The Digital Curation Centre Experience

(Science data & CCLRC experience)

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Outline

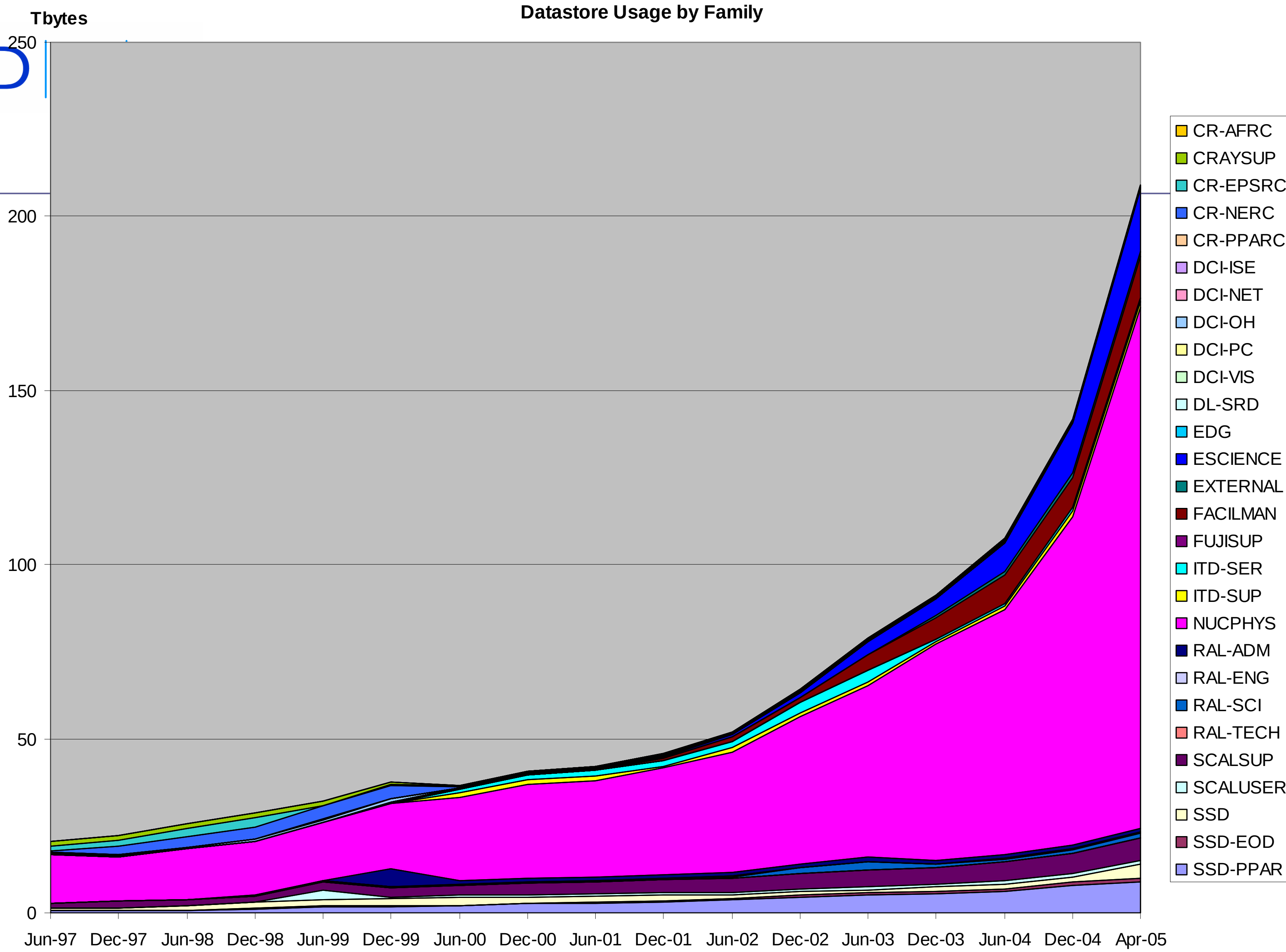
- Science data characteristics
- CCLRC experience
- Costs
- Benefits
- Trends
- Conclusions

Science Data Characteristics

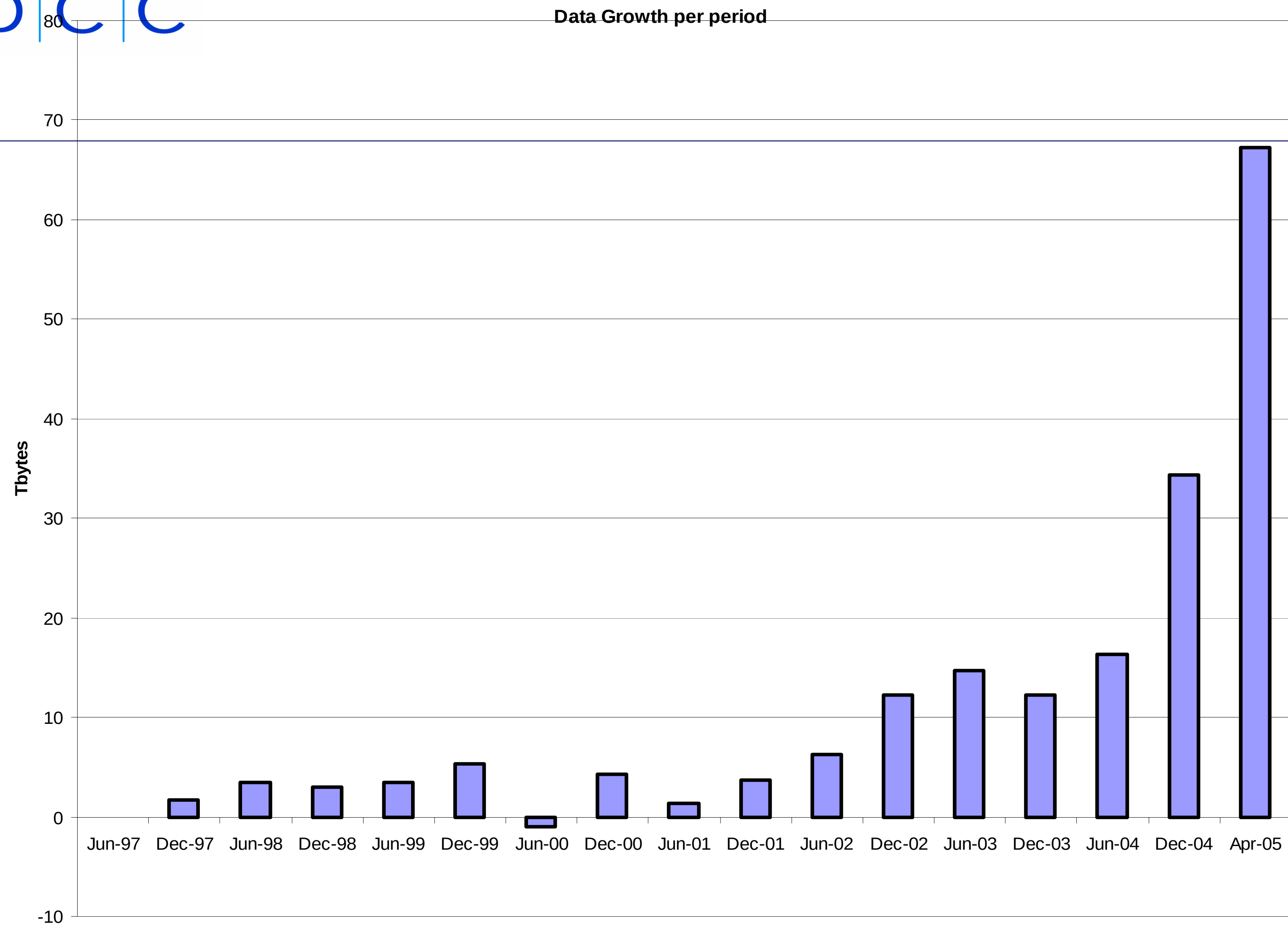
- Mostly numbers – objects often complex and interrelated
- Representation not Presentation
  - Not just to be looked at by humans (i.e. emulation of associated software usually not enough)
- Often needs processing
  - Different levels of processing & trends of access
  - On-the-fly processing from raw
- 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) (30TB/yr?)
- BBSRC ? (50 TB/yr?)
- Diamond (1 PB/yr?)
- GRID-PP (1 PB/yr)



