Data Preservation – Storage Systems

successful archives...

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decreasing lifetime

clay and stone

- very low density (few 100 bytes per sqm)
- slow
- natural language

paper

- higher density
- not as resistent as previous material
- natural language

microfilm

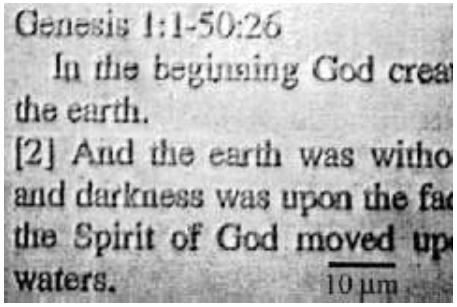
increasing density

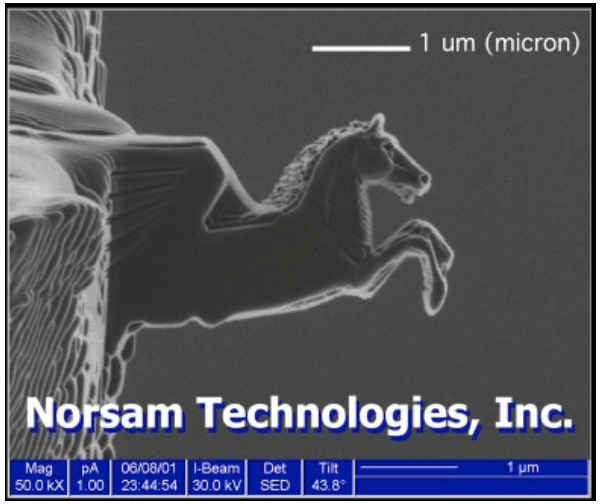
key attributes for classical long term archival

- natural language
- readable with ‘inbuild’ tools (i.e. eyes)
- low abrasive/durable media (i.e stone)

modern ‘classical archive’

- ION Beam based modelation of ‘very stable’ materials (i.e. gold plated silicon, stainless steel)
  - very high density (>20Gbit/sqin)
  - different formats/densities
    - binary, picture
  - good for >1000years !
  - store all
    - data + source of OS
    - C-Lang Books etc.





applicable to our ‘preservation’ question ?

- write once – stay forever model
  - deep archive – applicable ?
- data can be copied without information loss
  - no historical (original) objects i.e. documents
  - preserving
    - correlation with metadata (system and user)
    - authenticity
    - integrity
    - ...

digital archives

“Preservation is the process of migrating a digital entity forward in time while preserving its authenticity and integrity”

InterPARES Project

- **endless migrating archives works, if**
  - **next generation has half media costs (€/GB)**
  - **automated library slots stay at similar costs**
  - **all media is robot managed (labour costs)**
  - **migration time ~1 year**
  - **sequential bandwidth of storage devices keeps at reasonable rate compared to capacity**

activities - others

- several projects/orgs worldwide working on ‘digital data preservation systems’
  - InterPARES
  - NARA
  - CASPAR
  - DCC
  - .....
- standards
  - OAIS - Open Archival Information System Reference Model

what we have done...

- since today
  - just store the data as long as possible
    - mainly determined by available money and requirement
  - we have no active readable data from pre HERA Experiments !
    - probably some private ‘unverified’ copies
  - first HERA data is already copied 3 times (on different tape/interface/protocol technologies)
    - motivated by
      - its active data – not an archive
      - its funded – somebody exists who want that happened !
        - » no ‘last will’ expressed yet

storage technology

- what is driving us
  - no longer technology driven
    - last ‘singular/unique’ system was bought 15 years ago !
  - we are now market driven (commodity technology)
    - use what most others are using
      - mostly driven by costs
    - longer support times
    - less operational costs
    - not always a ‘perfect fit’ to problem
    - always best solution at the end of the day

storage technology, contd.

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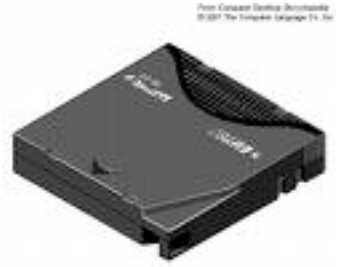
- Disks
  - good for 3-5 years
  - double capacity every 18-28 months
  - bandwidth grows with lower rate
  - rarely used for archive purposes
    - beside power, no real reason
    - still (only !) 1.5-3 times more expensive than tape
      - but much faster !

- market will drive future developments
- comparable area density 600 vs. 615 TB/m^2

Disk vs. automated Tape (Robotics)

storage technology, contd.



- Tape
  - market situation not as clear as for disks
    - regular ‘death predictions’ for tapes
  - predictable capacity/performance developments
    - x2 capacity every 20-36 months
    - slower growth rate for the bandwidth !
- media life
  - 12% signal reduction in 14 years !
  - at least good for 5 – 7 years
- successful read 12 year old media

storage technology, contd.

- Storage Class Memory/SSD (flash ...)
  - very reliable (better than tape & disk)
  - higher costs (~ x20) to disk
    - but coming down fast
  - less power than disk (x10 less)
  - getting higher density than disks (footprint)
    - based on conventional form factors (i.e. 3.5”, 2.5” disks)
    - expected this year

example – tape archive

- lets plan a tape based archive (10K Slots)
  - assume
    - lifetime of robotics – 10 years
    - lifetime of spec. tape technology (5 years)
    - costs per robot slot did not change
    - costs per cartridge did not change
    - next generation of tape technology has min. x2 capacity and min. 30% bandwidth increase
    - copy period no longer than 1 year
      - both drive technologies present

media costs

- double capacity, same unit costs
  - 1 + ½ + ¼ + ⅛ ..... = 2
- double the current media costs – thats good for the rest of the universe

robotics + drives

- 10 years invest + maintenance
  - ~60 € per slot for 10 years

- with todays LTO4 technology
  - could copy 1PB with one drive per year
    - assume 70K seconds effective copy time
    - with 50 MB/sec effective copy bandwidth
      - 25 MB/sec are todays (careful) assumption
  - results in ~10 drives
    - ~30 € per slot for 10 years

in total

- need always half the slots for each new tape generation
  - same rule as for the media (just double)
- starting with LTO4
  - ~375 € per TB (forever)
- labour costs ! ~ 1FTE per 10PB archive
- other sites reports (for 2004) total tape costs (including all) of ~$300 per TB per year

availability

- model produce always two copies on two media, assume Gen1 media is readable for ~10 years (including drive/interface technology)
- to address local fabric failure modes, a third, external copy is required
  - use Grid SE mechanism to copy off-site, building a deep archive – including catalog entries
    - credit based deal between (HEP) sites
      - i store your data – you store mine
        - » like “Mojo Nation”

final remarks

- feasable service !
  - current deployed technology
  - know how/experience partly existing
- reasonable costs (need further detailed calculations)
- make use of existing Data Grids installations worldwide !
  - abstract from real storage technology
  - federations + partly metadata management