

Architectural Assessment of Mass Storage Systems at GSFC

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Architectural Assessment of Mass Storage Systems at GSFC

NDADS: National Space Science Data Center
Data Archive and Distribution Service

GDAAC V.0: Earth Observing System Data Information System
Goddard Distributed Active Archive Center

M(DS)2: NASA's Center for Computational Science
Mass Data Storage and Delivery System

by

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OVERVIEW

- **Background**
- **System Functionality**
- **Characteristics**
- **Data Sources**
- **Hardware/Software Systems**
- **Performance Assessments**
- **Conclusions**

BACKGROUND OF MASS DATA STORAGE SYSTEMS

NDADS:

Prototype of the Hubble Space Telescope Data Archive and Distribution Service (HST-DADS) contracted to Loral AeroSys in 1989. Evolved as the Astrophysics and Space Physics archiving system for the National Space Science Data Center to maintain a mix of near and on-line data and manage a deeper data storage archive

GDAAC/V.0:

EOS prototype archive and distribution systems initiated in FY91 and planned for operational availability in FY94. One of nine geographically distributed discipline-oriented interoperable DAAC's

M(DS)2:

A mass storage and delivery system serving more than 1400 users within the NASA Computational Science Center at Goddard that has to manage both the high-speed computer-generated simulation data, as well as space-borne observational data

SYSTEM REQUIREMENTS

	NDADS	GDAAC V.0	M(DS)2
NEAR-ONLINE STORAGE /DEEP	2.6 TB/6 TB 16GB DASD	10TB/3TB 16GB/DASD	7TB/35TB 240 GB/DASD
SCALABLE UP TO	10 TB/50TB 100 GB DASD	18 TB 100 GB/DASD	225 TB/500 TB 3 TB/DASD
INGEST (RATE)	13 GB/DAY	30 GB/DAY	90 GB/DAY
DISTRIBUTE (RATE)	1050 MB/DAY - NET 700 MB/DAY - TAPE 100 PHOTOS/DAY	150 GB/DAY	100 GB/DAY
PEAK CONCURRENT USERS	146 240 CATALOG QUERIES/HR	100	MIN. 128 MIN. 32 SIMULTANEOUS FTP TRANSFERS

SYSTEM FUNCTIONAL CHARACTERISTICS

Data and Metadata Functions	NDADS	GDAAC	MDSDS
Network Access (Ethernet, FDDI, DecNet, UltraNet)	x	x	x
Security	x Barrier	x Barrier	x RACF/C2
Integrity and Quality Control	x	x	
Automated Data Migration and Compaction	Partial		x
User Ingest and Retrieval	Partial	Partial	x
Remote Ordering and Delivery Service	x	x	
Catalogues and Inventories	x	x	User
Browse - On-Line	x	x	
Interoperability		x	Partial
Database Queries and Subsetting	x	x	
Portable Software Operating Systems		x	x
Incorruptible Archive	x	Partial	Partial
Remote Back-Up/Safe Store	x		-----
Data Compression	x	x	-----
Redundancy (NSPOF)	Partial	Partial	x
Scalable Upgrade	x	x	x
Accounting & Monitoring	x	Partial	x

NDADS Data Sources:

