united nations
educational, scientific
and cultural
organization

international atomic
energy agency

the
abdus salam
international centre for theoretical physics

40th anniversary 1964 2004

SMR.1589 - 8

Workshop on
Managing Nuclear Knowledge

8 - 12 November 2004

Preservation of Nuclear Information and Records

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These are preliminary lecture notes, intended only for distribution to participants

International Atomic Energy Agency

Preservation of nuclear information and records

Anatoli Tolstenkov

Workshop on Managing Nuclear Knowledge
Trieste, Italy, 8-12 November 2004

Preservation of Nuclear Information and Records

- Main components of knowledge preservation
- Digital preservation (management issues)
- Digital preservation (technical primer)
- Review of Main IAEA Knowledge Preservation Projects

Goals of Preservation

- Select the most valuable information to convey to the future
- Ensure that it remains readable, accessible and understandable
- Manage technological change so that those objectives are met

Type of Information

- Text (book, journal article, brochure, listing …)
- Image (photo, film, picture …)
- Sound
- Data (numerical, graph …)
- Interactive (rule-based, training, database …)
- Multimedia
- Computer code
- Sample (physical object)
- Tacit knowledge
- …

Main Components of Knowledge Preservation

- Select
  - Capture
    - Describe/classify
      - Store
        - Provide access

- Maintain (longevity)

Selection of Information for Preservation

- Why Select?
  - Storage is not equal to Preservation
  - High costs and limited budget
  - Maintenance mortgage
  - Legal issues
- Evaluation
- Prioritization by Value, Use and Risk

Copyright Issues

- **Copyright protects the actual expression of an idea, not the idea itself**
- **The absence of copyright notice does not mean absence of copyright protection**
- **Possession or ownership of physical item does not mean the possessor or owner owns the copyright**
- **Copyright does not apply to all works, and it does not last forever**

Information Capture

- Purchasing
- Copy (the same media or different)
- Interview (tacit knowledge)

Describe and Classify Information

Create metadata

- Metadata is structured data about data
- Metadata is a summary of information about the form and content of resource to facilitate identification and retrieval

Type of Metadata

- **Administrative**
- **Descriptive**
- **Structural**
- **Semantic**

Administrative Metadata

- Management information needed to maintain, retrieve and display an object
- Rights and permissions
- File format, size compression, etc.
- Hardware, software
- Physical location
- Etc.

Descriptive Metadata

- Information that provides access to the subject of an object
- Author or Creator
- Title
- Subject terms
- Classification

Structural Metadata

- Information used to display and navigate an object
- Structural divisions of an object
- Sub-object relationships (internal links)

Semantic Metadata

- Subject
- Descriptors (controlled, multilingual)
- Semantic links
- Information audience
- Related sources of information

Store

- Environment
- Media
- Format

Provide access

- Media
- Format
- Infrastructure
- Interface

Maintain. Ensure longevity.

- Control
- Refreshing (media)
- Migration (format)
- Emulation (application software)

INIS records management 1970 to present

- **1970: first generation of the Bibliographic Database (paper based INIS Atomindex)**
- **1978: available on-line**
- **1991: available on CD-ROM**
- **1996: available on Internet**
- **1997: migration from magnetic tape to CD-ROM**
- **migration from EBCIDC to ASCII**
- **transition from microfiche to digital images**
- **2002: migration of archive from microfiche to digital images, OCR**
- **2003: migration from tag-text format to XML**
- **transition from TIFF image format to image+text PDF**

Analog versus Digital

Analog

- ‘Simple’ climate - controlled environment
- Long life
- No special equipment needed
- Simple maintenance technology
- Readability even after partial damage

- Space
- Search trough metadata only
- Manual maintenance
- Not easy access

Analog versus Digital

Digital

- Easy access and search
- Content and semantic search
- Automated maintenance
- Easy duplication and distribution
- Multilinguality

- High risk of damage
- Short life
- Special equipment and software needed
- Too many different formats
- Dependency on digital technology
- Non-stop maintenance
- Legal constrains

Analog versus Digital

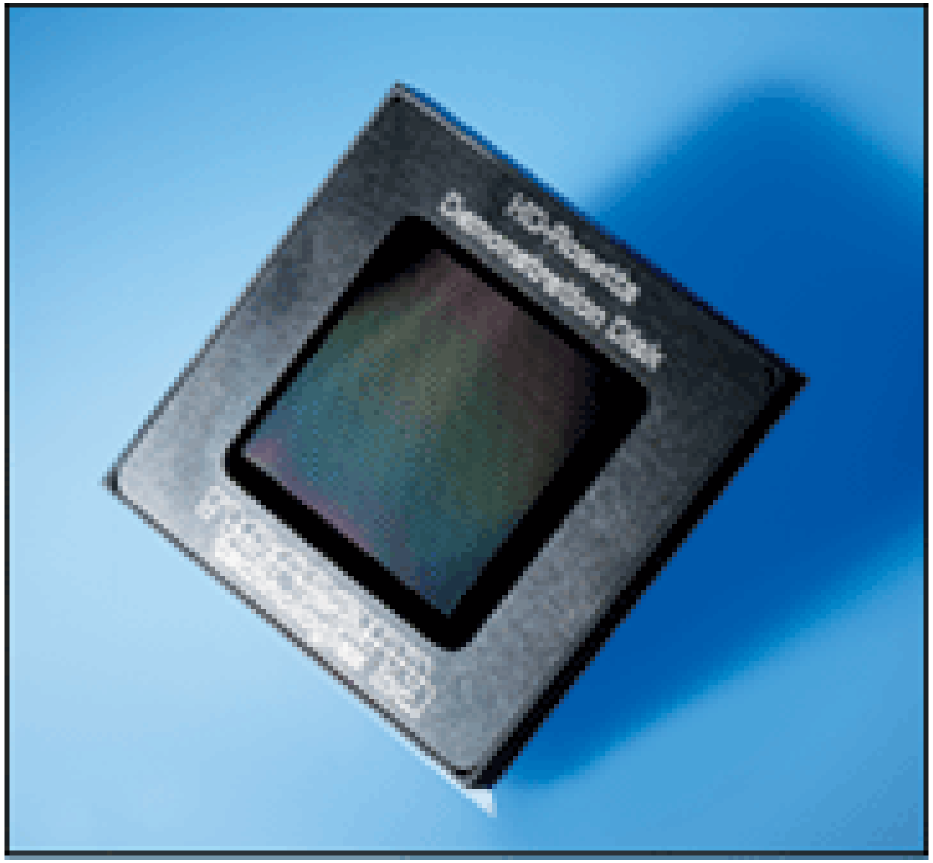
- Volume of information published in digital form is growing up dramatically (in 2 times for the last 3 years)
- Young generation preference is digital information
- Electronic document analysis, translation and data mining

