# Design for the Long Term: Authenticity and Object Representation

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# Agenda

- **Digital Object Management at the British Library**
  - Drivers
  - DOM Programme
  - Key aspects of the DOM system
- **Focus on integrity and authenticity**
  - Challenges
  - Our approach
- **Focus on object structure**
  - Challenges
  - Our approach

# Digital Material at the British Library

- **The British Library has a duty of care to preserve non-print material in perpetuity**
  - Legal deposit legislation for non-print material
    - Royal assent in October 2003
    - Secondary legislation being established
  - Existing voluntary deposit scheme operational since 2000
- **The British Library has extensive and growing digital assets**
  - Digitised versions of BL material from early '90s onwards
    - Treasures, Collect Britain, Newspapers
  - Electronic journals
  - Sound Archive's 15TB of material per year (with 50 year collection)
  - New digitisation initiatives: newspapers, sound, theses, etc
  - Collections from scientists and authors
  - Web archiving
  - Cartography and datasets, …
- **Plan for 500TB within five years**

# Digital Object Management (DOM) Programme

**<u>Our mission</u> is to enable the United Kingdom to preserve and use its digital intellectual heritage forever**

**<u>Our vision</u> is to create a management system for digital objects that will**

- Store and preserve any type of digital material in perpetuity
- Provide access to this material to users with appropriate permissions
- Ensure that the material is easy to find
- Ensure that users can view the material with contemporary applications
- Ensure that users can, where possible, experience material with the original look-and-feel

# Key DOM System Design Features

- **Disaster tolerant**
  - Robust engineering
  - Multi-site design
  - Clear security boundaries
- **Scaleable**
  - 100s of Terabytes; millions of objects
- ✓ **Ensure integrity and authenticity**
- **Flexible**
  - Support multiple ingest and distribution services
  - ✓ Handle any kind of digital object
- **Designed for the long term**
- **Cost effective**
- **OAIS Compatible**

# Integrity and Authenticity: Challenges

- **Detect when a document is damaged**
  - Paper has visible tears, folds, stains
- **Detect when a document is modified**
  - Paper shows visible signs of change
- **Detect when a document is inserted after the fact**
  - Shelfmark is written on binding
  - Paper is date-stamped on accession
  - Paper ages
- **We need to give digital content the best properties of paper!**

# Integrity: Approach

- **Detect damage: Use checksum or digest**
  - Wide-spread approach; we use SHA-1
  - A digest is a (fixed length) summary or fingerprint
  - Change one bit in the object, and the digest changes a lot; it is **very hard** to create another object with the same digest
- **To check for damage**
  - Store the digest at ingest
  - Periodically recompute from bitstream, and test
  - Test will fail if digest or document are damaged
- **But what about a malicious operator who modifies the digest and the content?**
  - We lose. The archive is corrupted!

# Authenticity: Approach

- **Detect modification: Digitally sign every object**
  - Digital signatures using public-key cryptography
  - I use my private key to encrypt the digest of an object
  - You use my public key to decrypt the digest and test it
  - As long as my private key is safe, no-one can forge my signature
- **But what about a malicious operator who has access to the private key?**
  - It is very hard to keep the private key safe in software
- **We use a specialised hardware solution**
  - The hardware is tamper-resistant and tamper-evident
  - Any changes require m-of-n people present
  - But anyone can verify the signature using standard software

# Doing More with Digital Signatures

- A digital signature can sign any statement – not just the content
- We use the digital signature to permanently bind a identifier to each object
- The digital equivalent of writing the shelfmark on the binding
- We sign (approximately)

digest( identifier + digest (content) )

```
<domBoundObject>
  <contentDigest>2FA3CED4…</contentDigest>
  <domID>10001</domID>
</domBoundObject>
```

# Authenticity: Approach

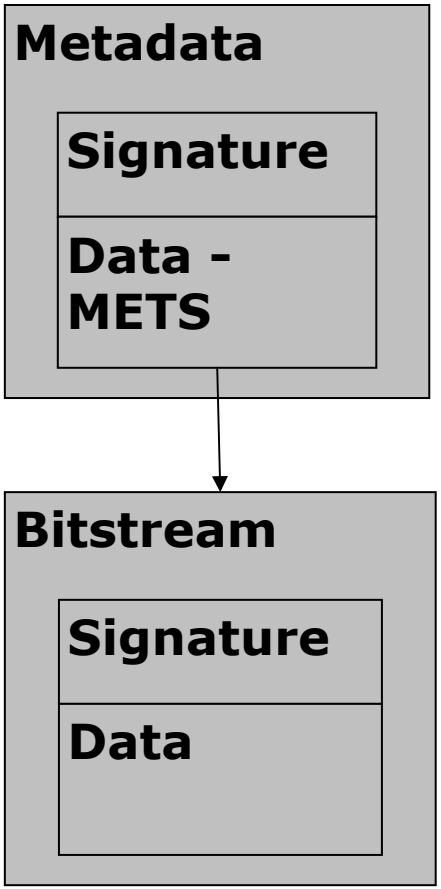
- **Detect when a document is inserted**
  - Extend the digital signature with a timestamp
- **But what about a malicious operator who resets the system clock?**
  - We lose!
- **Our hardware solution provides trusted time-stamps**
  - Well established technology use a time-stamp authority to get a trusted time
  - Protocols and methods are complex, but fairly easy to use
  - Cryptographic methods, audit trails, and a tamper-resistant internal hardware clock prevents spoofing

# Layered Representation: Authenticity

- **Challenge: Ensure technology independence**
  - Software vendors may fail
  - New technologies, systems will provide better solutions
- **Approach: Layered representation**
  - Minimal assumptions: uniquely identified bytestreams
  - File system holds all important information
  - Every ingested content object exists in a bit-identical file
  - Authenticity information is stored in a separate file
  - Any secondary index or data can be built from the files
- **But isn't that inefficient?**
  - No – secondary indices allow efficient traversal, etc
- **But what if a malicious operator renamed the files?**
  - The authenticity file holds time-stamped signature

# Layered Representation: Metadata

- **Challenge: Associate metadata with content**
- **Approach:**
  - The authenticity layer doesn't know about metadata
  - METS provides the framework for specifying metadata
    - Flexible and expressive
    - Supports descriptive, technical, administrative, and structural metadata
    - Supports multiple records of each type
  - The METS object links to the bitstream identifier
  - The authenticity layer ensures that the link can't be modified
- **But won't metadata standards evolve?**
  - The content bitstream and its signature remain untouched



# Layered Representation: Relationships

- **Challenge: Handle compound objects and other relationships**
  - A serial issue has articles, pages
  - A newspaper issue has scanned pages, OCR text, articles that span pages
- **Approach: Leverage METS**
  - The next layers use METS to store named relations between objects
- **Challenge: Update or withdraw objects without actually modifying them**
- **Approach: Ingest a new METS object with the appropriate relationships**
  - Access layer sees only the latest generation

# Conclusion

- **The British Library is engaged in an ambitious programme to preserve the digital intellectual heritage of the United Kingdom**
- **We are building a system that is**
  - Disaster tolerant, scaleable, flexible, cost effective
- **Today we focused on**
  - Ensuring the integrity and authenticity of digital material
    - Hardware provides secure time-stamped signatures
  - Establishing a flexible layered representation

- http://www.bl.uk/about/policies/dom/homepage.html