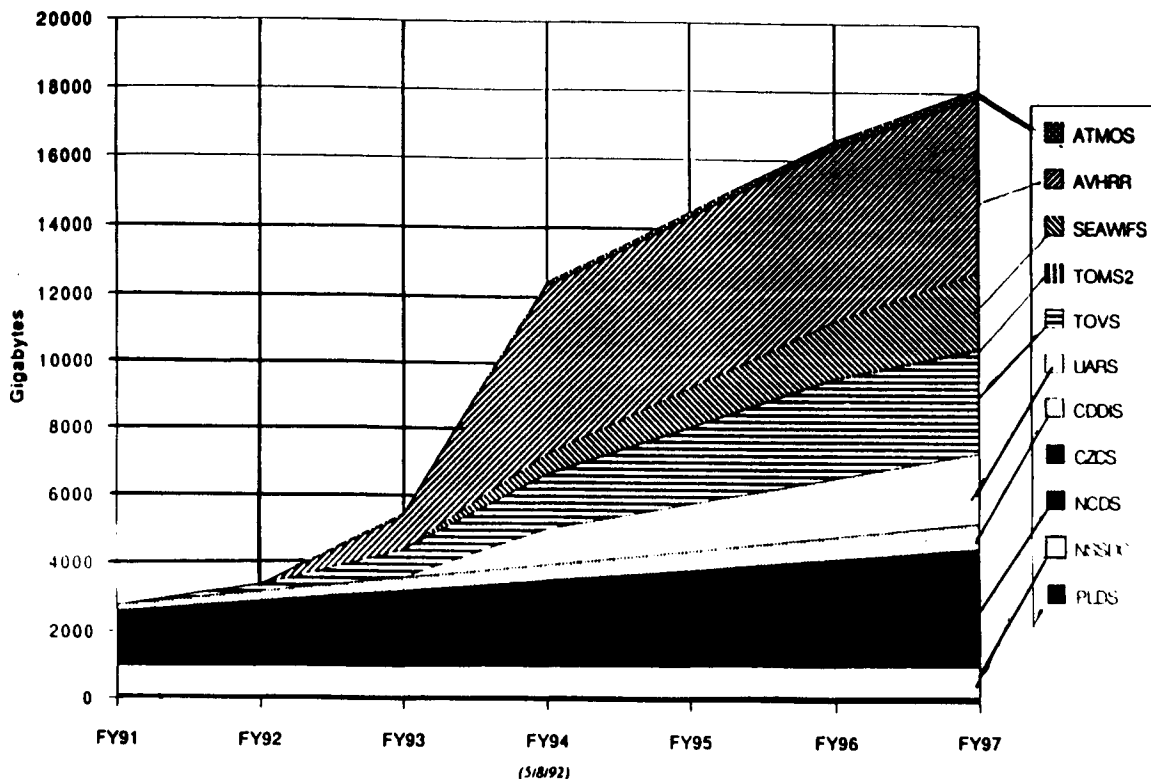
Astrophysics:

Wave Length	Project	DataTypes	Granules	Archived	Total Size
High Energy	EXOSAT	10	34K		150 GB
	HEAO-3	2	10K	100%	4 GB
	HEASARC	200	100K		20GB
	EINSTEIN	20	15K	30%	120 GB
	ASTRO-D	launch 1993	---	---	1650GB
	XTE	launch 1996	---	---	
	GRO	100	---	none	50GB/year
	ROSAT	60	> 100K	30%	100 GB
	VELA 5B	1	1K	100%	3GB
	Ultra Violet	IUE	6/8	80K	100%
Copernicus	EUVE	launch 1992	--	---	50 GB
Optical	HST	4			1GB/4GB
Infrared	COBE	6	100K	0	30 GB
	IRAS	6	150K	100%/10%	5GB+78GB
Radio	VLA	1	---	60%	1000 GB
Miscellaneous	ADC Catalogs	Various	1K	100%	1GB
TOTAL					2.41 + (1.75)

Space Physics:

Mission	Data Types	Granules	Archived	Total Size
SKYLAB	1	3500	100%	10 GB
ISTP-GOES	8			.4 GB
ISTP-IMP8	8			.4 GB
ISTP-GEOTAIL	8			1.0 GB
Atomic Physics	2	100	10%	1 GB
DE-1				100 GB
VOYAGER				2 GB
TOTAL				114 GB

GSFC V0 DAAC Data Volume Requirements (by Project)



Science Project Data Products

Project	Product Description
UARS	<ul style="list-style-type: none"> • Profiles of 15 trace species, temperature, and wind • Solar UV irradiance measurements (115 - 400 nm)
SeaWiFS	<ul style="list-style-type: none"> • Ocean pigment, chlorophyll a concentrations • 5 water leaving radiances, 3 aerosol radiances • Diffuse attenuation coefficient
Atlas / ATMOS	<ul style="list-style-type: none"> • Profiles of 30+ upper atmosphere trace species • Upper atmospheric temperature profiles
TOMS2	<ul style="list-style-type: none"> • Total ozone, effective tropospheric reflectivity • 6 backscattered UV radiances (313 - 340 nm)
AVHRR Pathfinder	<ul style="list-style-type: none"> • Binned 5 channel clear sky radiances • Daily cloud fraction, height, and reflectivity at 9 km and 1 degree spatial resolutions • Daily, weekly and seasonal surface reflectance NDVI at 9 km resolution • Daily Surface albedo at 9 km resolution • Aerosol optical thickness, longwave surface flux
TOVS Pathfinder	<ul style="list-style-type: none"> • Profiles of atmospheric temperature, humidity, and geopotential height • Precipitable water in 6 tropospheric layers, total ozone, and tropopause pressure • Surface air and skin temperatures, 3.7 micron bidirectional surface reflectance, and 50 GHz surface microwave emissivity • Cloud fraction, cloud top pressure, precipitation estimate, visible reflectance, outgoing longwave radiation, and longwave cloud forcing

