF) Node, for calibration and ephemeris information, and the Central Node, leading the project, at the Jet Propulsion Laboratory.

Work within PDS is organized into two major divisions: 1) serving the users with data and expertise, and operating the PDS system itself; and 2) planning and preparing planetary archive data to be added to the PDS collection. These divisions are called Baseline and Mission Products [Figure 4]. Since a quality data collection is critical, approximately half of the PDS resources are allocated to the Mission Products tasks. Most tasks require participation by more than one node. Roles of nodes are described in the next section.

Baseline tasks include project management, user services, system development, and system engineering. User services, the largest task within Baseline for all nodes, is responsible for responding to user requests for data, special processing, and expertise; hardware, software, and storage maintenance of the catalogs and holdings at each node; and workshops and demonstrations for science users using PDS data. System development specifically identifies infrastructure or user tools that PDS develops to improve performance, such as new catalogs to handle future data deliveries, product validation tools, or data access tools. System engineering includes evolution of the system across all nodes as well as standards maintenance and advanced development.

Mission Products tasks come in two types, Active Missions and Restorations. Active Missions tasks are those where the data products are prepared by the flight project and delivered to PDS. PDS takes a proactive role early in flight project lifecycles to ensure that quality archives are available to users as soon as possible, Specific work steps are defined later in the section "Innovations: Mission Interface. " FY95 work includes planning, product preparation, product validation, or distribution for these active missions: Clementine, Galileo, Mars Surveyor, Mars Pathfinder, Near Earth Asteroid Rendezvous, Discovery, Cassini, Shoemaker-Levy 9, Ulysses, Mars 96, and Pluto Fast Flyby.

Restoration tasks, performed and funded by PDS, publish data products in a form more useful than that delivered to an archive by the original flight project or scientist team. Priorities are based on user and active missions requests, as well as the risk of losing the data in its original form. During FY95, PDS will publish new products from Magellan, Voyager, Viking, Pioneer Venus Orbiter, Pioneer, and Mariner 9 and 10.

Roles of Nodes

Discipline Nodes provide direct service to their science discipline communities through science data distribution, special processing, and expertise. Their user communities, and advisory groups, set priorities for work within each node. Discipline Nodes also prepare new archive products by leading restorations and by coordinating with science teams from active missions to plan their archive deliveries. Finally, these nodes develop and maintain detail level catalogs and tools to help users find data easily.

There are two special kinds of nodes within the project, international nodes and data nodes. To improve the safe holding and sharing of planetary data across nations, PDS has established two international nodes, with more in the planning stages. The concept is that under the leader of a discipline node manager, an international node would be the prime source of PDS information to its constituency while providing PDS with data from international sources. PDS does not explicitly fund these nodes, however they provide service to U. S. investigators by allowing access to data not available by other channels,

Data nodes are transient entities that are funded for brief periods to restore specific data sets that PDS wants to add to its collection. Priorities and funds come from one of the discipline nodes. The data node concept allows us to save data that the community thinks is valuable and that would otherwise be lost.

The Central Node provides five specific functions within PDS. First, the project management is at this node, concentrating on future planning as well as current status and funding across all nodes, Next, system engineering for PDS as a single system is done at Central Node. This function includes project-wide system design, archive standards, advanced technology, software tools, and coordination with external technical interfaces such as the National Space Science Data Center (NSSDC).

The largest portion of Central Node staff supports the Discipline Nodes. Central Node provides development support to each Discipline Node and subnode as the node systems and catalogs evolve. In addition, Central Node data engineers assist in restorations, premastering of CDs, and validation of new products. Also, the Central Node provides help in receiving and filling user orders.

The Central Node takes the lead for PDS in coordinating with active missions, since many of those mission staffs are at JPL. Finally, the Central Node developed, maintains, and operates the high level PDS catalog which describes all PDS products and points to more detail information at each node. This catalog has been operational since 1989.

Distribution Approach

PDS currently provides data sets without charge to our prime customers, those scientists funded by the NASA Solar System Exploration Division. To distribute products quickly to these users, PDS nodes canvas their communities before products are available so that distributions can be pre-defined, and most users do not have to order explicitly from PDS catalogs or nodes. PDS has usually ordered approximately 300 copies of most new titles to address this "first printing" audience. In the future, due to the enormous increase in new titles, we plan to offer data online as well, hoping that the number of CD copies can be reduced yet users still be satisfied.

PDS relies on NSSDC for distribution to a broader audience, and they charge nominal fees to replenish their inventory. PDS provides NSSDC with copies of all PDS products for distribution as well as long-term backup digital product storage. Non-digital products are not archived by PDS, but are instead delivered to NSSDC.

PDS INNOVATIONS

PDS innovations give benefits to the science community in multiple ways. PDS standards save NASA and scientists future costs by enabling the sharing of data and predictable access to information for years. PDS-provided products from missions are accessible quickly since they are peer reviewed and well-documented before release, PDS technology has lowered the cost and risk for large archives in its use of CD media and tools. Finally, PDS itself stands as a role model for newer archive systems in the way that we are organized and the lessons that we can share.

PDS Standards

PDS standards exist to make planetary science data easier to find and to use many years after the original data was collected. They have evolved over the last ten years as a result of science user needs. These standards address file formats, terminology, volume organization, CD technology, and user platforms [PDS Standards Reference, 1992 and Gibbs, et al, 1992]. Descriptive information uses consistent syntax and semantics so that data can be compared and shared. In PDS file format standards, there are rules for describing data files, with headers, called labels, and a set of data objects on the same or separate files. This format is usable across different media, platforms, and applications. It is an archive format which is well defined, human readable, and is "easy to automate. The Planetary Science Data Dictionary keeps the proliferation of science keywords to a minimum, and is used within planetary flight projects as well as PDS. It includes valid ranges for terms, and is an integral part of an automated system of creating and validating new data products.