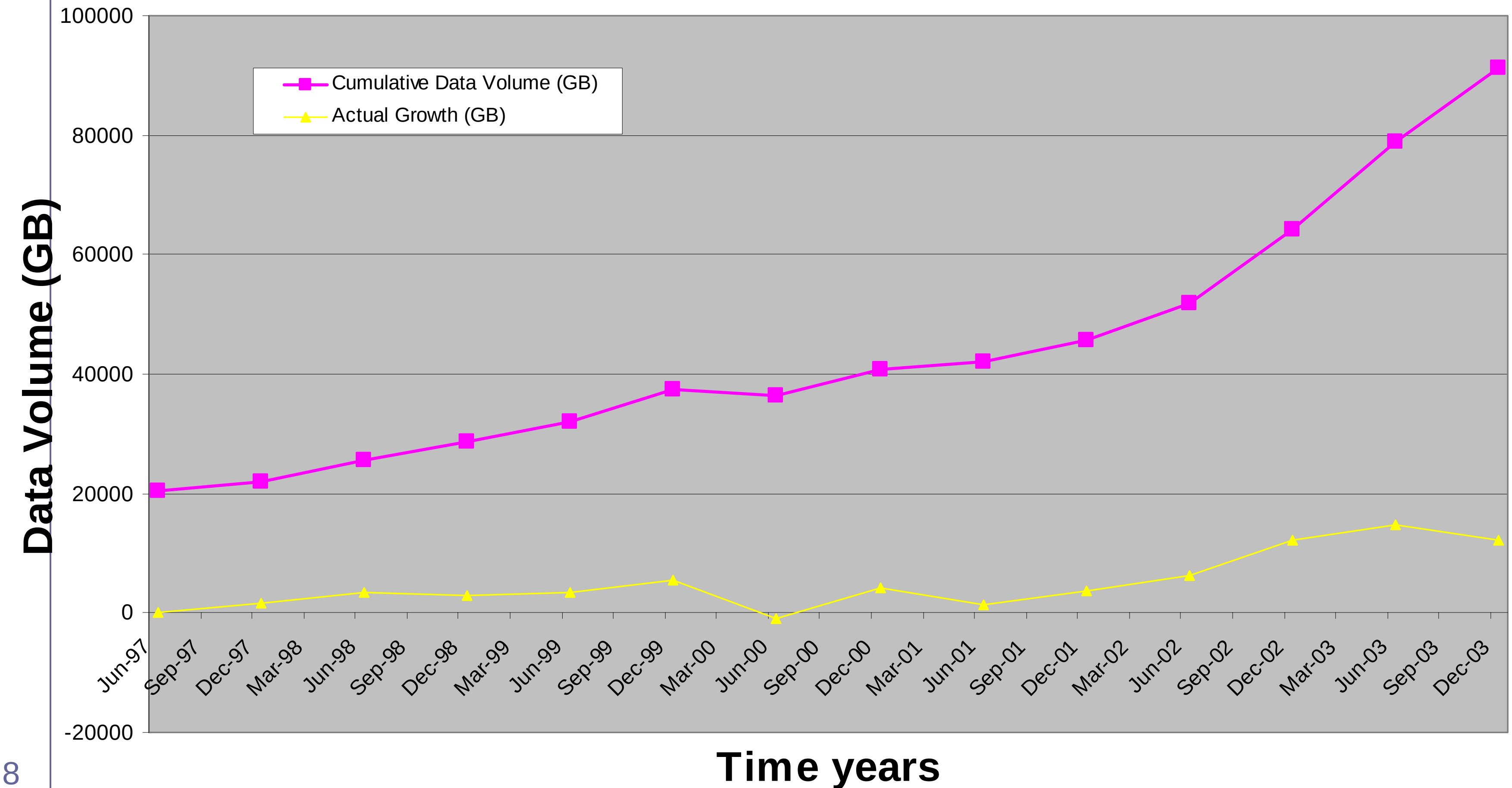
Datastore Usage by Family
Tbytes
250
200
150
100
50
0
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Apr-05
CR-AFRC
CRAYSUP
CR-EPSRC
CR-NERC
CR-PPARC
DCI-ISE
DCI-NET
DCI-OH
DCI-PC
DCI-VIS
DL-SRD
EDG
ESCIENCE
EXTERNAL
FACILMAN
FUJISUP
ITD-SER
ITD-SUP
NUCPHYS
RAL-ADM
RAL-ENG
RAL-SCI
RAL-TECH
SCALSUP
SCALUSER
SSD
SSD-EOD
SSD-PPAR


Data Growth per period
Tbytes
80
70
60
50
40
30
20
10
0
-10
Jun-97
Dec-97
Jun-98
Dec-98
Jun-99
Dec-99
Jun-00
Dec-00
Jun-01
Dec-01
Jun-02
Dec-02
Jun-03
Dec-03
Jun-04
Dec-04
Apr-05

