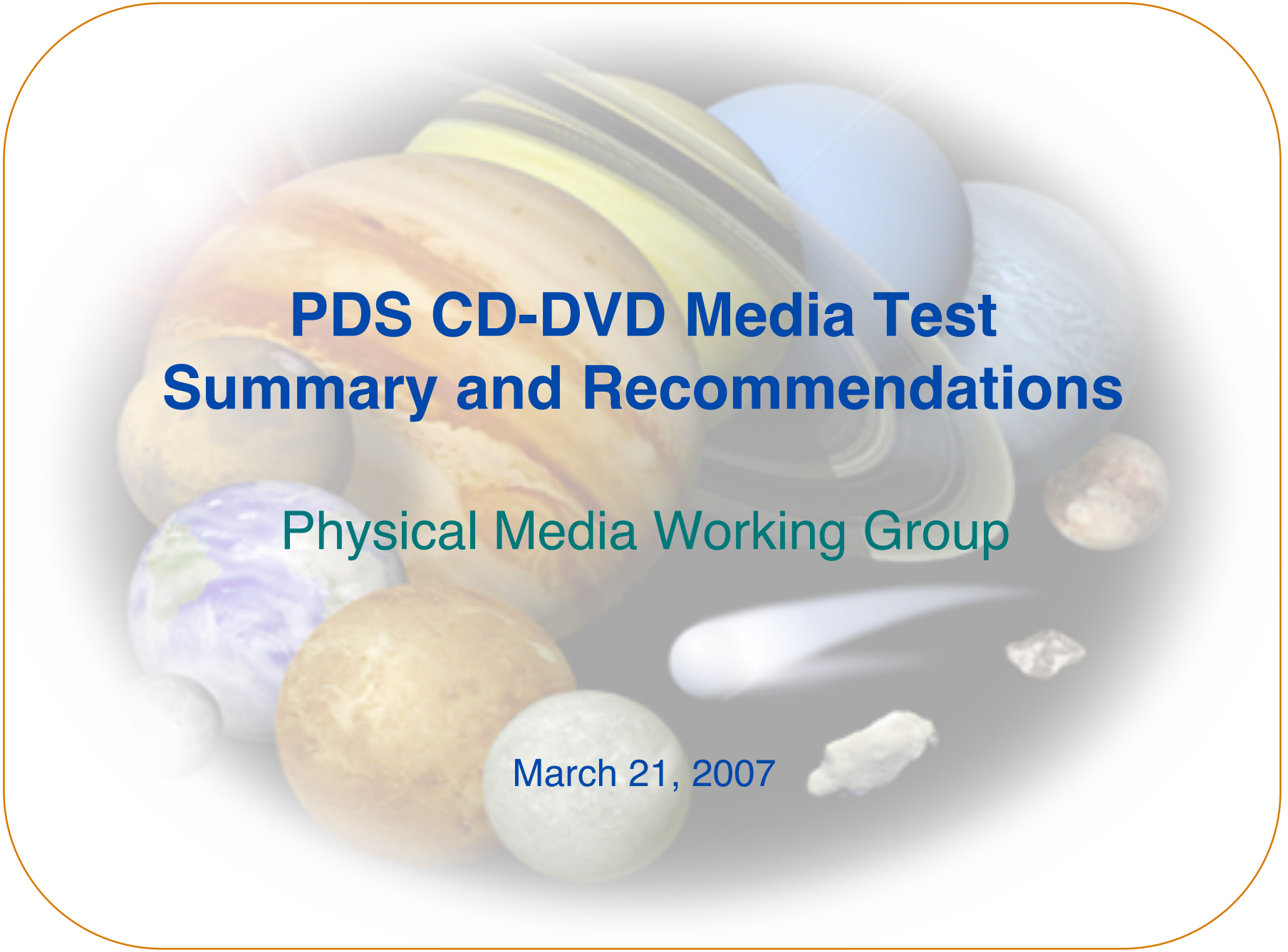


# PDS CD-DVD Media Test Summary and Recommendations

## Physical Media Working Group

March 21, 2007

# Topics

- Test Results
- Media Matrix
- Media Check and Migration
- Recommendations and Next Steps