PDS labels on data products provide information to users on the data, including mission, spacecraft, instrument, and references for original investigators. PDS catalogs include this information for searching by science users; catalogs also include comments from the peer reviews of the data so that users can be warned of special problems in the use of certain data.

Volume organization standards promote a physical and logical structure of data products that can be easily read by archive users. PDS encourages the use of standard directory trees for overview information, multi-platform software, and the data itself. Also, size of files must be considered when forming a product, whether on CD or tape, so that users on the simplest computer platforms can access the data. PDS strives to make its products portable to UNIX, PC-DOS/Windows, MAC, and VAX environments.

PDS team members participate in international standards committees on languages, formats, and media hardware,

Peer Review

An integral part of the PDS archiving process is the peer review used for each PDS-produced product. These reviews use a group of working scientists who are familiar with the type of data to examine the contents and format of the data and its description. The goal is to ensure the usability of the total product, In some cases these reviews are held face-to-face over one or more days; sometimes they are done remotely via electronic mail and telecon, with the review products distributed ahead of time. Feedback from these reviews can lead to rewrites of descriptive information, restructuring of the product content, or re-generation of the product itself. Infrequently, certain data sets have been removed from a final product when they contained significant errors or were not usable by scientists outside the original investigation. In cases where the PDS found problems with a product but PDS was not able to rework it, usually due to financial limitations, the product was released but peer review comments were entered in the PDS catalogs so that product users could be warned.

Mission Interface Approach

PDS has pioneered the approach for coordinating with active missions for preparation and delivery of archive products. Historically, projects ignored archive deliveries until the end of the project, leaving delivery up 'to the individual scientist, whose funding was gone, or providing whatever was remaining in the project offices when its funding ran out. Too frequently that approach resulted in boxes of paper and unexplained tapes being sent to NSSDC, or many products never showing up at the archive. PDS has taken an active role in defining archive needs at the early stages of project, when engineering and science plans are still evolving. Our goal is to help a project to plan its archives early so that its preparation costs can be minimized, the investigators' expertise is applied directly to the archive products during the mission, and the products can be distributed immediately after project validation to the general science community,

There are five major steps to project archiving and distribution: archive planning; data preparation; data cataloging, data transfer, and data distribution. These steps have milestones that parallel the classic documents and reviews within a flight project. By working with the project, PDS lessens the work, and the PDS resources which support a project save that project money. The PDS systematic approach to quality products provides a path for projects to follow, rather than inventing new archive techniques within each project.

Early in the project, PDS names a data engineer to support that project and holds a PDS orientation for project personnel. During archive planning, PDS provides data preparation workshops for the project science teams and mission engineering staff as they define the Project Data Management Plan (PDMP) and Archive Policy and Data Transfer Plan (APDTP), These two critical documents describe how the project processes its data stream and what, in detail, will be delivered by each experiment to the archives. Our" experience is that the PDMP is a general document which should be generated early in the project. The APDTP should be updated throughout the project, as the investigators and teams envision new products to be added to the archive set. PDS generates a mission interface plan which documents the agreements for handling delivery details. At this stage, PDS and project personnel meet on a regular basis as a formal working group.

Data preparation is the responsibility of each flight project. PDS Central Node provides standards and data engineering support while its discipline nodes offer their science archive expertise to the relevant science teams. Efficient product generation requires close design between the project ground data processing element, science teams, and PDS since the goal is to create products only once and have them be usable by the science teams as well as later by the general science community. After products are prepared, PDS validates them and conducts a data delivery review or peer review before distribution.

PDS maintains active databases or catalogs of project deliveries. Contents of these catalogs are drafted early in the project life by PDS. PDS also coordinates the transfer of project data to PDS and its storage at the NSSDC. Currently most transfers to PDS and NSSDC are contained on tape or CD media. However some deliveries have been electronic. The method of delivery depends on a number of factors, including the volume of data and the nature of the instrument.

CD Technology

In our search for robust media that would survive 50 or more years, yet be affordable to store and use, PDS has experimented with several types of storage techniques. Leveraging on the audio CD developments, the optical CD-ROM and CD-Write Once technologies now provide us with reliable storage and access. Data saved on CD-ROM can contain approximately ten digital tapes worth of data and have a shelf life of 50 to 100 years, compared to 15 years for tape. This technique provides large savings over tape usage in controlled storage environments, labor to copy/re-write, and risk of loss. For example, using an average of 10 tapes per. CD, the PDS holdings by the end of FY95 will include approximately 600 unique CD-ROMs and 8,000 CD-Write Once discs, which are the equivalent of 86,000 tapes. Using the tape storage rate of $1 per tape per year for GAO-approved facilities, the equivalent tapes would cost NASA $86,000 per year in storage alone. This savings is a lower bound since the collection grows yearly.

PDS now uses CD-Write Once discs for quick-look feedback before the expense of CD-ROM vendor mastering. An unexpected benefit of CD-WO has been that it appears to be viable medium-term storage medium (approximately 50 years). PDS now uses CD-WO for curation copies of tapes, instead of making tape copies of tapes, and for sending data to users when there are a small number of requests that do not justify the expense of CD-ROM mastering.