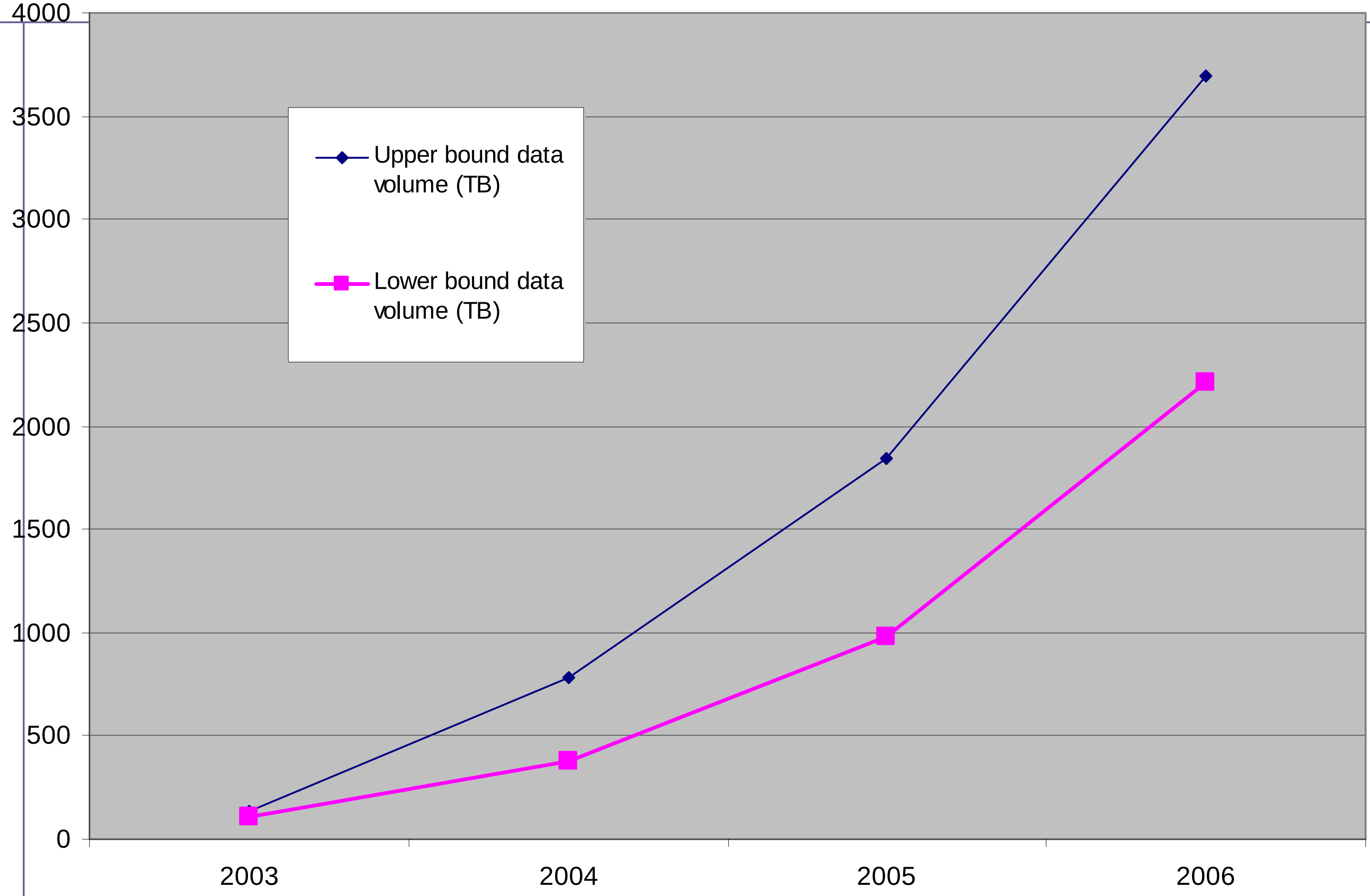
Expected future demand

Year	2005	2006	2007	2008
LHC bandwidth (MB/sec)	50	250	400	600
LHC data volume (PB)	0.3	0.6	1.2	3.4
Diamond (data volume (PB)	0	0	1.0	1.0
CCLRC (data volume PB)	0.2	0.5	0.7	1.0
External	0.05	0.10	0.2	0.2
Total (PB)	***0.55***	***1.2***	***3.1***	***5.6***

Actual Growth 1997-2003



Atlas Storage: Predicted Demand (TB)

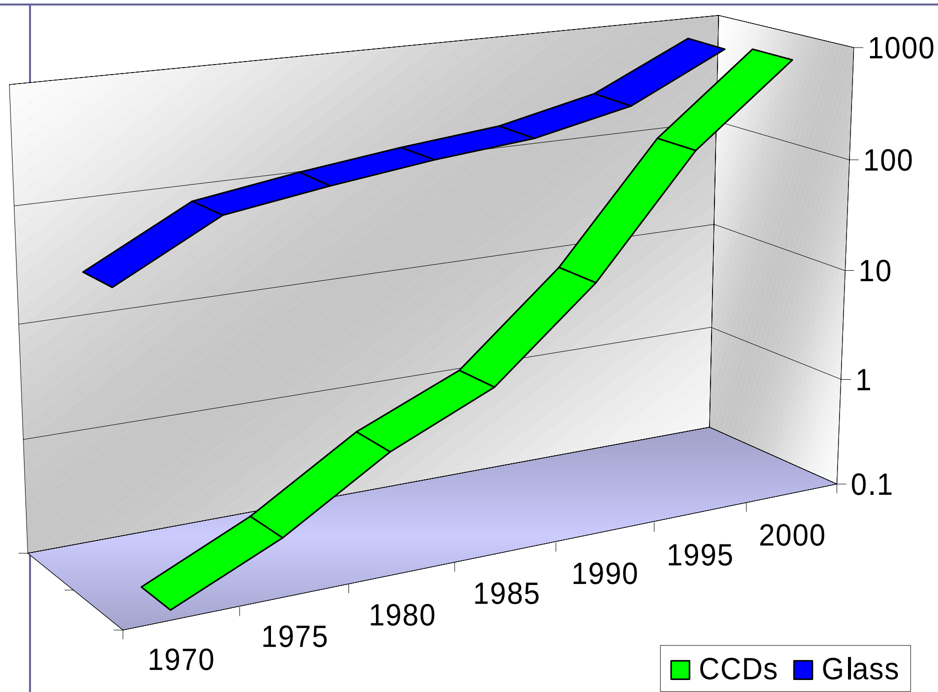


Capacity & performance - Hardware

- 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:

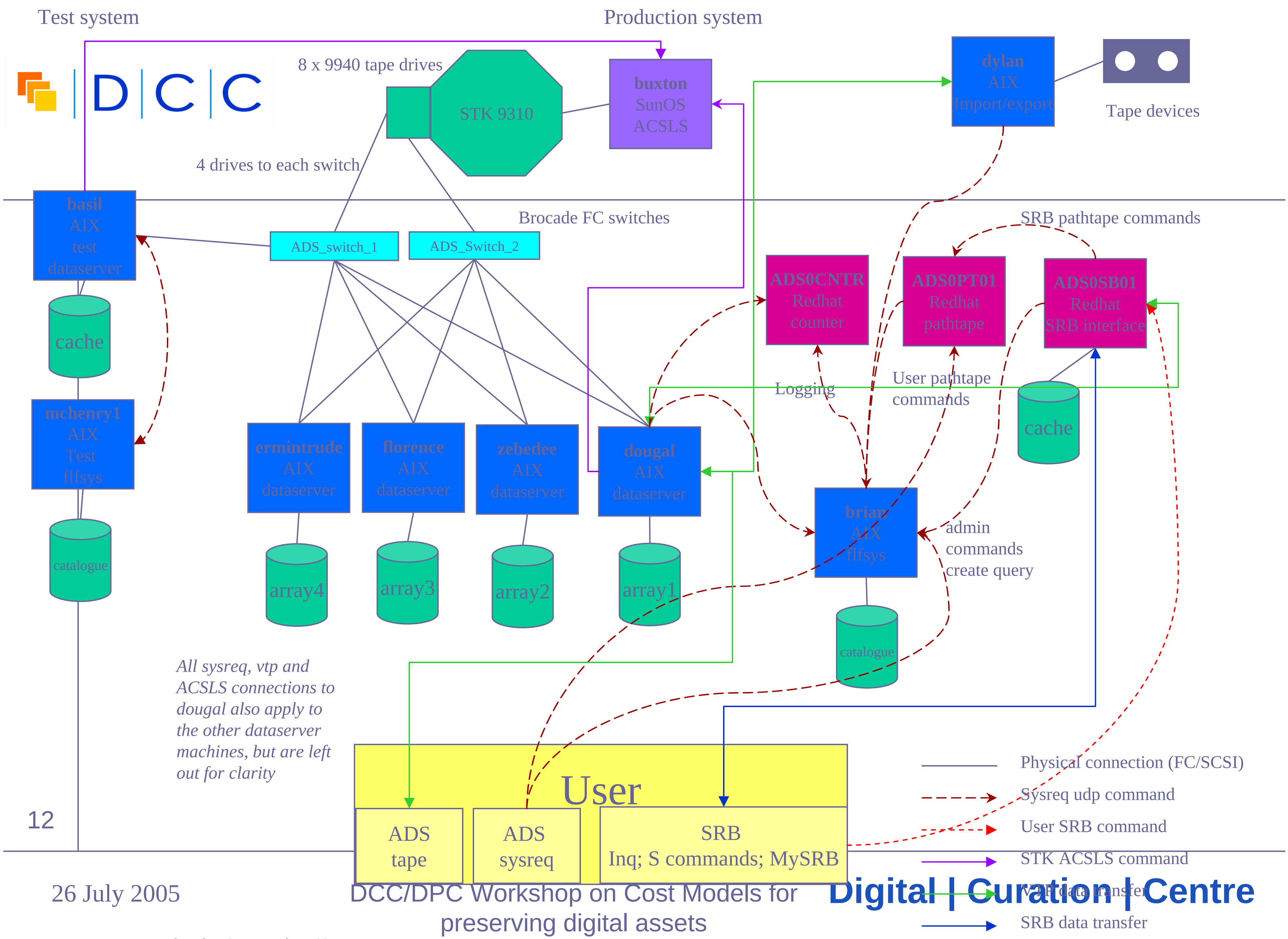
Year	2003/04	2006/7	2008/9
Technology	9940B	Titanium 1	Titanium2
Tape capacity	200GB	500 GB	1000 GB
Bandwidth (MB/sec)	30 - 40	80 -100	~200
Capacity (PB)	1.2 PB	3PB	6PB

Data Growth



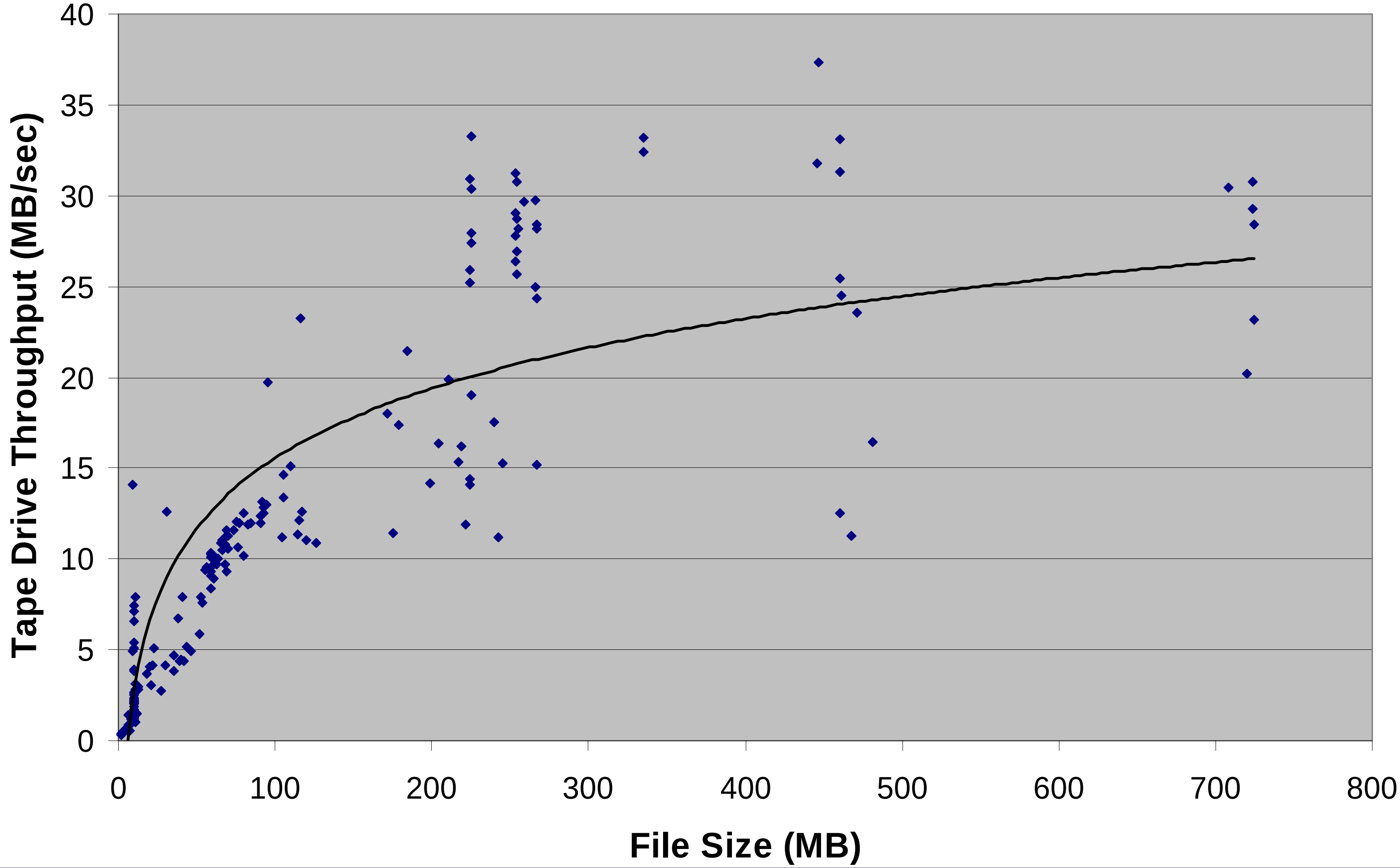
- world area of 3m+ (sq.m.)
- largest detectors (Mpix)

