The Digital Curation Centre Experience

(Science data & CCLRC experience)
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Outline

• Science data characteristics
• CCLRC experience
• Costs
• Benefits
• Trends
• Conclusions
Science Data Characteristics

- Mostly numbers – objects often complex and interrelated
- Representation not Presentation
  - Not just to be looked at by humans (i.e. emulation of associated software usually not enough)
- Often needs processing
  - Different levels of processing & trends of access
  - On-the-fly processing from raw
- Often freely available (e.g. after 1 year)
- Often large volumes
  - Automated systems
- Unforgiving
  - Need to beware of “junk” science
- Needs to be usable in current tools (i.e. emulation is not enough)
CCLRC Recent New Users & Potential New Users

- National Crystallography Service, Southampton University (2 TB/yr)
- VIRGO Consortium (3 TB/yr?)
- Integrative Biology (15 TB/yr?)
- WASP (Astronomy) (30 TB/yr?)
- BBSRC ? (50 TB/yr?)
- Diamond (1 PB/yr?)
- GRID-PP (1 PB/yr)
Data Growth per period

Tbytes

## Expected future demand

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LHC bandwidth (MB/sec)</strong></td>
<td>50</td>
<td>250</td>
<td>400</td>
<td>600</td>
</tr>
<tr>
<td><strong>LHC data volume (PB)</strong></td>
<td>0.3</td>
<td>0.6</td>
<td>1.2</td>
<td>3.4</td>
</tr>
<tr>
<td><strong>Diamond (data volume (PB))</strong></td>
<td>0</td>
<td>0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>CCLRC (data volume (PB))</strong></td>
<td>0.2</td>
<td>0.5</td>
<td>0.7</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>External</strong></td>
<td>0.05</td>
<td>0.10</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td><strong>Total (PB)</strong></td>
<td><strong>0.55</strong></td>
<td><strong>1.2</strong></td>
<td><strong>3.1</strong></td>
<td><strong>5.6</strong></td>
</tr>
</tbody>
</table>
Atlas Storage: Predicted Demand (TB)

Upper bound data volume (TB)

Lower bound data volume (TB)

Graph showing predicted data volume for the years 2003 to 2006, with a linear increase in demand.
Capacity & performance - Hardware

- Hardware
  - Defines both performance and capacity
  - Changing fast but well understood; (buy as late as possible)
  - Tied into technology futures of manufacturers and HEP community;
  - Currently hardware is effectively “infinitely” scalable
- Future estimated storage capacity & bandwidth for a 6000 slot robot:

<table>
<thead>
<tr>
<th>Year</th>
<th>2003/04</th>
<th>2006/7</th>
<th>2008/9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>9940B</td>
<td>Titanium 1</td>
<td>Titanium2</td>
</tr>
<tr>
<td>Tape capacity</td>
<td>200GB</td>
<td>500 GB</td>
<td>1000 GB</td>
</tr>
<tr>
<td>Bandwidth (MB/sec)</td>
<td>30 - 40</td>
<td>80 -100</td>
<td>~200</td>
</tr>
<tr>
<td>Capacity (PB)</td>
<td>1.2 PB</td>
<td>3PB</td>
<td>6PB</td>
</tr>
</tbody>
</table>
Data Growth

- world area of 3m+ (sq.m.)
- largest detectors (Mpix)

- observatory archives growing as detectors grow
- VISTA will have a Gpixel array
Tape Drive Performance as a Function of File Size

![Graph showing Tape Drive Performance as a Function of File Size]
Types of costs

- Captures costs
- Storage costs
- Maintenance costs
- Access/Dissemination costs
- Total cost of ownership
Trends

- 1986 disk 5MB/£250 = 20KB/£
- 1994 disk/DAT 3GB/£3K = 1MB/£
- 1995 disk 420MB/£40 = 10MB/£
- 1998 disk 5GB/£250 = 20MB/£
- 2004 disk 60GB/£60 = 1000MB/£

Doubles every year

» Data from Byte new products
The expected cost of the Atomic Holographic DVR disc drive will be from $570 to $750 with the replacement discs for $45.