# CD / DVD Testing (NIST / PPI)

- 21 Discs were scanned using a CD or DVD CATS device by the National Institute of Standards and Technology (NIST).
- Each disc was also tested using CD-DVD Speed program at the Planetary Plasma Interactions (PPI) Node.
- DVDDisaster was also used by Mike Martin to test the disks

| Disc | Media | Node | Volume | Size (MB) | Vendor | Recorder Model | Date | Label | Quality |
|---|---|---|---|---|---|---|---|---|---|
| 1 | CD | - USGS: | CD_PA060 | 534 | Mitsubishi | | 03-APR-00 | Surface | Good |
| 2 | CD | - GEO: | USA_NASA_PDS_MG_4564 | 676 | - | | 25-JUN-97 | Stick-on | Good |
| 3 | CD | - USGS: | USA_NASA_PDS_CL_4020 | 634 | Kodak Japan | | 24-Jan-00 | Surface | Good |
| 4 | DVD-R | - USGS: | USA_NASA_PDS_DMGSC_1017 | 906 | MCC/Verbatim | Pioneer DVR-104 | 01-APR-03 | Surface | Good |
| 5 | DVD-R | - SBN: | NIEROS_5001 | 761 | MCC/Verbatim | Pioneer DVR-103 | 15-JAN-04 | Stick-on | Flawed |
| 6 | DVD-R | - USGS: | USA_NASA_PDS_DMGSC_1018 | 4,251 | MCC/Verbatim | Pioneer DVR-104 | 01-OCT-03 | Surface | Marginal |
| 7 | CD | - SDDPT: | MGN SAR-EDR (MGN_0038) | 625 | Kodak (gold) | | 22-OCT-98 | Hub | Flawed |
| 8 | CD | - SDDPT: | VIKING LANDER (VL_1001) | 236 | Taiyo Yuden | | 03-MAY-95 | Hub | Good |
| 9 | CD | - SDDPT: | VIKING ORBITER (VO_1101) | 674 | Taiyo Yuden | | 12-JUN-95 | Hub | Scratched |
| 10 | DVD-R | - USGS: | USA_NASA_DMGSC_1016 | 3,807 | MCC/Verbatim | Pioneer DVR-104 | 01-APR-03 | Surface | Marginal |
| 11 | DVD-R | - SBN: | USA_NASA_PDS_NICRU1_3001 | 3,945 | MCC/Pioneer | Pioneer DVR-S201 | 10-SEP-02 | Handwriting | Flawed |
| 12 | CD | - SDDPT: | MGN SAR-EDR (MGN_0017) | 642 | Kodak (gold) | | 06-OCT-98 | Hub | Good |
| 13 | DVD+R | - USGS: | USA_NASA_PDS_DMGSC_1036 | 3,940 | PVCR | Pioneer DVR-103 | 01-0CT-04 | Stick-on | Flawed |
| 14 | DVD-R | - USGS: | LO3_HIGH_RES_V1 | 4,213 | MCC/Verbatim | Pioneer DVR-104 | 29-JUN-05 | Surface | Marginal |
| 15 | DVD-R | - USGS: | USA_NASA_PDS_DMGSC_1036 | 3,940 | MCC/Verbatim | Pioneer DVR-104 | 01-OCT-04 | Print on lacquer | Good |
| 16 | DVD-R | - PPI: | MGN_9001 | 2,876 | MCC/Pioneer | | 16-MAR-00 | Handwriting | Flawed |
| 17 | CD-ROM | - PPI: | USA_NASA_PDS_VG_1001 | 556 | - | | 08-JAN-03 | Surface | Good |
| 18 | DVD-ROM | - PPI: | USA_NASA_PDS_DMGSM_2001 | 4,227 | - | | 31-May-00 | Surface | Good |
| 19 | DVD-R | - PPI: | USA_NASA_PDS_CORPWS_0001 | 4,585 | PRINCO | Pioneer DVR-105 | 21-APR-05 | Stick-on | Flawed |
| 20 | CD | - PPI: | GOMA_3009 | 671 | CMC Magnetics | | 14-DEC-98 | Hub | Good |
| 21 | CD | - PPI: | HAL_0025 | 479 | CMC Magnetics | | 19-SEP-00 | Hub | Marginal |

# CD / DVD Test Environments

- NIST / Oliver Slattery
  - Expensive test devices for evaluating CD (CATS SA3) and DVD (DVD+R Pro and DVD-R Pro) physical parameters and disc quality.
    - Normally these devices are beyond the budget of end-users to procure and use.
- PPI / Bill Harris
  - The CD/DVD Speed program (a free program for Windows) was used on three different CD/DVD drives at various read speeds. It provides numerous tests including benchmark, disk quality, disk info and scandisc. It is widely used for testing CD/DVD recorder performance and media. The program is not well documented and we do not understand the interpretation of some tests.
- Tahoe/Mike Martin
  - The DVDDisaster program (a free program for Windows) was used to scan discs and check for read errors while also graphing the read speed
  - Windows Explorer was used to copy the contents of each disc to a hard drive