- observatory archives growing as detectors grow
- VISTA will have a Gpixel array



Test system
Production system
8 x 9940 tape drives
STK 9310
buxton
SunOS
ACSLS
dylan
AIX
Import/export
Tape devices
4 drives to each switch
basil
AIX
test
dataserver
Brocade FC switches
ADS_switch_1
ADS_Switch_2
SRB pathtape commands
ADS0CNTR
Redhat
counter
ADS0PT01
Redhat
pathtape
ADS0SB01
Redhat
SRB interface
cache
mchenry1
AIX
Test
flfsys
ermintrude
AIX
dataserver
florence
AIX
dataserver
zebedee
AIX
dataserver
dougal
AIX
dataserver
Logging
User pathtape
commands
cache
brian
AIX
flfsys
admin
commands
create query
catalogue
array4
array3
array2
array1
catalogue
All sysreq, vtp and
ACSLS connections to
dougal also apply to
the other dataserver
machines, but are left
out for clarity
User
ADS
tape
ADS
sysreq
SRB
Inq; S commands; MySRB
Physical connection (FC/SCSI)
Sysreq udp command
User SRB command
STK ACSLS command
VTP data transfer
SRB data transfer

Tape Drive Performance as a Function of File Size



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Types of costs

- Captures costs
- Storage costs
- Maintenance costs
- Access/Dissemination costs

- Total cost of ownership

Trends

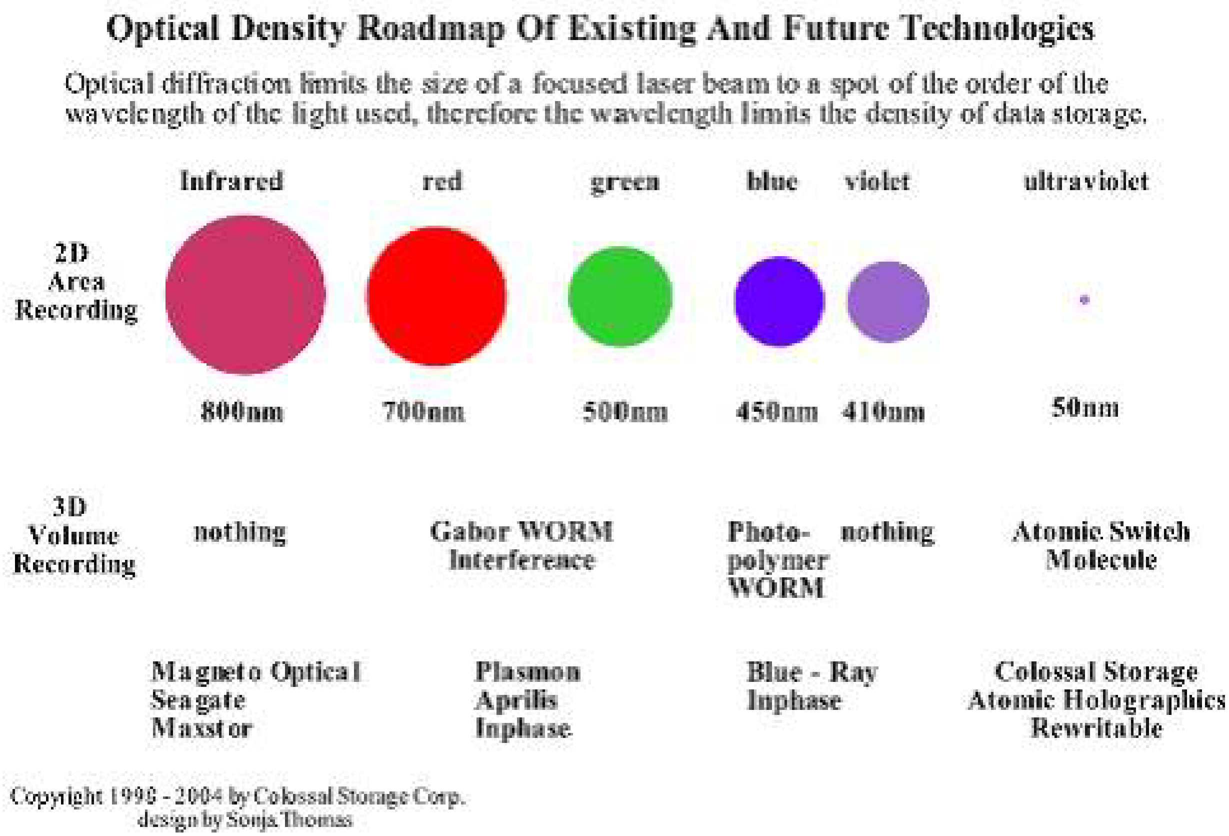
- 1986 disk 5MB/£250 = 20KB/£
- 1994 disk/DAT 3GB/£3K = 1MB/£
- 1995 disk 420MB/£40 = 10MB/£
- 1998 disk 5GB/£250 = 20MB/£
- 2004 disk 60GB/£60 = 1000MB/£