PDS CD-ROM experience matured during the operations phase of the Magellan Project. MGN was convinced of the worth and cost savings of this technique, and planned to change its mission operations procedures after launch to use CD-ROM in place of tapes. While that project ended prematurely before the full conversion, many M GN products were eventually produced on CD-ROM before delivery to PDS. A major ongoing task for PDS nodes is to convert Magellan tape products to CD-WO. The Geosciences Node is archiving the full basic image data record (FBIDR) data tapes, while the Atmospheres and 'Planetary Plasma Interactions Nodes are putting the original data records onto CD-WO media.

PLANS

FY95 Plans

During FY95, PDS plans to add an additional 260 new CD-ROM titles to its collection, with an initial distribution for each of more than 300 copies. Many of these CD-ROMs are from the Clementine project (150 titles) and the Pioneer Venus Orbiter and Voyager restorations. Data is also included from thirteen other projects. Between 4,000 and 8,000 CD-Write Once discs will also be generated for safe-keeping data or for small orders. Each of these new archive products is the result of years of coordinated planning between the PDS nodes and the science experts from the related missions. Figure 5 summarizes the PDS FY95 mission activity across all nodes.

To aid users in finding archive data, PDS has developed an online overview central catalog plus catalogs for the discipline node holdings. All nodes, and some subnodes, have World Wide Web (WWW) homepages that describe data sets and point to further detail [Figure 6]. During FY95, the central catalog is planned to be accessible via WWW. Additional catalogs and many data holdings will also be put online.

Node articles include more information about catalog development and archive products from specific project experiments.

Future Plans

Trends for PDS in future years show a constant budget, where the Baseline activities are at a stable level, there is greatly increased emphasis on support to active missions, but PDS restorations shrink significantly. Figure 7 graphically shows the future planned archive deliveries from each project, including the major restorations from PDS. PDS will validate, ingest, and duplicate products from Galileo, Mars Surveyor, Discovery, and Cassini missions. Planning continues for future missions and in support of science data analysis programs. PDS will complete the series from Voyager, Viking Orbiter, PVO, and Pioneer by FY97.

PDS emphasizes that active missions prepare quality archive products from the start since PDS cannot afford to restore the data products after a mission has ended.

Many potential restorations have been identified, although they are not yet scheduled: Viking Lander; education products; 1,000 Infrared Thermal Mapper (IRTM) tapes; 200 CD-Write Once discs of raw data from many projects; thousands of tapes of Voyager Master Data Records; thousands of radio science tapes; old data stored at NSSDC; calibration files; and roomfuls of historic mission documentation.

CONCLUSION

PDS has been operational five years, with substantial data archives available to scientists. We expect large increases in both the number of new products and the number of user orders in future years as planetary missions acquire more information and PDS expands its online capabilities.

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APPENDIX A: DEFINITIONS OF TERMS

Calibrated data - edited data that are still in units produced by instruments, but that have been corrected so that values are expressed in or are proportional to some physical unit such as radiance. No resampling, so edited data can be reconstructed. NASA Level 1A.

Cataloging - inserting and/or updating the PDS Central Catalog database with new information about data sets.

Data distribution - processing orders for and distributing PDS data sets to the planetary community.

Data ingestion - the design, assembly and validation of PDS data sets; updating the PDS Central Catalog database to include new information about data sets; storing data sets onto physical media; and adding data sets to the Discipline Node data inventory.

Data product label - a data structure (expressed in the Object Description Language) that defines the content and format of each data product.

Data Set - a set of data products, ancillary data, software and documentation that completely describe and support the use of the data products.

Primary data object - a grouping of data results from a scientific observation.

Raw data - telemetry data with data embedded

Restoration - the process of creating a PDS data set from scientific data gathered during a previous mission.

Secondary data object - any data needed for processing or interpreting the primary data object.

Tool - the software and methodology used during each phase of data ingestion.

Validation - the set of activities which test an assembled data set for adherence to PDS standards anti guidelines, which review the science content of the data, and bv which an assembled data set is made readv for cataloging.

APPENDIX B: PDS NODE CONTACTS

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APPENDIX C: PDS WORLD WIDE WEB ACCESS

PDS Homepage
http: //stardust.jpl. nasa.gov/pds_home.html

CN Homepage
http: //stardust.jpl. nasa.gov/pds-cn-homepage,html

Atmospheres Homepage
http: //sslab.colorado. edu:2222/pds/atmos.html

Geosciences Homepage
http: //wwwpds.wustl. edu/
Geophysics Subnode
http: //wwwpds.wustl. edu/geophys/
Infrared Imaging Subnode
http: //esther.la, asu. edu/asu_.tes
Microwave Subnode
http: //delcano.mit.edu/
Spectroscopy Subnode
http: //www.planetary. brown. edu/pds/

Planetary Plasma Interactions Homepage
http: //www.igpp.ucla.edu/scc/pdsppi/Welcome.html
Outer Planets Subnode:
http: //www.physics.uiowa.edu/pds/