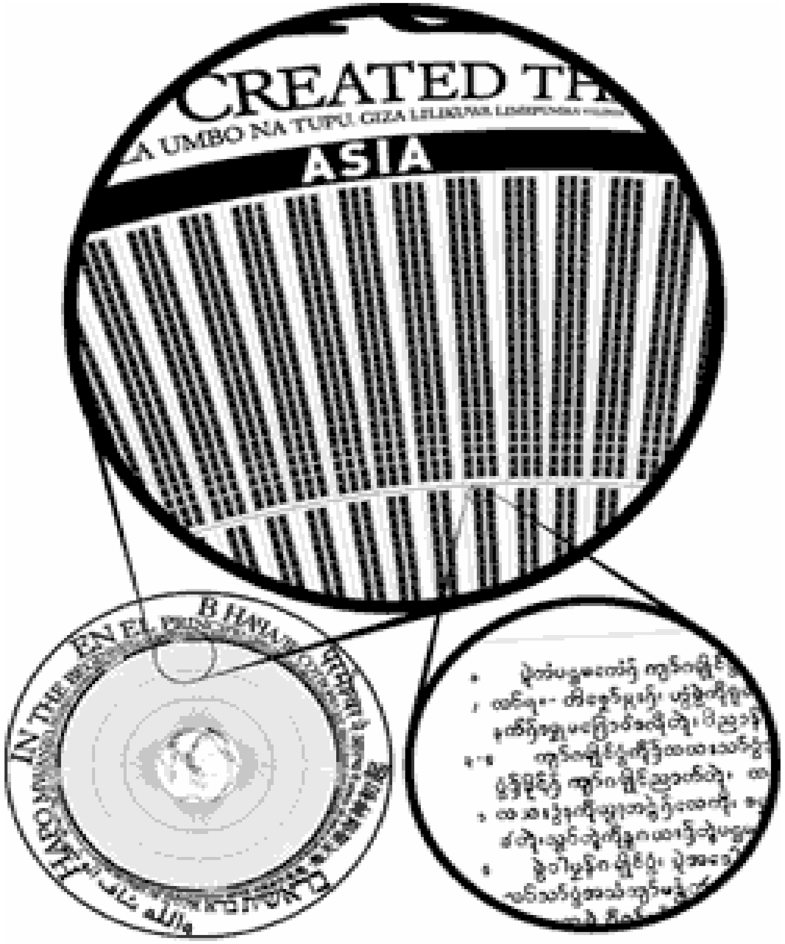
Type of Media

- Paper
- Film, photo materials
- Gramophone record/plate
- Magnetic tape
- Diskette, CD/DVD …
- Hard disk, flash memory
- Magneto-Optical
- Glass, metal … (holography)
- Etc.

High Density Analog Storage Devices (extreme longevity)

- **Developed by Los Alamos Laboratories and Norsam Technologies**
- **Analog images on a 3" nickel disk or on a 3" square plate at densities of up to 350,000 pages per disk**