M(DS)² DATA SOURCES

PROJECTS: NIMBUS/TOMS
ISTP
IUE
GRO

MODELING: DATA ASSIMILATION
COUPLED OCEAN/ATMOSPHERE/STRATOSPHERE
GEODYNAMICS
SPACE PHYSICS PLASMA MODELING

ANALYSIS: TOVS PATHFINDER
ALGORITHM DEVELOPMENT (TRMM, MODIS...)
HST IMAGE DEBLURRING

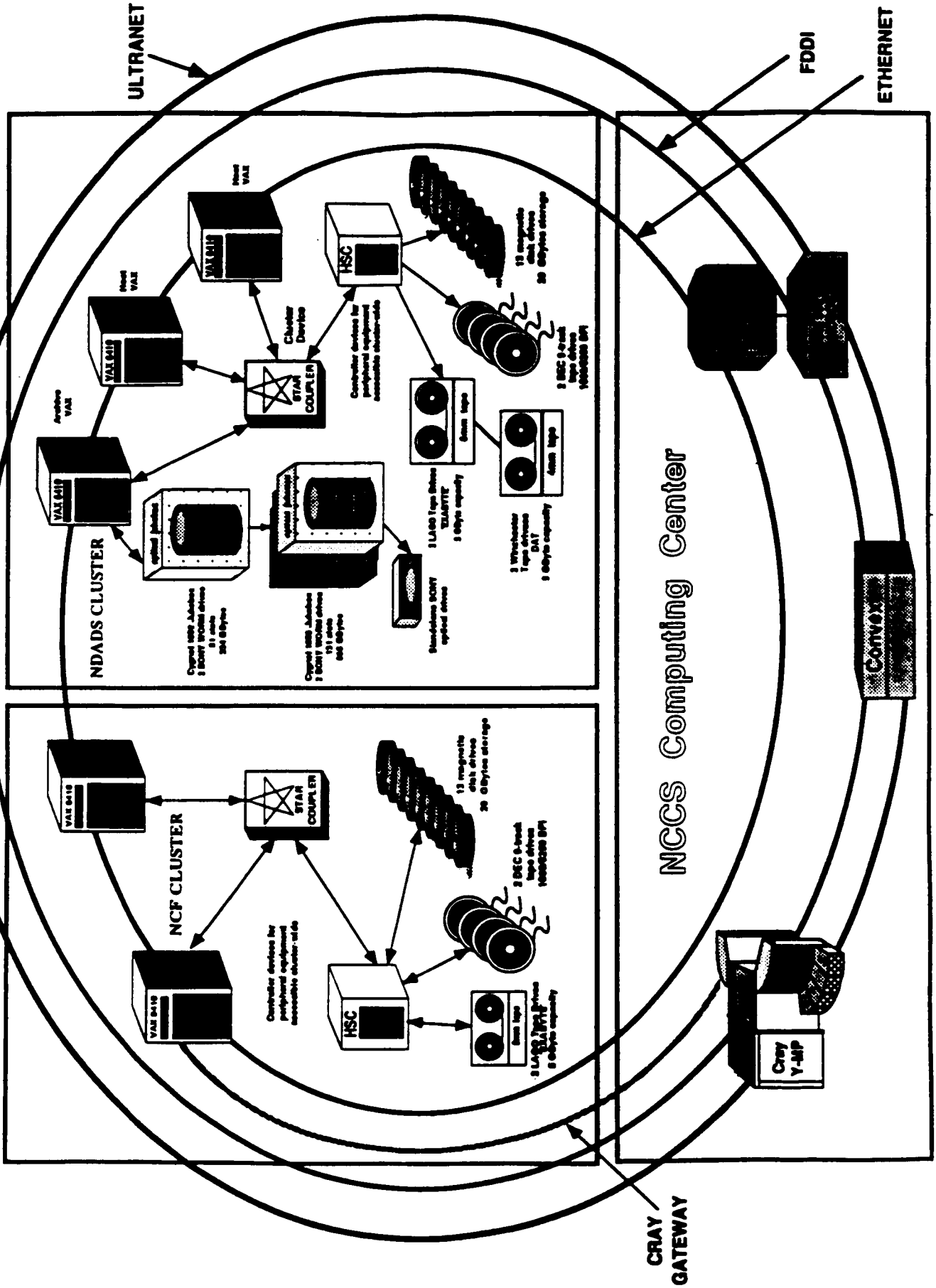
HPCC: EARTH AND SPACE SCIENCE TESTBEDS

Mass Storage Hardware Systems

NDADS	GDAAC	MDSDS
<ul style="list-style-type: none"> • 3 VAX 6410's (14GB/DASD) 	<ul style="list-style-type: none"> • 2 SGI 4D/440 (16 GB DASD) 	<ul style="list-style-type: none"> • IBM ES 9021/500 (56 ch, 128 MB) • IBM 3980 - (240 GB/DASD) • Convex 3240 - (512 MB)
<ul style="list-style-type: none"> • 2 CYGNET WORM Jukeboxes with 4 SONY drives 	<ul style="list-style-type: none"> • 2 CYGNET WORM Jukebox with 4 ATG 9001 drives (24 TB) • 1 Metrum ACS (8.7TB) w/ 4 drives 	<ul style="list-style-type: none"> • 3 STK 440 (4.8TB) • 1 Dataware WORM Jukebox 3 34/850 (1.2 TB) ----- • B-Test Helical E-Systems Tower (8.2 TB)
<ul style="list-style-type: none"> • 2 9-track Dec tape drives • 2 8mm Exabyte tape drives • 2 4mm Winchester tape drives • CD-ROM pre-mastering 	<ul style="list-style-type: none"> • 1 I/O power channel 80MB/s • 5 6250 9 track tape • 4 Exabyte 8 mm tape drives • 2 3480 tape cartridge • CD-Rom pre-mastering • 2 4mm DAT tape drives 	<ul style="list-style-type: none"> • 8 ESCON Channel • Ultranet • 40 Memorex 3480 compatible tape drives