Rings Homepage
http: //ringside, arc. nasa.gov/

Small Bodies Homepage
http: //pdssbn.astro.umd.edu/home.html

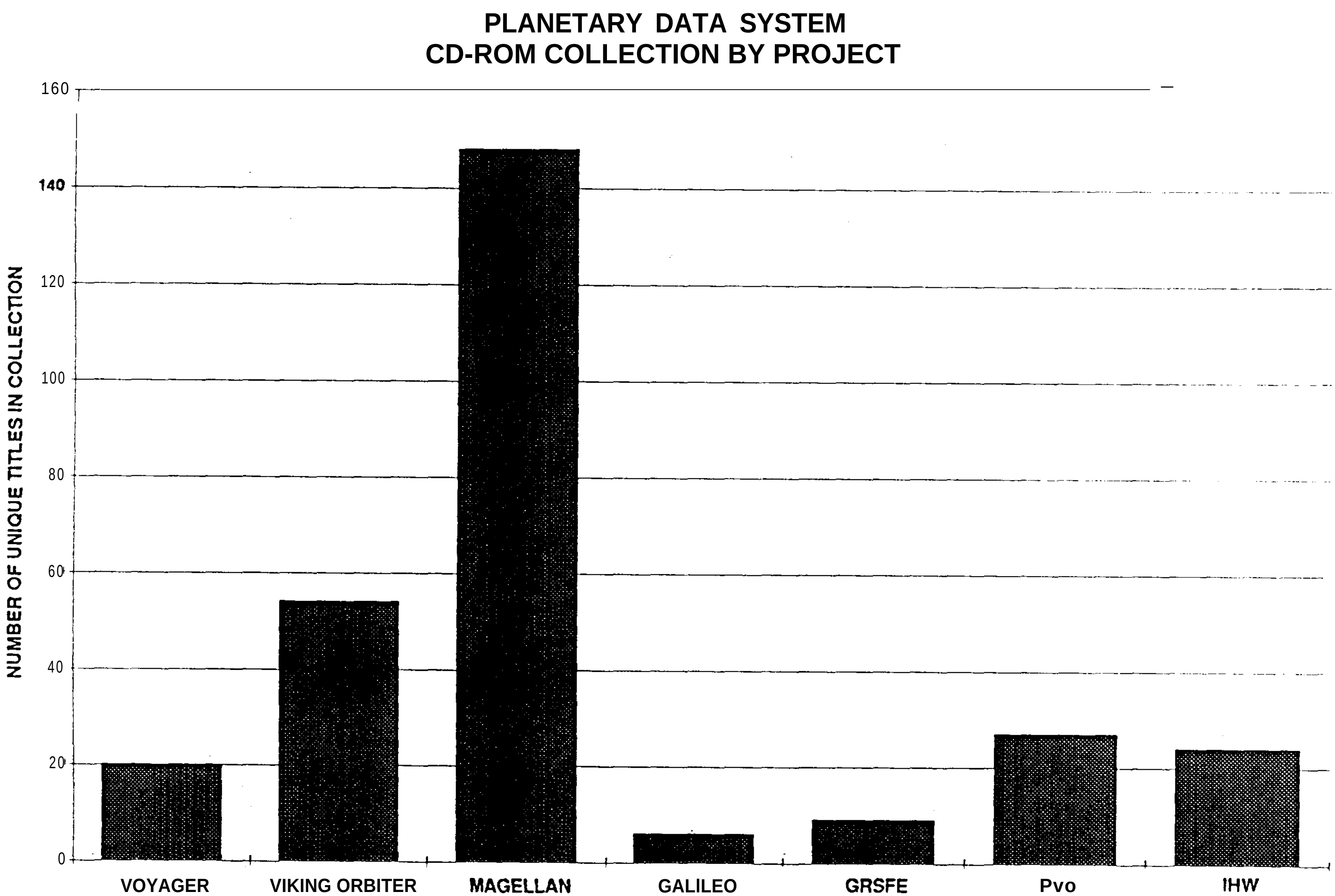

PLANETARY DATA SYSTEM
CD-ROM COLLECTION BY PROJECT
NUMBER OF UNIQUE TITLES IN COLLECTION
160
140
120
100
80
60
40
20
0
VOYAGER
VIKING ORBITER
MAGELLAN
GALILEO
GRSFE
Pvo
IHW