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Part 2

Digital Preservation

Digital Preservation

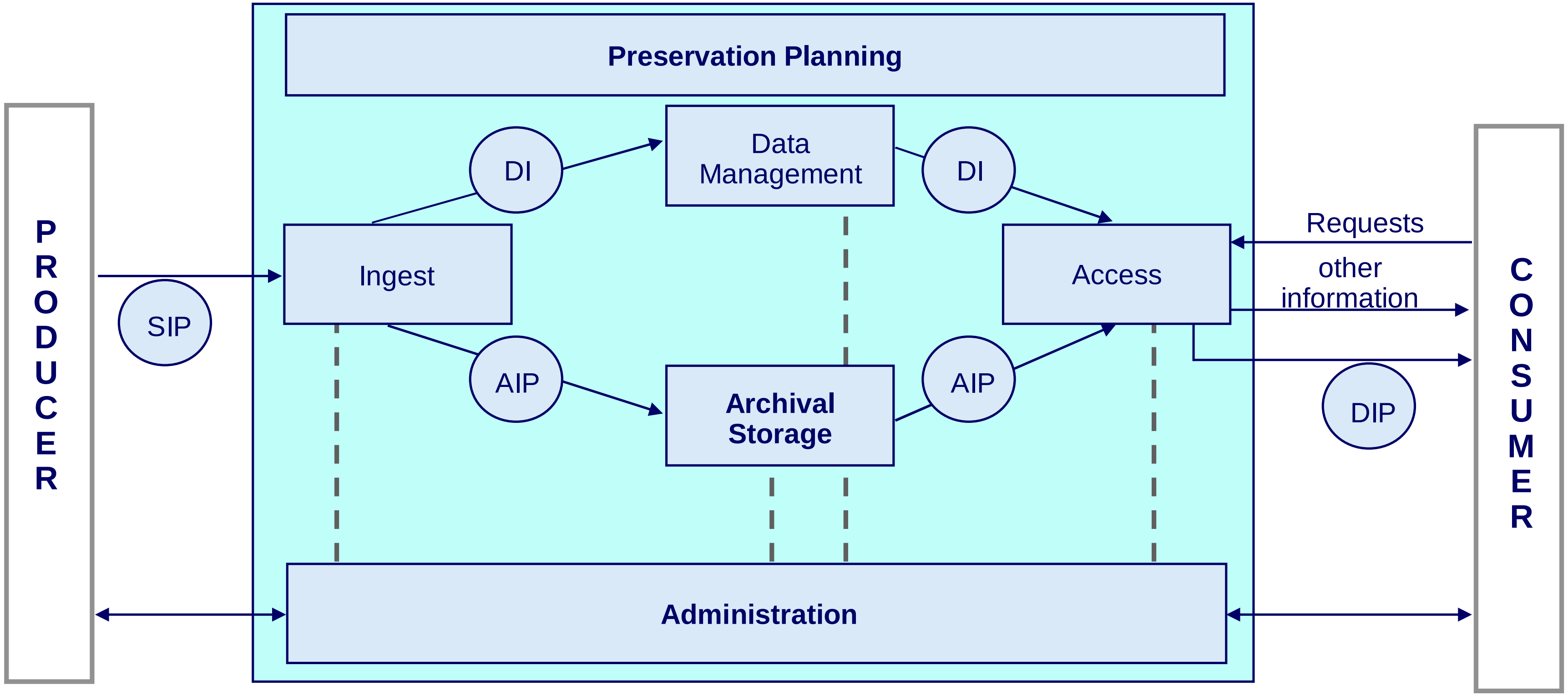
- **Organizational Infrastructure:** *consistent, systematic management; comprehensive policy framework; co-operation*
- **Technological Infrastructure:** *technology anticipates needs; open architecture; well defined standards*
- **Resources:** *sustainable funding*

Two main standards

TDR ***- Trusted Digital Repositories: Attributes and Responsibilities***

OAIS ***– Reference Model for an Open Archival Information System***

OAIS Functional Entities



SIP = Submission Information Package
AIP = Archival Information Package
DIP = Dissemination Information Package
DI = Descriptive Information

Open Archival Information System (OAIS)

- *Was initiated by NASA in June 1995*
- ***To define an archive reference model and service categories for the intermediate and indefinite long term storage of digital data obtained from, or used in conjunction with, space missions.***
- ***To provide a framework and common terminology that may be used by Government and Commercial sectors in the request and provision of archive services. This will also encourage commercial support for the provision of archive services which would truly preserve our valuable data, not only for space related data but also for all long term data archives***
- ***Became an ISO standard in June 1999***

Open Archival Information System (OAIS)

- **provides a framework for the understanding and increased awareness of archival concepts needed for Long Term digital information preservation and access;**
- **provides the concepts needed by non-archival organizations to be effective participants in the preservation process;**
- **provides a framework, including terminology and concepts, for describing and comparing architectures and operations of existing and future archives;**
- **provides a framework for describing and comparing different long term preservation strategies and techniques**
- **Does NOT specify any implementation**

Open Archival Information System (OAIS)

- Open
  - Reference Model standard(s) are developed using a public process and are freely available
- Information
  - Any type of knowledge that can be exchanged
  - Independent of the forms (i.e., physical or digital) used to represent the information
  - Data are the representation forms of information
- Archival Information System
  - Hardware, software, and people who are responsible for the acquisition, preservation and dissemination of the information
  - Additional OAIS responsibilities are identified later and are more fully defined in the Reference Model document

Trusted Digital Repositories

- **March 2000 – start: to establish attributes of a digital repository for research organizations, building on international standard of the *Reference Model for an Open Archival Information System (OAIS)***

- **A trusted digital repository is more than just organization responsible for storing and managing digital files.**

  A trusted digital repository is one whose mission is to provide reliable, long-term access to managed digital resources to its designated community, now and in the future.

Trusted Digital Repositories

To meet expectations all trusted digital repositories must

- **accept responsibility for the long-term maintenance of digital resources on behalf of its depositors and for the benefit of current and future users;**
- **have an organizational system that supports not only long-term viability of the repository, but also the digital information for which it has responsibility;**
- **demonstrate fiscal responsibility and sustainability;**
- **design its system(s) in accordance with commonly accepted conventions and standards to ensure the ongoing management, access, and security of materials deposited within it;**
- **establish methodologies for system evaluation that meet community expectations of trustworthiness;**
- **be depended upon to carry out its long-term responsibilities to depositors and users openly and explicitly;**
- **have policies, practices, and performance that can be audited and measured; and meet the responsibilities detailed later in this presentation.**

Trusted Digital Repositories

Definition of "trusted archives":

For assuring the longevity of information, perhaps the most important role in the operation of a digital archive is managing the identity, integrity and quality of the archives itself as a trusted source of the cultural record. Users of archived information in electronic form and of archival services relating to that information need to have assurance that a digital archives is what it says it is and that the information stored there is safe for the long term.