# Testing Process Conclusions

- CD-CATS
  - All discs fail the CD-CATS tests on one parameter or another.
  - Most of the discs tested show burst errors in the lead-in and lead-out areas which are artifacts of the recording process.
  - It would be nice to retest all the discs and skip the lead-in and lead-out areas, but would not be likely to change our conclusions.
- CD/DVD Speed
  - There is a great deal of variation in the scans done using the CD/DVD Speed program on different drives at different speeds.
  - We feel scans performed at 4x are useful for DVD quality analysis and should be used to do scans on newly created DVD volumes.
  - We need to do more research on CD scanning.
- DVDisaster
  - This is a useful tool for verifying disc readability and the location of errors for DVD's, but has some flaws testing CD's.

A simple disc copy can identify bad or marginal discs or gross mismatches between the drive and the media. A disc that can't be read on one drive can often be read on another drive

# Test Results

- Out of nine **CD-R**'s tested, six look stable. One is marginal and one is flawed and should be copied to new media. One disc appears to have been scratched somehow during the testing process.
- Out of nine **DVD-R**'s tested, two look stable. Three discs are marginal. Four discs show a similar error pattern which may indicate a recorder/media incompatibility (we believe they were all recorded on Pioneer recorders). We recommend testing more discs in these series and copying these volumes to new media.
- The one **DVD+R** that was tested was marginal with lots of errors near the end of the disc. Other discs in this series should be tested. The two pressed **CD-ROM**'s that were tested both looked good.

Despite difficulties with many discs, all the data was recoverable, however multiple readers had to be used to successfully copy all the discs

# CD / DVD Testing – Conclusions

- The discipline nodes are having problems recording DVD media and to a lesser extent CD media.
  - Half the nodes have trouble recording CD's and nine out of ten have trouble recording DVD's
  - Recording environment is different at every node (operating system, hardware, software and media)
- There are numerous issues in setting up a successful DVD or CD recording capability.
  - Recorder must be compatible with media
  - Recorder must utilize latest firmware
  - Software must record the proper format and optimal speed
  - Load on host system must allow successful recording
  - High quality media must be identified and used
  - Appropriate labelling techniques should be used
  - Testing must be carried out to identify if the media has been successfully recorded, NOTE: this requires more than standard “validation” which verifies that bytes were copied correctly

It will take a substantial effort to implement a successful distributed CD / DVD recording capability

–Evaluate and “certify” recorders, software, media, and recording process

## CD and DVD manufacturers are not all alike

- Taiyo Yuden manufactures CD and DVD media
  - This is the only manufacturer that would state in writing an estimated archive time of both their CD-R media and their DVDR media
    - DRDR media series == may exceed 50 years
    - CD-R media series == may exceed 100 years
  - There are counterfeit Brand name media being circulated with faked Media ID indicating it is of better quality
  - A good source for information on the quality of DVD media can be found at:
    - http://www.digitalfaq.com/media/dvdmedia.htm
  - A good (free) tool for revealing the Media ID is:
    - DVD Identifier (http://dvd.identifier.cdfreaks.com/)

**Purchase Brand Name (Taiyo Yuden) media from trusted vendors**

# Media Suitability Matrix

- The Media Suitability Matrix (MSM) delineates various attributes for media used either currently within the PDS or possibly in the near-future

| Technology Approach | Scal | Long | Cap | Viab | Obs | Rel | Sus | RF | EU | EB | AO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *CD-R (archival quality media)* | Med | High | Low | Med | High | High | High | Low | High | Med | High |
| *DVD-R (archival quality media)* | Med | High | Med | Med | Med | High | High | Med | Med | Med | High |
| *Hi-density DVD (HD and Blu-Ray)* | Med | Low | High | Med | Med | Med | High | Med | Med | Med | High |
| *Mass Storage (network accessible magnetic disk)* | High | High | High | High | High | Med | High | High | High | High | High |
| *Digital Linear Tape (DLT)* | High | Med | High | High | Med | Med | High | High | Low | Med | Low |
| *Digital Audio Tape (DAT)* | High | Low | High | Med | Low | Med | Med | Med | Low | Med | Low |

**Scal = Scalability**
**Long = Longevity**
**Cap = Capacity**
**Viab = Viability**
**Obs = Obsolescense**
**Rel = Reliability**

**Sus = Susceptibility**
**RF = Review Frequency**
**EU = Ease of Use**
**EB = Ease of Backup / Recovery**
**OA = Online Accessibilty**

# Media Archive Integrity Check Schedule

| | At Production | Monthly | 1 Year | Every 3 Years |
|---|---|---|---|---|
| CD-R | X | | X | X |
| DVD-R | X | | X | X |
| Mass Storage (online) | X | X | | |

- Based on review of policies at NARA, NIST and other archive programs
  - Many PDS DVDs would already have failed at the 1 year test
- Mass storage has the benefit of having integrity checking be automated (with some vendors integrating functional capabilities into the hardware)

Each node is responsible for periodically verifying the integrity of its archival holdings based on a schedule approved by the Management Council. Verification includes confirming that all files are accounted for, are not corrupted, and can be accessed regardless of the medium on which they are stored. Each node will report on its verification to the PDS Program Manager, who will report the results to the Management Council.