Figure 1

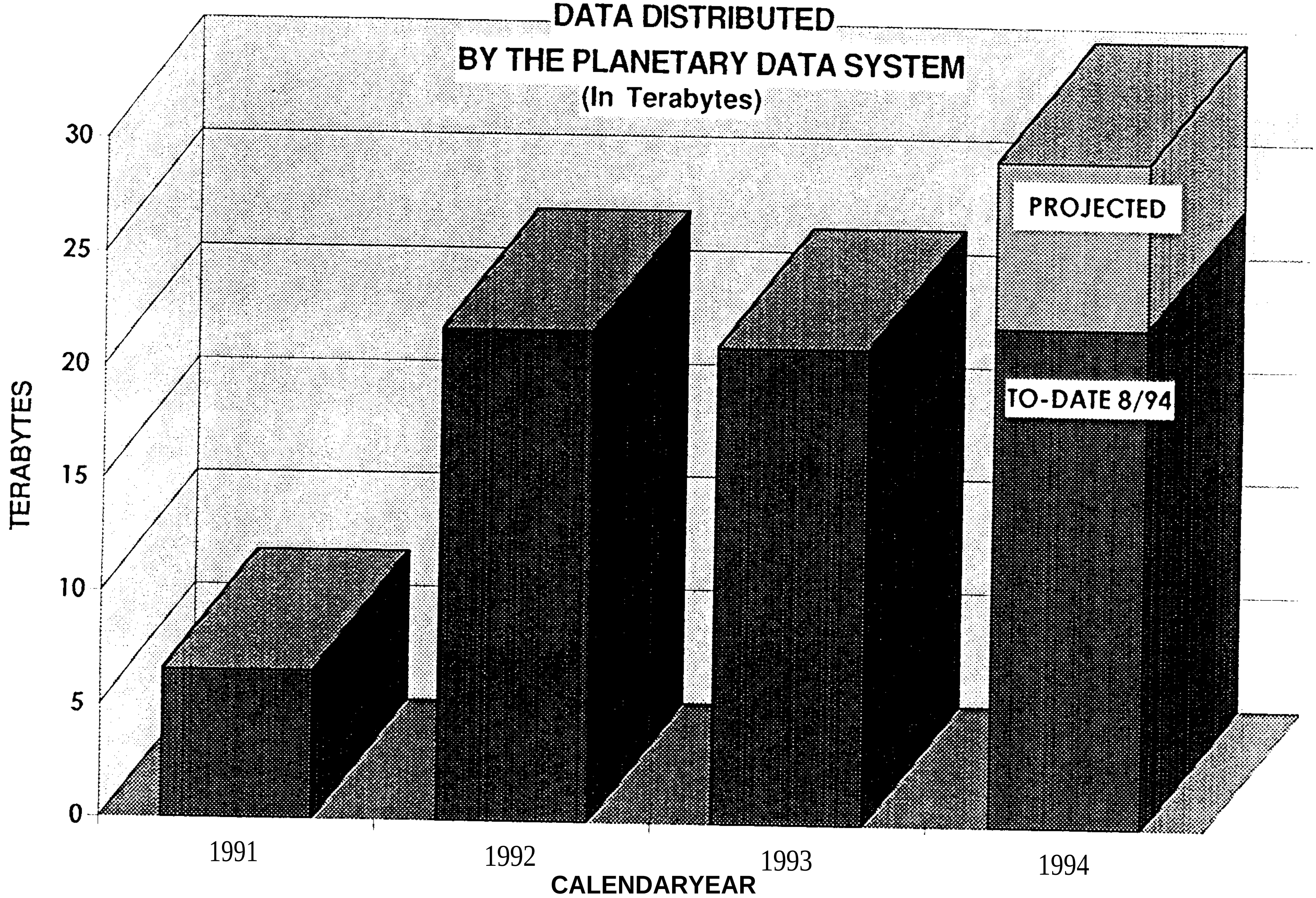

DATA DISTRIBUTED
BY THE PLANETARY DATA SYSTEM
(In Terabytes)
TERABYTES
30
25
20
15
10
5
0
PROJECTED
TO-DATE 8/94
1991
1992
1993
1994
CALENDARYEAR