TDR: Attributes

- **Compliance with the *Reference Model for an Open Archival Information System (OAIS)***
- **Administrative responsibility** (standards for physical environment, backup and recovery procedures, and security system …)
- **Organizational viability** (commitment to the long-term retention, management of, and access to digital assets on behalf of depositors and users)
- **Financial sustainability**
- **Technological and procedural suitability** (preservation strategies; h/w, s/w, storage, access; comply with all relevant standards and best practices)
- **System security** (should be designed to assure the security of the digital assets; authentication systems, firewalls, backup system; policies and plans for disaster preparedness; data integrity)

Principles of Responsibility

- Everyone doesn’t have to do everything
- Everything doesn’t have to be done at once
- Responsibility can be time constrained
- Someone must be willing to take a lead on almost all steps
- Small steps are usually better than no steps
- Preservation should not be postponed until a perfect solution appears.

Collin Webb
“Digital Preservation – A Many Layered Thing”

Issues to Consider

- Clear mandate?
- Defined scope?
- Policy framework, procedures, standards?
- Multi-year plan?
- Relationship between various stakeholders whithin your organisation?
- Terms and conditions for access and use?
- Preservation planning?
- Appropriate technology?
- Designated, sustained resources?

Part 3

Digital Preservation. Technical Primer

Digitization is not preservation

Main steps in digitization process (Digitizing Workflow)

- Document benchmarking
- Scanning
- Quality Control
- Image Enhancement
- OCR
- Output Formats and Compression
- Archiving & Longevity

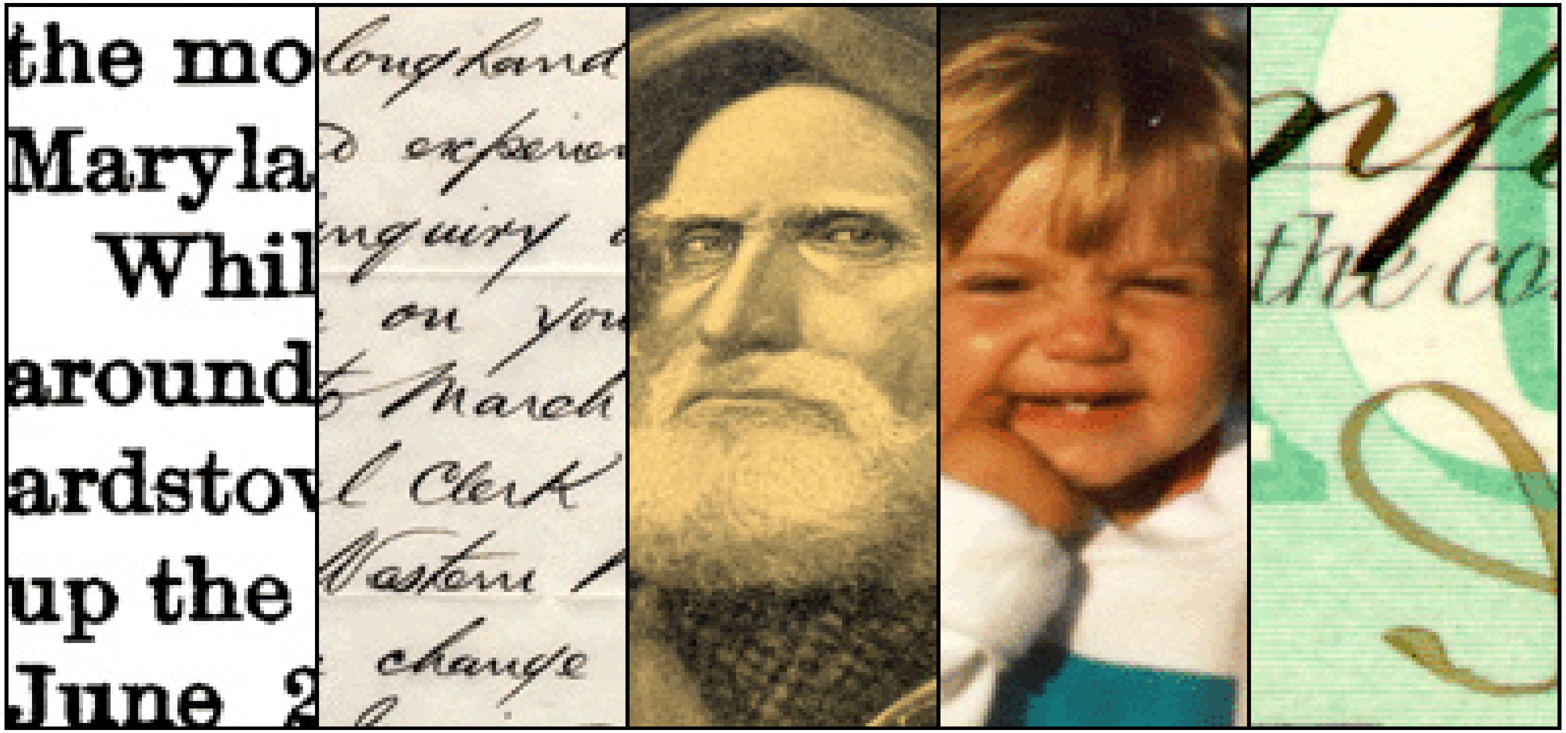
Document benchmarking

- the first and very important step in digitizing. The results of document benchmarking effect further steps very much (scanning, enhancement, format, etc.)
- The purpose of document benchmarking is to define/clarify the following:
  - Can the informational content of a document be adequately captured in digital form?
  - Do the physical formats and condition of material correspond to digitizing requirements?
  - Document type
  - Resolution
  - Bit-Depth for colour and grayscale, and threshold for bitonal
  - Output file format and compression