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

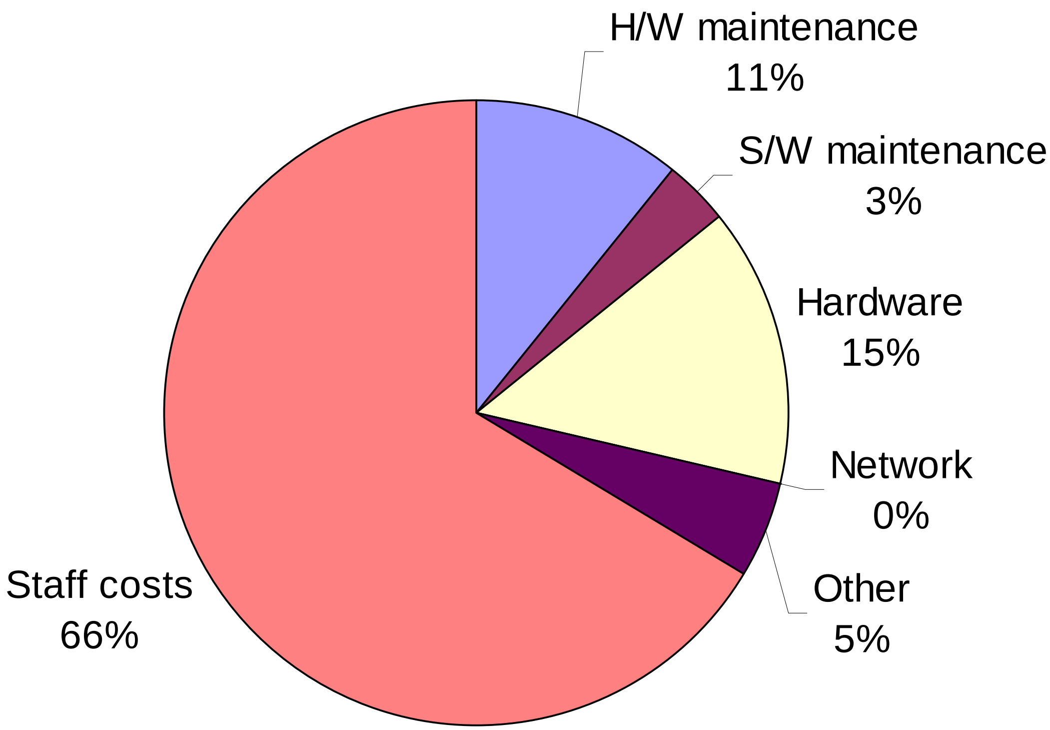
Consideration of service quality

- 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

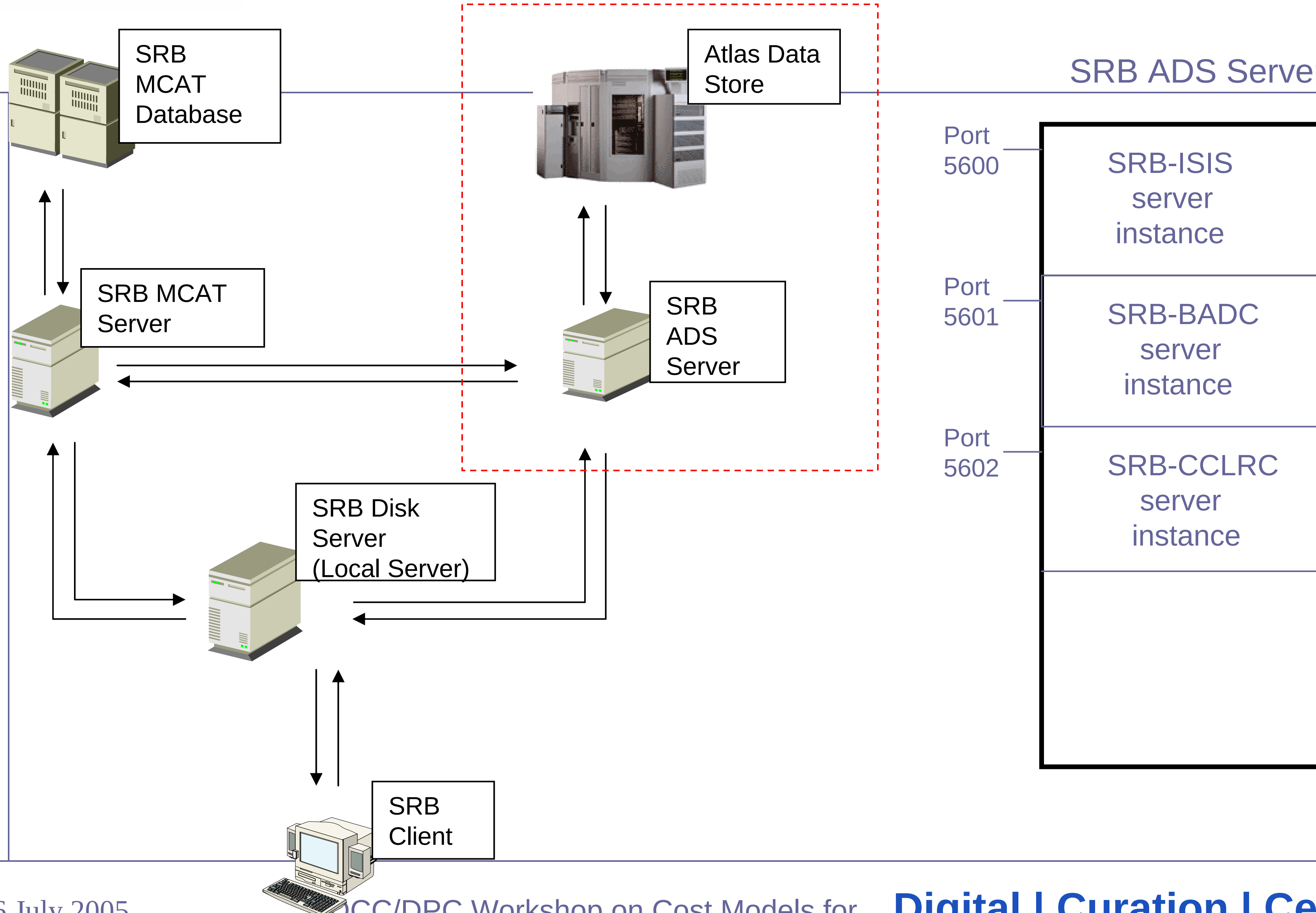
Costs and charging

- 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

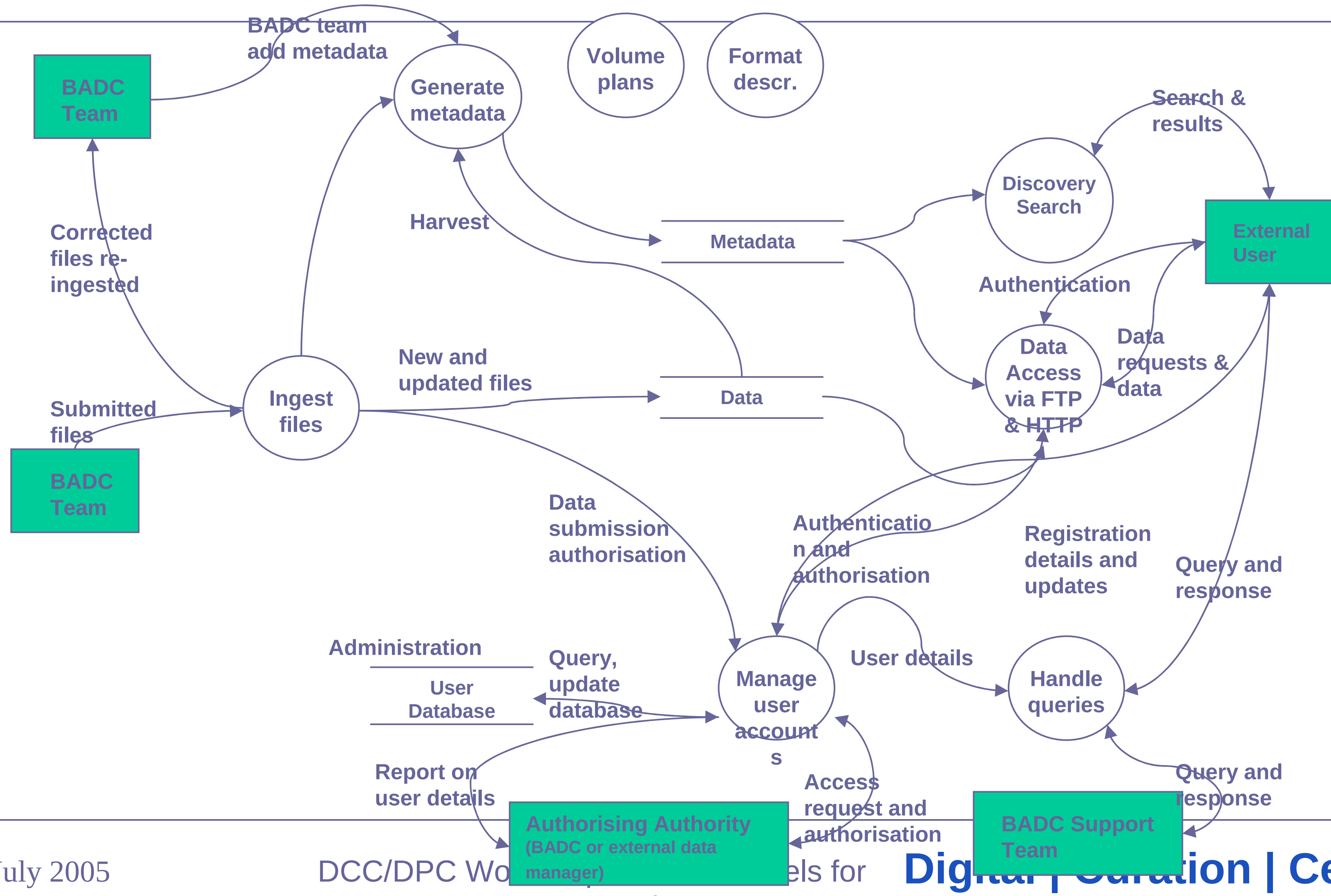
ADS Running Costs 04/05. (Option 1).