Figure 2

Planetary Data System

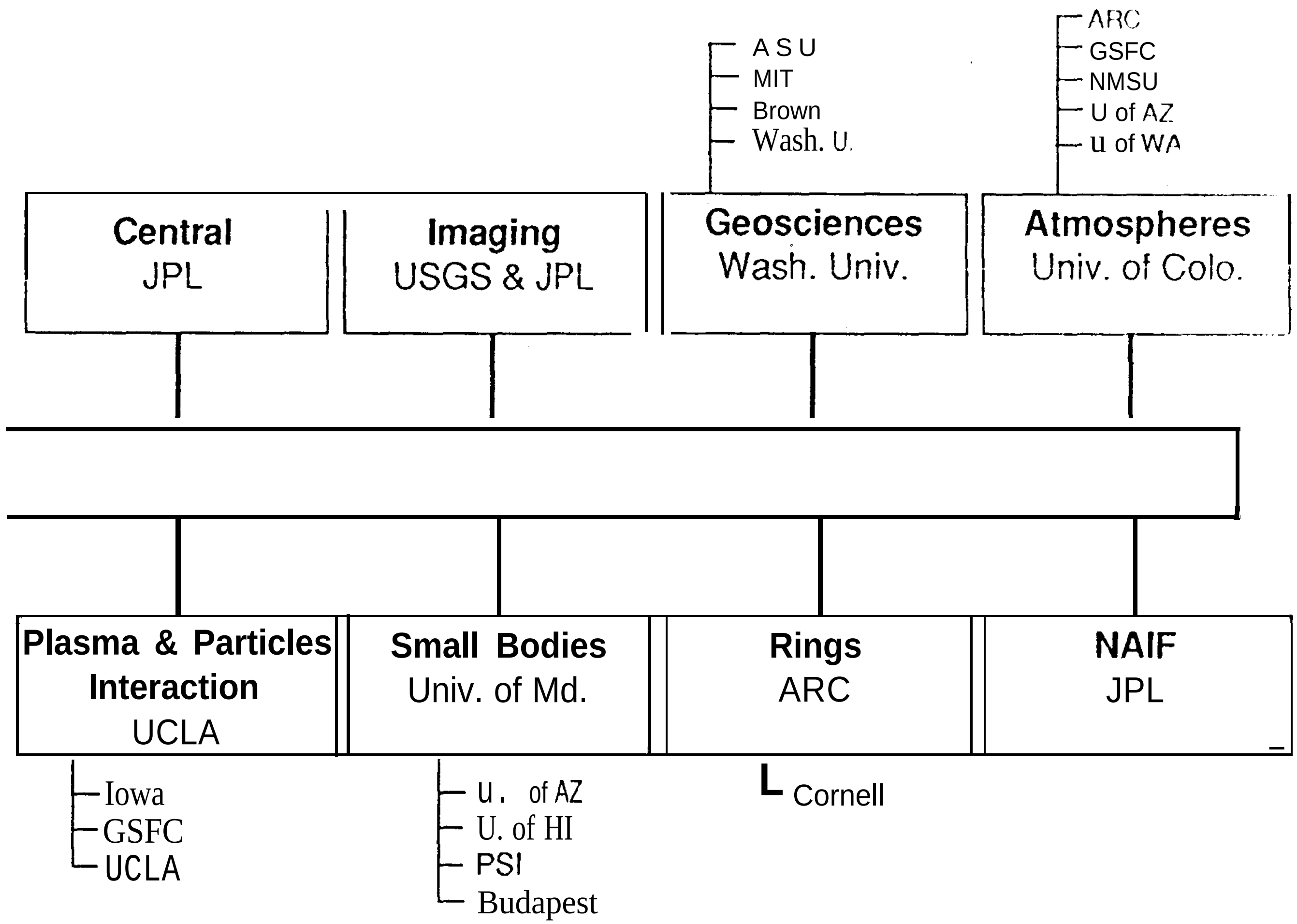


Figure 3