One 10 terabyte to 100 terabyte 3.5 in FEdisk
Issues

- System changes
- Collection migration to new systems
  - Descriptive Information
  - Finding Aids
Consideration of service quality

- bit preservation
- currently aiming to be self funding
- aim to cover costs only
- lower storage costs are dependant on increased usage
- increased usage is hard to predict
- current charge of £1k/Tb/yr
Costs and charging

- **H/W Costs**
  - Total ~ £1m every 4-5 years, equiv to ~ £250K/yr
  - H/W upgrades are costly – installation, configuration, test; and associated data migration - many months
  - Example component costs:
    - Robot (6000 slots) ~ £300K
    - Media £420K (@ £70 per unit)
    - Disk ~ 1.5K/TB? ~ £50K for 75TB commodity?
    - Tape drives £20K each. (est. T1s and T2s) Total ~ £200K for 10
    - Data Servers:
      - Linux: £3K each. Total ~ £30K for 10
      - AIX: £14K each. Total ~ £140K for 10
    - Network/switches ~ £50K
  - Numbers are the Key to flexible performance – esp. data servers and tape drives.

- **S/W Costs** – Currently limited to staff development costs
- **Staff 2.5 FTE:** system manager + system developer + 0.5 operations staff
ADS Running Costs 04/05. (Option 1).

- Staff costs: 66%
- Hardware: 15%
- Network: 0%
- Other: 5%
- S/W maintenance: 3%
- H/W maintenance: 11%
SRB-ADS architecture

SRB MCAT Database
SRB MCAT Server
SRB Disk Server (Local Server)
SRB Client

Atlas Data Store
SRB ADS Server

Port 5600
Port 5601
Port 5602

SRB-ISIS server instance
SRB-BADC server instance
SRB-CCLRC server instance

DCC/DPC Workshop on Cost Models for preserving digital assets
26 July 2005
Digital | Curation | Centre
Functional Diagram of BADC/APS
OAIS Functional Model

Preservation Planning

Ingest

Data Management

Archival Storage

Access

Descriptive Info

Descriptive Info

queries

result sets

orders

SIP

AIP

AIP

DIP

MANAGEMENT

PRODUCER

CONSUMER

CONSUMER

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BADC mapped to OAIS
Space Missions - special features

- Space missions are very expensive (100’s of Millions of dollars/euros)
  - Specialised hardware and software
- Information if usually the only thing left after the mission
- Data Exploitation costs are usually small
Costs of Preparation

- **IUE Final Archive**
  - IUE launched in 1978
  - Early example of long-term preservation
    - 12 years after launch
  - New processing algorithms
  - New products
    - Trends in access
  - New Formats
  - Translation of telemetry
  - Dictionaries for keywords in header
  - Capture of hand-written Observer logs
  - New catalogues
Cost Sharing

- Shared archival storage – economies of scale
- Shared discovery/access
- Shared Preservation Planning
  - Technology watch
  - Representation Information – Registries
    - Abstraction and virtualisation
    - Automated migration
  - Preservation Description Information - tools
- Bring benefits forward
  - Curation
  - Interoperability
    - Distance in discipline is like Distance in time
Metrics for Benefits

- National/organisational pride
- Scientific
  - Number of references
  - Number of publications
  - Number of requests
- Financial
  - Sale of data
  - Investment in information systems
- Legal
  - Avoid penalties
large fraction of astro-papers based on archives
HST archive use growing faster than archive

Already more retrieval than ingest!
Conclusions

• Preservation costs of any item:
  – Storage costs of the bits will fall
  – Migration can be automated (and done on request)
  – Costs to keep information usable (as in OAIS) could grow but can be shared
    • Sharing nationally and internationally

• Ingest costs can be reduced by forward planning by/agreements with producers

• Benefits can be brought forward
  – Link to widening Interoperability

• Benefits must be measured