Planetary Data System Management Council Meeting, 29-30 November 2006.

# CD / DVD Testing – Recommendations

- Replace obsolete recorders and buy archive quality media
  - WG can work with nodes to help them determine reliability of their recorders
- Test additional media that appears to be problematic and migrate off problematic media (at nodes and NSSDC)
- Develop instructions for verifying media based on the “freeware” software that’s been used
  - Email and upload links and information to the PDS MC website
  - Store test data along with media information in the catalog
- Capture and retain media information about volumes and the media they are stored on
  - Add media type, recorder, record speed, media vendor to catalog
- Partner with other NASA efforts investigating storage (e.g., at the NSSDC meeting)

Detailed information about the results along with Mike Martin’s white paper have been uploaded to the PDS MC website.

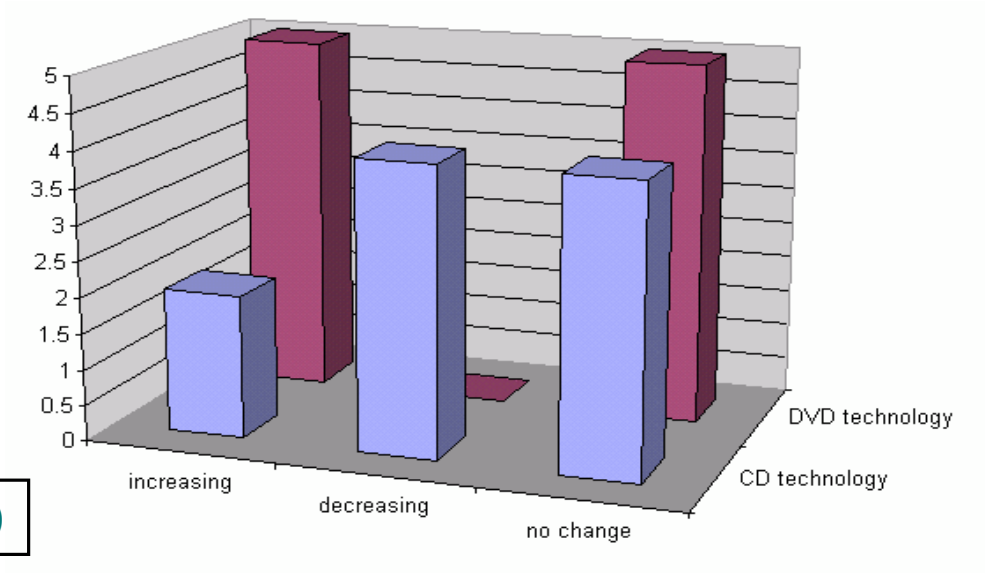
# Some Options for Future Archiving on Media

What's the MC technical roadmap?

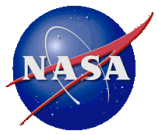
(1) – Develop and maintain distributed DVD and CD production capabilities on archive-quality media and writers for archiving on physical media

(2) – Develop and maintain a center-of-excellence for DVD and CD production at a subset of nodes (e.g., 1 or 2 nodes) for archiving on physical media

(3) – Move to mass storage for archiving (once production electronic delivery to NSSDC is in-place)




From Media Survey (Jun 2006)





# Backup Material

# Archive Media Cost Matrix

| Technology Approach | Drive Cost | Transfer Rate (MBPS) | Media Cost | Media Capacity (GB) | Media Cost (GB) | Notes |
|---|---|---|---|---|---|---|
| *CD-R (archival quality media)* | *$0* | *3.6* | *$0.50* | *0.6* | *$0.83* | 24X |
| *DVD-R (archival quality media)* | *$100* | *10.5* | *$2.00* | *4.7* | *$0.43* | 8X |
| *Hi-density DVD (HD and Blu-Ray)* | *$800* | *36* | *$18.00* | *25* | *$0.72* | Blu-Ray |
| *Magneto-Optic* | *$540* | *25* | *$50* | *35* | *$1.43* | Iomega 32961 |
| *Mass Storage (network accessible magnetic disk)* | *$100* | *50* | *$100* | *250* | *$0.40* | |
| *Digital Linear Tape (DLT)* | *$3,000* | *32* | *$85* | *320* | *$0.27* | SuperDLT II |
| *Digital Audio Tape (DAT)* | *$800* | *2.4* | *$6.00* | *20* | *$0.30* | DDS-4 |