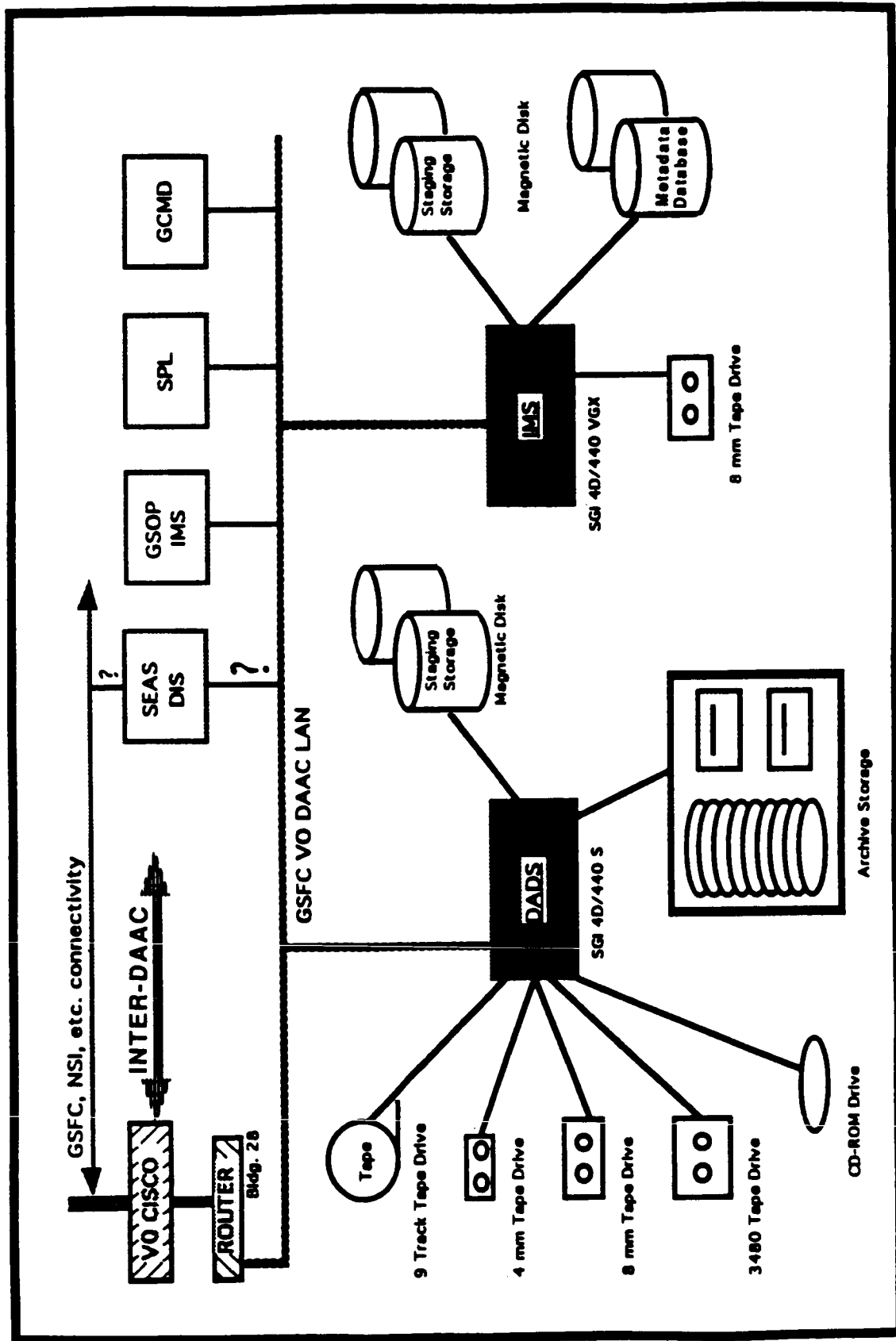
NCF VAX Cluster

NDADS Cluster



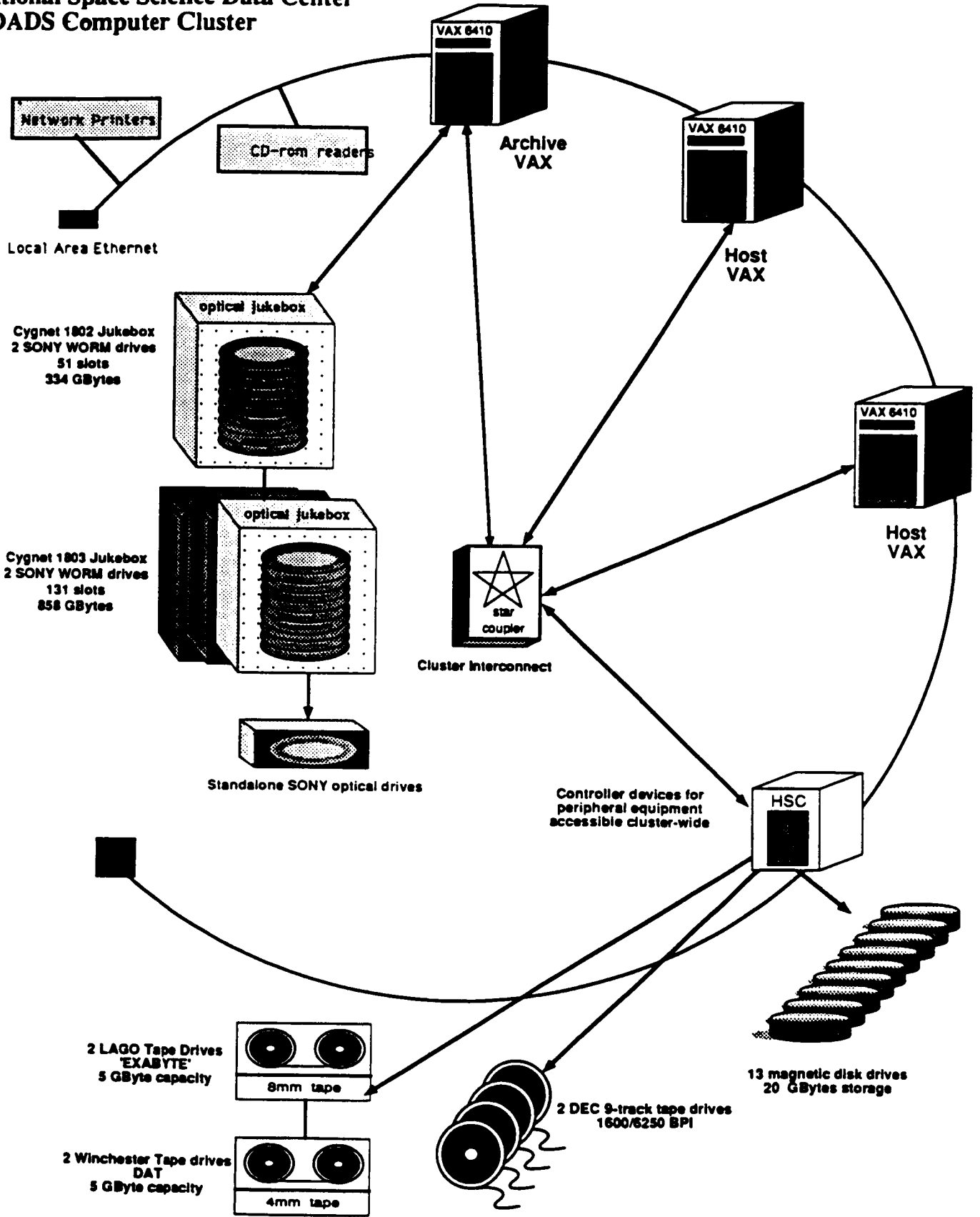


Hardware Architecture Components



Goddard DAAC

National Space Science Data Center NDADS Computer Cluster



Mass Storage Software Systems

Software System	NDADS	GDAAC	MDSDS
Client/Server Operating System	VAX VMS	IRIX	MVS, AIX
Networks Supported	DECnet TCP/IP SPRINTnet	TCP/IP	TCP/IP Ethernet BITNET NSFNET InterNet InterLink UltraNet
Database/Library Management System	FSTAGE/FSTORE SYBASE INGRES	Unitree ORACLE	HSM Unitree Oracle (Opt.)
Physical Storage Device Driver Software	JIMS SOAR	Unitree Drivers	Dataware STK Unitree Drivers
User Interface	NCDS ARMS* NSSDC ARCHIVE	NCDS/PLDS EOSDIS/IMS	USER CONTROL

* AUTOMATED RETRIEVAL MAIL SYSTEM

System Assessments

	NDADS	GDAAC	MDSDS
Strengths:	<ul style="list-style-type: none"> • Project customization • FTP Accessible • Distribution of archive media • Intelligent data access and optimization • Data compression • Metadata search/browse • Remote back-up 	<ul style="list-style-type: none"> • Project customization • FTP Accessible • Interoperable • Metadata search/browse • NCDS/PCDS Experience • Intelligent Data Mgmt. • SpatialTemp Data Fusion — • Metadata search/browse • IEEE Mass Storage Compliant • Open 	<ul style="list-style-type: none"> • FTP Accessible worldwide • Archival/retrieval by user request • Intelligent hierarchical storage migration • Remote back-up option • IEEE Mass Storage Compliant
Weaknesses:	<ul style="list-style-type: none"> • Non-portable systems • In-house customization of software and hardware 	<ul style="list-style-type: none"> • In-house customization of software • Embryonic HW/SW systems 	<ul style="list-style-type: none"> • Embryonic HW/SW systems • Costs

PERFORMANCE CHARACTERISTICS

THESE ARE ALL PRELIMINARY ESTIMATES FOR THE NDADS M(DS)² AT THIS POINT!!

(DOES NOT INCLUDE PROJECT SPECIFICS)

NDADS

SONY Optical Disk Drives:	Read: 600 KB/sec
	Write: 300 KB/sec
Actual Rates:	Read: 250 KB/sec
	Write: 107.52 KB/sec (average)
	250 KB/sec (max)
Platter load speed:	11 seconds
Data Storage: Current:	120 GBytes
Growth:	240 GBytes/year
Storage Input:	5 GB/day (average), 17 GB/day (max)
Storage Output:	330 files/day, electronically
Inquiries on the archive:	24/day

M(DS)²

DASD:	80 MB/S Throughput
Mass Storage:	18 MB/S Throughput

CONCLUSION

- Mass storage systems allow scientists to perform research previously impossible because of logistic burdens and maintain pace with rapid data growth arising from increasing computational power and observational resolution
- Mass storage hardware systems technology evolving faster than software available to integrate into system. IEEE mass storage standards model changing faster than vendors can keep up with; still need standards.
- Community needs to acquire much more performance test data reliability, stability and data access speeds across small to large mass storage systems
- Not yet clear whether many small distributed client-servers are more effective than fewer large-scale client servers
- Mass storage management systems need to become more robust and more stable