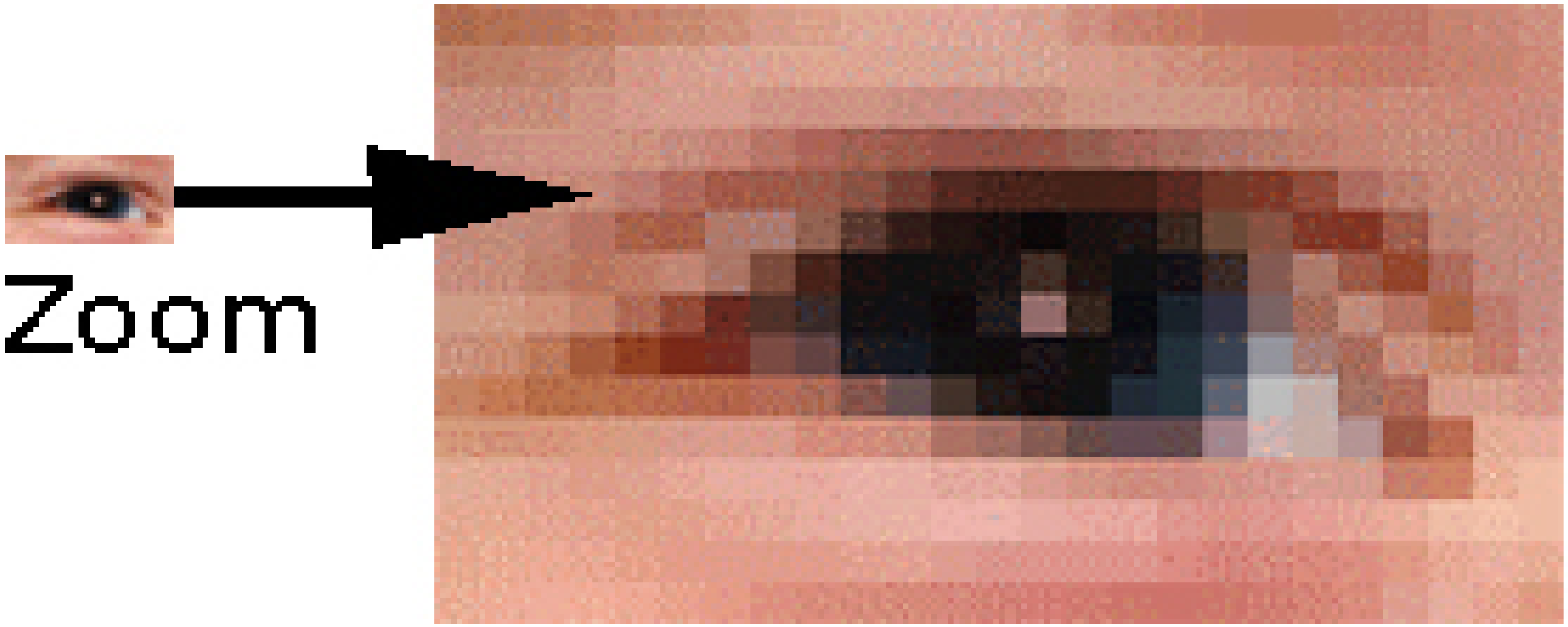
Document Types

- ***Printed Text/Simple Line Art*—distinct edge-based representation, with no tonal variation, such as a book containing text and simple line graphics**
- ***Manuscripts*—soft, edge-based representations that are produced by hand or machine, but do not exhibit the distinct edges typical of machine processes, such as a letter or line drawing**
- ***Halftones*—reproduction of graphic or photographic materials represented by a grid of variably sized, regularly spaced pattern of dots or lines, often placed at an angle. Includes some graphic art as well, e.g., engravings**
- ***Continuous Tone*—items such as photographs, watercolors, and some finely inscribed line art that exhibit smoothly or subtly varying tones**
- ***Mixed*—documents containing two or more of the categories listed above, such as illustrated books**