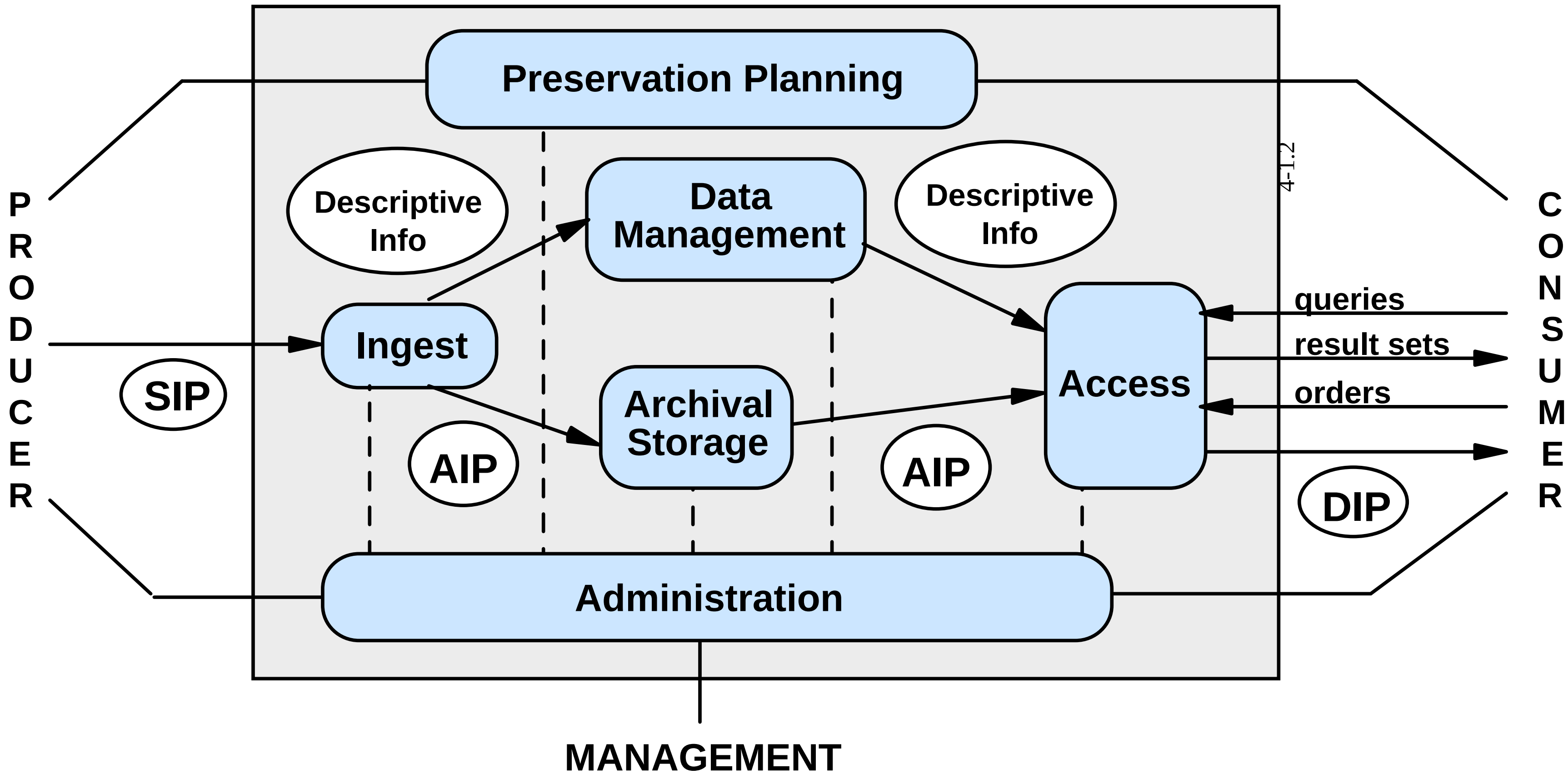
SRB-ADS architecture



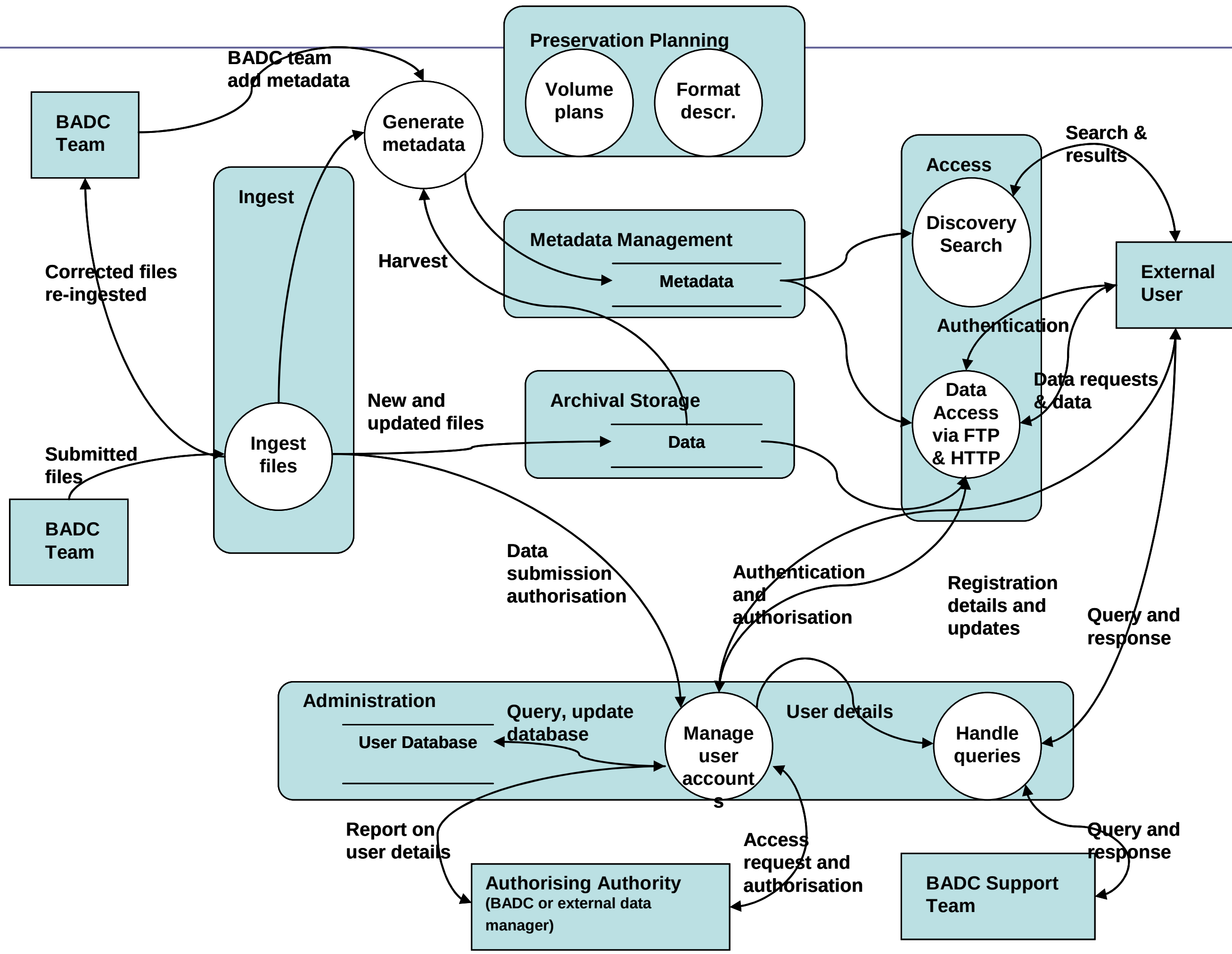
Functional Diagram of BADC/APS



OAIS Functional Model



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

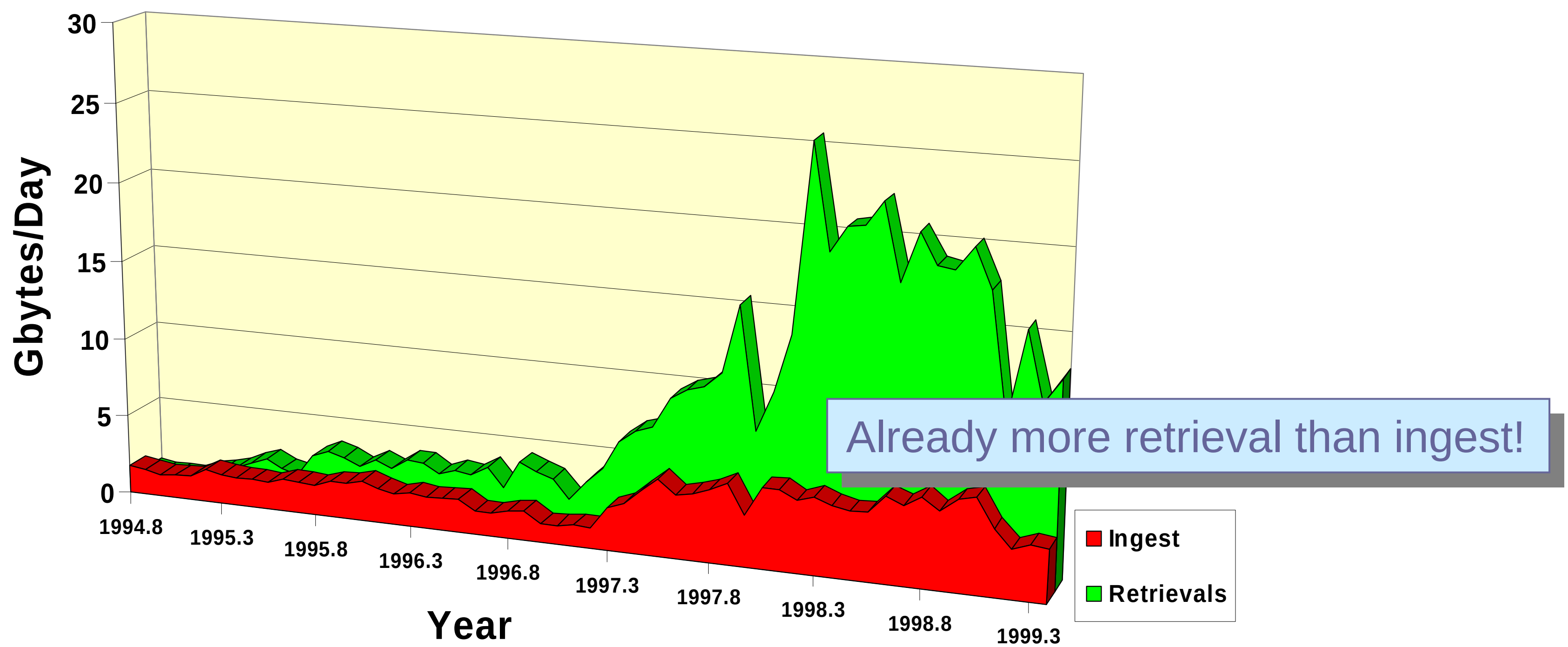
- Shared archival storage – economies of scale
- Shared discovery/access
- Shared Preservation Planning
  - Technology watch
  - Representation Information – Registries
    - Abstraction and virtualisation
    - Automated migration
  - Preservation Description Information - tools
- Bring benefits forward
  - 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

Archive Research

- large fraction of astro-papers based on archives
- HST archive use growing faster than archive



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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