# Data Transfer Matrix - Definitions

| | |
|---|---|
| 1. Scalability: | A measure of the ease with which the user can expand and contract its resource pool to accommodate heavier or lighter loads.<br><br>Low = not scalable; High = highly scalable |
| 2. Longevity: | A measure of the expected duration in which the resource will retain its integrity. The media should have a proven life span of at least 10 years. Greater longevity is not necessarily an advantage, since obsolescence of technologies usually preceeds physical deterioration of the storage medium.<br><br>Low = predicted to have limited longevity; High = predicted to have high longevity |
| 3. Capacity: | A measure of the amount of data the resource can retain. The media should provide a storage capacity appropriate<br>for the quantity of data to be stored, and the physical size of the storage facilities available. Minimizing the number of actual media to be managed will usually create efficiencies and resource savings.<br><br>Low = low data capacity ; High = high data capacity |
| 4. Viability: | A measure of the likelihood that the resource will remain viable. The media and drives should support robust error-detection methods for both reading and writing data. Provision for testing the integrity of media after writing is also a benefit. Proven data recovery techniques should also be available in case of data loss.<br>Media should be write-once, or have a reliable write-protected mechanism, to prevent accidental erasure and maintain the evidential integrity of the data.<br><br>Low = predicted to have low viability; High = predicted to have high viability |
| 5. Obsolescence: | A measure of the likelihood that the resource will "survive" today's rapidly evolving technical environment. The media and its supporting hardware and software should preferably be based on mature, rather than leading-edge technology, and should be well established in the market place and widely available. Media technologies which are based upon open standards for both media and drives should generally be preferred to those which are proprietary to a single manufacturer.<br><br>Low = prone to rapid obsolescence; High = prone to long term obsolescence |
| 6. Reliability: | A measure of the ability of the media and drives to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances.<br><br>Low = has reliability issues; High = highly reliable |

# Data Transfer Matrix – Definitions (cont'd)

| | |
|---|---|
| 7. Susceptibility | A measure of the media's ability to be tolerant of outside influences. The media should have a low susceptibility to physical damage, and be tolerant of a wide range of environmental conditions without data loss. Magnetic media should be able to minimize the chances of erasure. Any measures required to counter known susceptibilities (such as packaging or storage requirements) should be affordable and achievable.<br><br>Low = prone to being susceptible; High = tolerant of susceptible influences |
| 8. Review Frequency: | A measure of how frequently the media should be reviewed / tested for degradation / loss of data.<br><br>Low = review frequently; High = review infrequently |
| 9. Easy of Use: | A measure of how easily users can employ a particular tool or process in order to achieve a particular goal. Ease of use also refers to the methods of measuring usability and the study of the principles behind an object's perceived efficiency or elegance.<br><br>Low = not so easy to use; Hugh = easy to use |
| 10. Ease of Backup / Recovery: | A measure of how easily users can employ the media and drives for the specific purpose of backup and recovery.<br><br>Low = not so easy to use; High = easy to use |
| 11. Online Accessibility: | A measure of how suitable the media is for providing online access of the data. The media and drives should support access by as many people as possible in a timely manner and without a degradation of performance.<br><br>Low = not suitable; High = suitable |

# Media Suitability Matrix (cont'd)

- The pros & cons of each media used either currently within the PDS or possibly in the near-future

| Technology Approach | Drive Cost | Media Cost (GB) | Pro / Con |
|---|---|---|---|
| *CD-R (archival quality media)* | $0 | $0.83 | + *recorder available on nearly all computers*<br>- data volume too low |
| *DVD-R (archival quality media)* | $100 | $0.43 | + *reader available on most computers*<br>- data volume limiting factor |
| *Hi-density DVD (HD and Blu-Ray)* | $800 | $0.72 | + *media prices should come down*<br>- *competing formats, immature* |
| *Mass Storage (network accessible magnetic disk)* | $100 | $0.40 | + pervasive and easy to use<br>- |
| *Digital Linear Tape (DLT)* | $3,000 | $0.27 | + *very high storage capacity*<br>- costly drives |
| *Digital Audio Tape (DAT)* | $800 | $0.30 | + *leader in automated backup*<br>- not a popular vehicle for archiving |