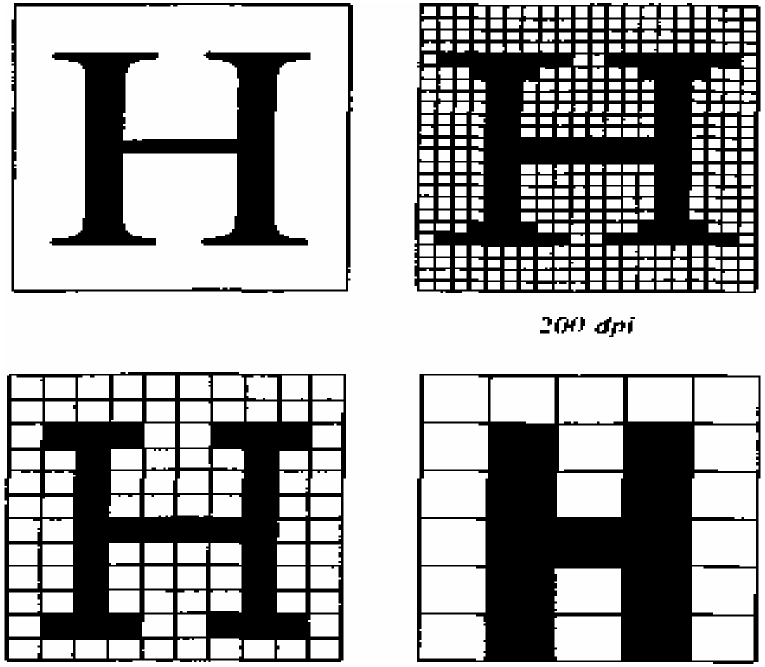
Document Types



Resolution



Resolution



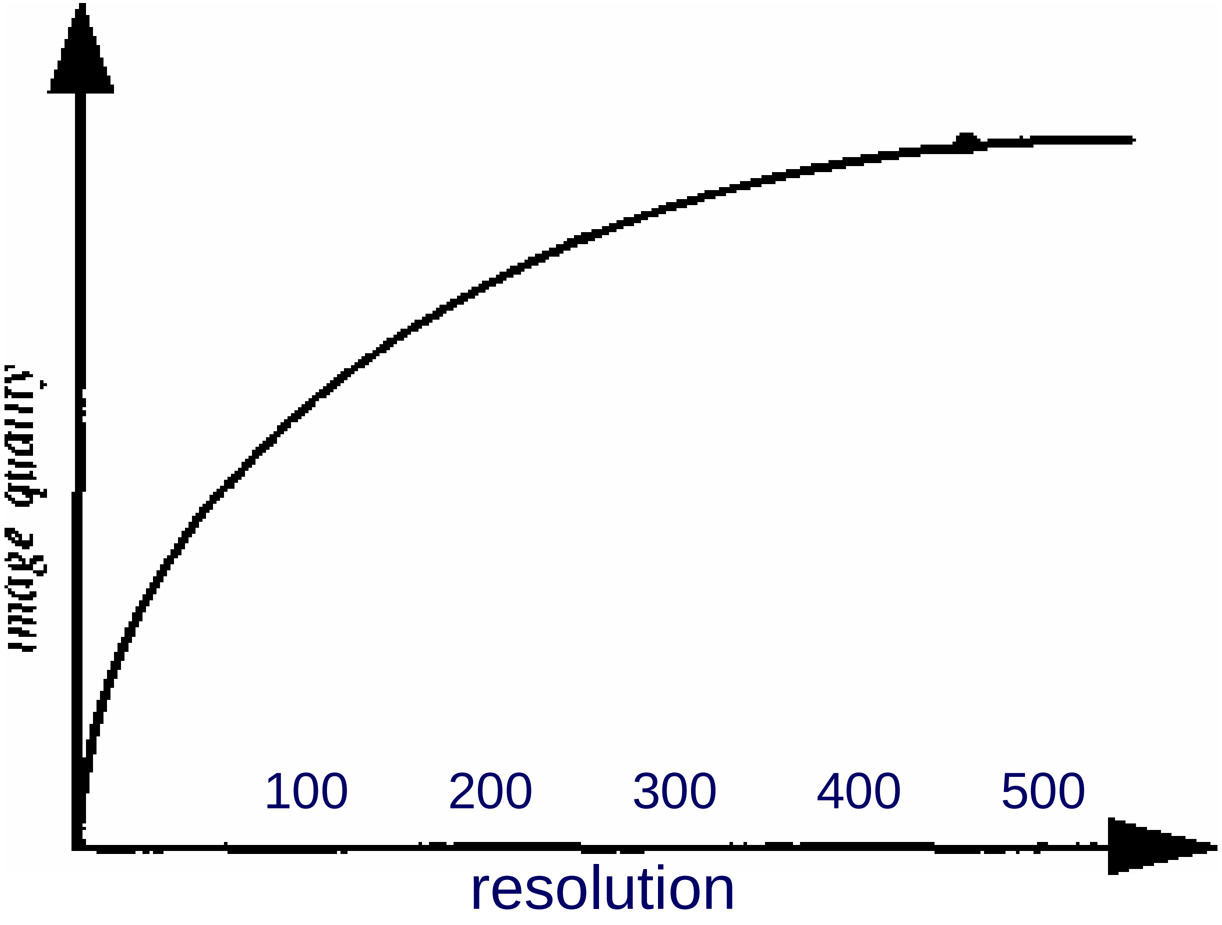
100 dpi

50 dpi

Resolution

- **is determined by the number of pixels used to represent the image, expressed in dots per inch or as pixel dimensions.**
- **Increasing resolution enables the capture of finer detail. *At some point, however, added resolution will not result in an appreciable gain in image quality, only larger file size*. The key is to determine the resolution necessary to capture all significant detail present in the source document.**
- **Main approach to imaging: “No More, No Less”**