PDS TASK STRUCTURE

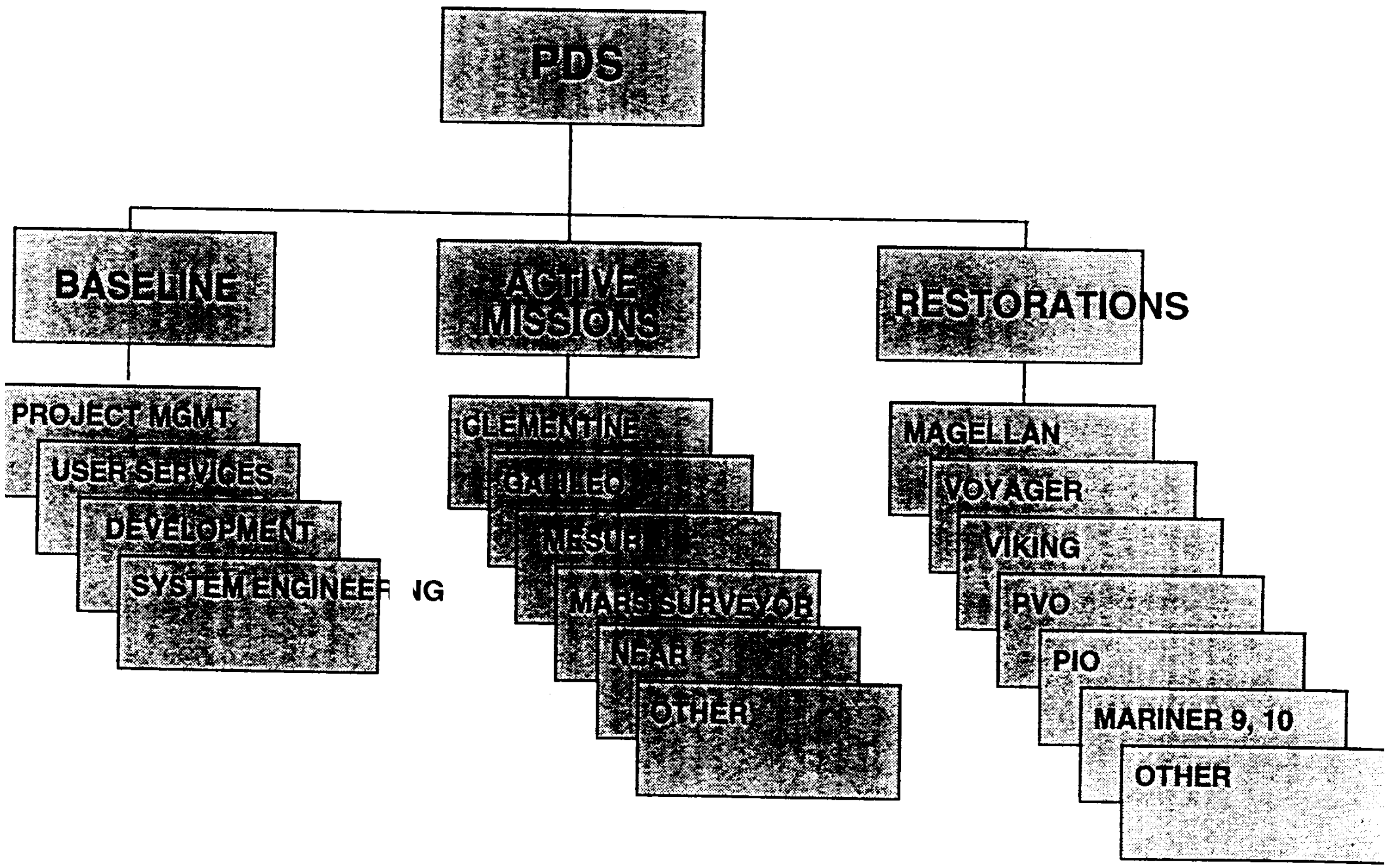
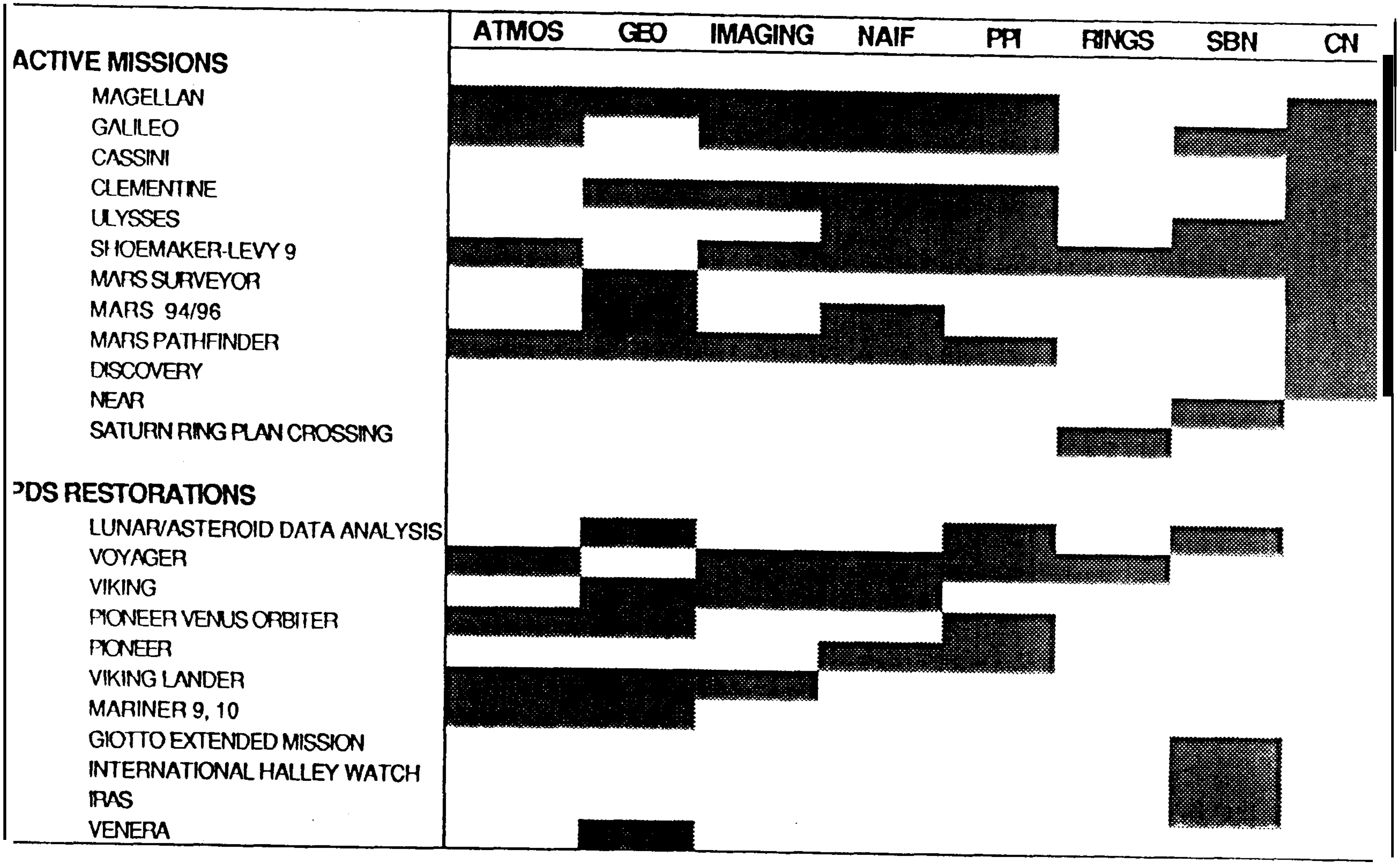