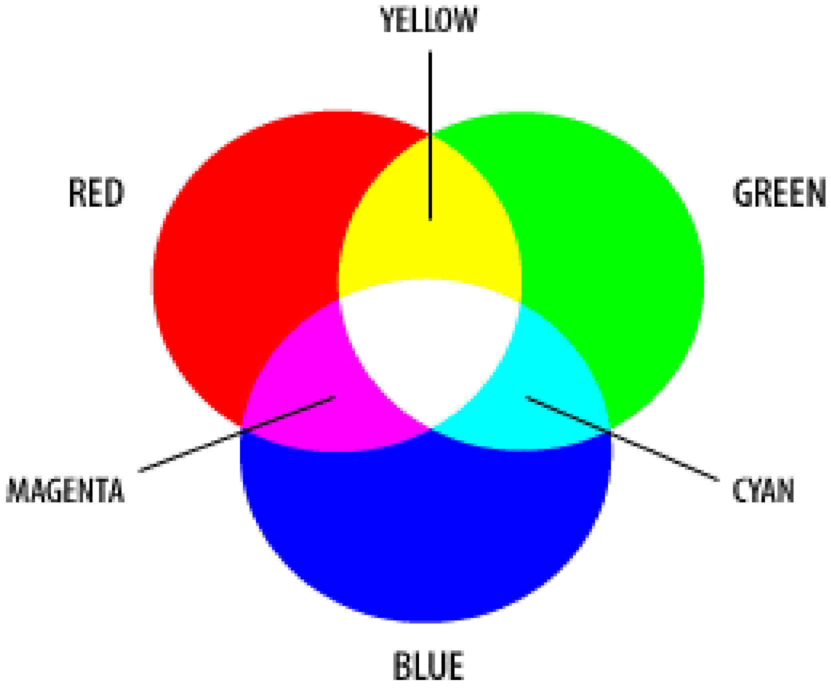
Resolution



Resolution

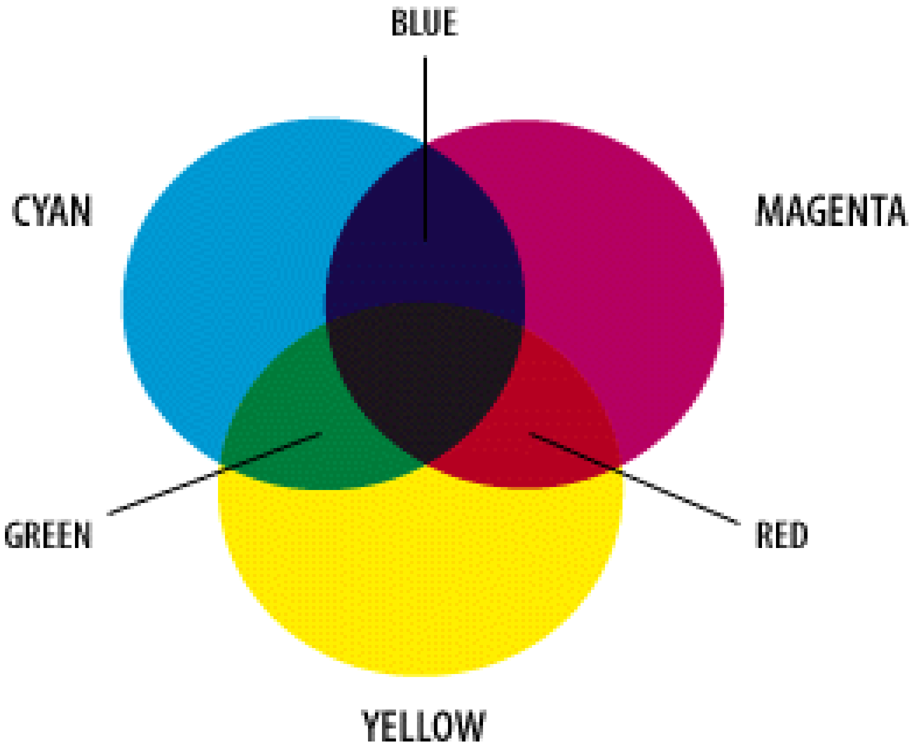
- Electronic Access and Display
  - Screen resolution (800x600; 1024x768)
  - 50 – 150 dpi
- Reproduction/Printing
  - 300-400dpi (8-bits for greyscale and 16/24-bits for colour)
- Preservation
  - 400 dpi for text
  - 600 dpi for photographs

Colour System (RGB)



Red, Green, Blue

Colour System (CMYK)