Figure 4

PDS FY95 MISSION ARCHIVE ACTIVITIES

NODE PARTICIPATION



ATMOS	*ATMOSPHERES NODE*	**PPI**	*PLANETARY PLASMA* ***INTERACTIONS*** *NODE*
GEO	*GEOSCIENCES NODE*	**RINGS**	*RINGS NODE*
IMAGING	*IMAGING NODE*	**SBN**	*SMALL BODIES NODE*
NAIF	**NA** ***VIGATION*** **ANCILLARY** *INFORMATION NODE*	**CN**	*CENTRAL NODE*

Figure 5

WWW HOMEPAGES

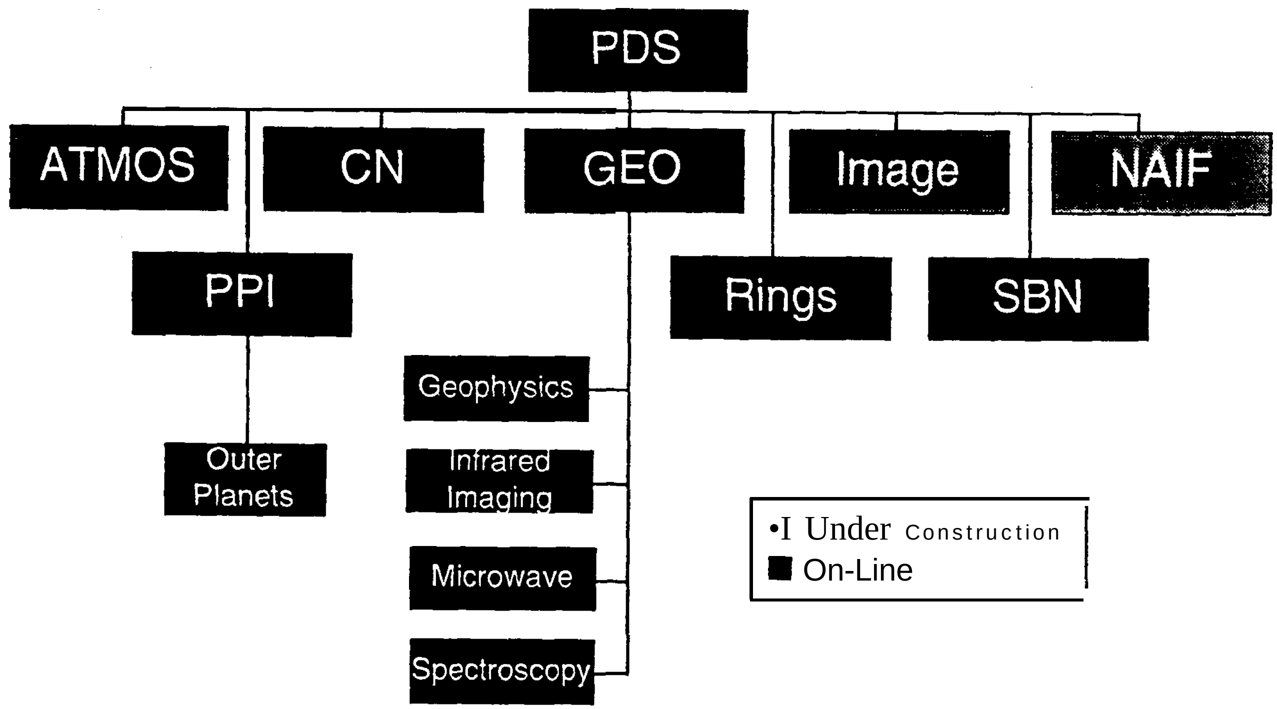


Figure 6

MISSION ARCHIVE DELIVERIES TO PDS
September 1994

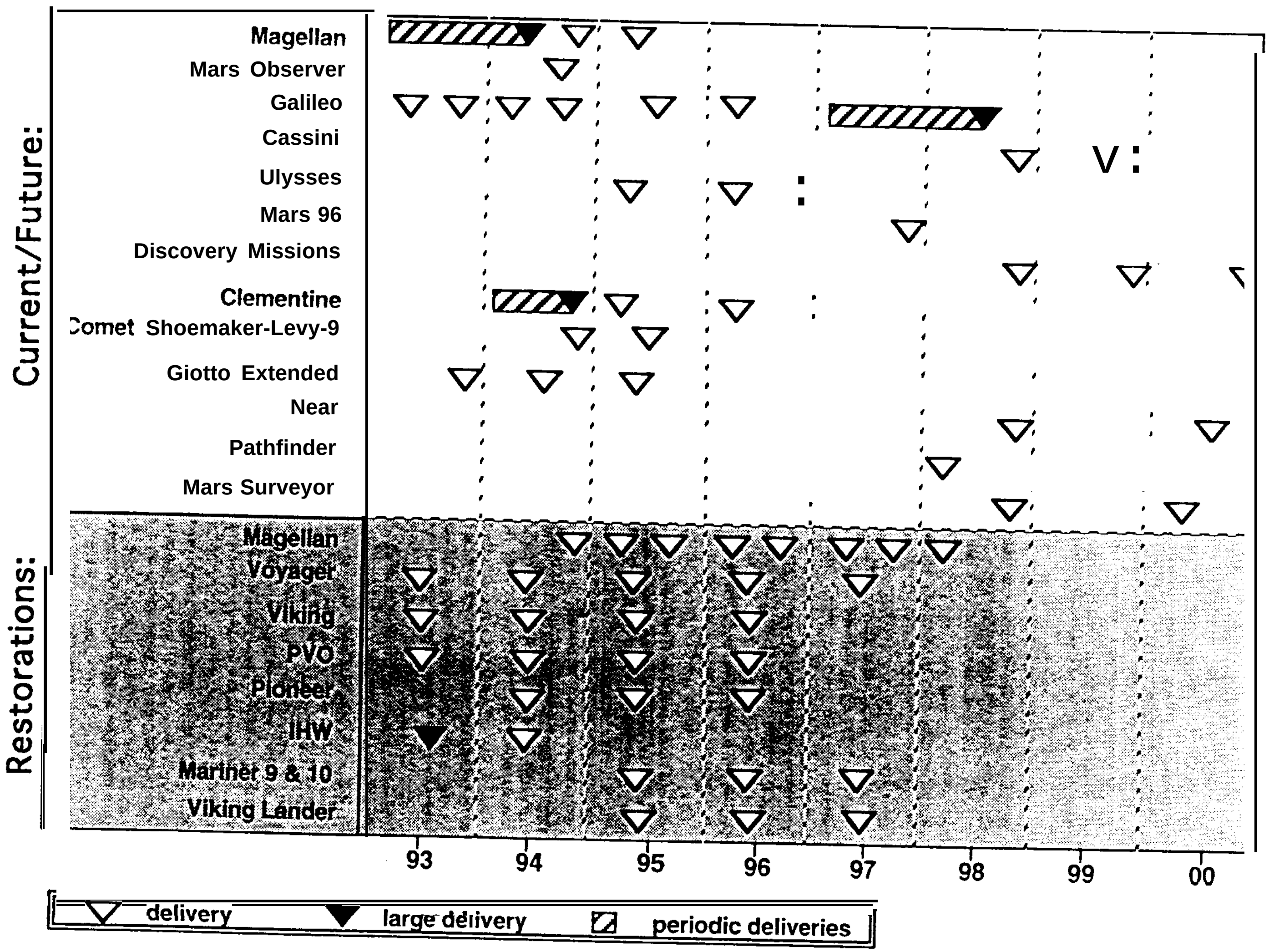


Figure 7