Cyan, Magenta, Yellow, Black

Colour Systems

- **Save colour images as RGB files**

- **Avoid CMYK for master image files!**

Colour/Greyscale/Bitonal

- **Bit Depth – number of bits of data representing each pixel (dot) of image**

- **Number of tones for colour and greyscale images = $2^{(\text{Bit Depth})}$**

1 bit – black & white (bitonal) = 2^1

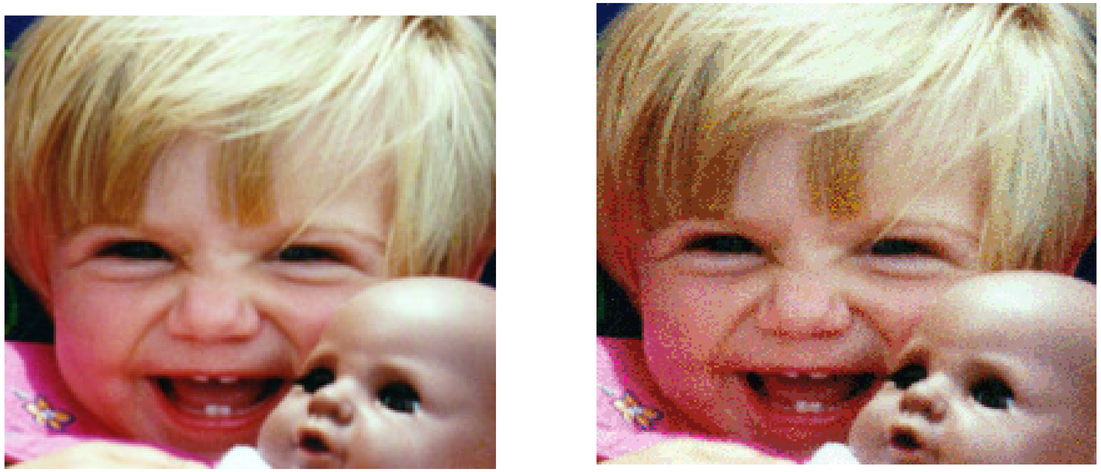
2 bits – 4 tones = 2^2

4 bits – 16 tones = 2^4

8 bits – 256 tones = 2^8

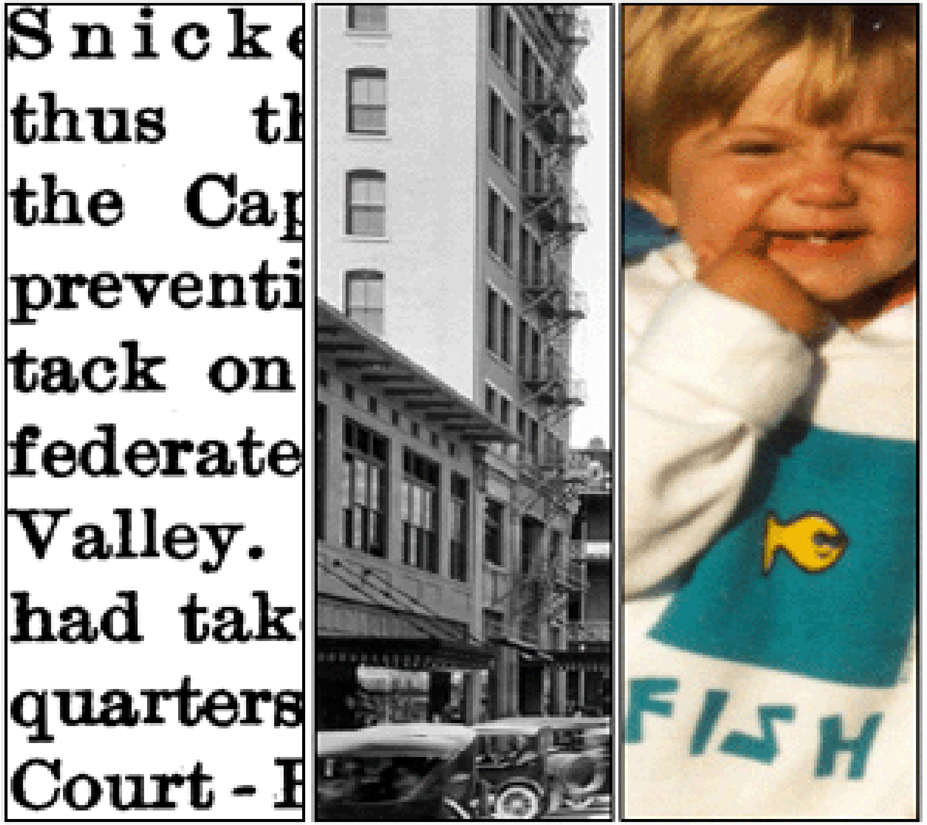
16 bits – 65,536 tones = 2^{16}

Colour/Greyscale/Bitonal



Bit Depth: When a 24-bit image (left) is reduced to an 8-bit one (right), the color reduction may result in quantization artifacts

Bitonal/Greyscale/ Colour



Bit Depth: Left to right - 1-bit bitonal, 8-bits grayscale, and 16-bits color images.

Size of file with scanned image

- **file size (in bytes) =**
- **H *W*(Bit depth)*(dpi)^2 /8**

- **H – <u>height of image</u>** (in inch)
- **W – <u>width of image</u>** (in inch)
- **dpi – <u>resolution</u>** (dots per inch)

Size of file with scanned image

- **Examples:**
- **1. A4, 300 dpi, Bitonal**
- **file size (in bytes) =**
- **8.5 *11*(1)*$(300)^2$ /8 = 1,05 MB (uncompressed)**

- **2. A4, 300 dpi, 256 tones**
- **file size (in bytes) =**
- **8.5 *11*(8)*$(300)^2$ /8 = 8,4 MB (uncompressed)**

Image Enhancement

- Deskewing (100% INIS documents)
- Despeckling
- Black border removing
- …

OCR

- OCR (Optical Character Recognition)
  - No longer based on optical processing
  - OCR s/w algorithms process Raster bit maps
- ICR (Intelligent Character Recognition)
  - Became synonymous with OCR
- 3D OCR
  - Uses greyscale/colour information to improve character recognition of low resolution images (50-150 dpi)

Required OCR Accuracy

- For full text searching
  - Above 75%

- For republishing documents
  - Above 99.9% (5 errors per 5000 characters)

Output Formats and Data Compression

- To ensure necessary level of quality
- To save space and time

- Lossless technology
  - File reconstruction is identical to original image

- Lossy technology
  - A certain amount of original information discarded during imaging (compression) process

Output Formats and Data Compression

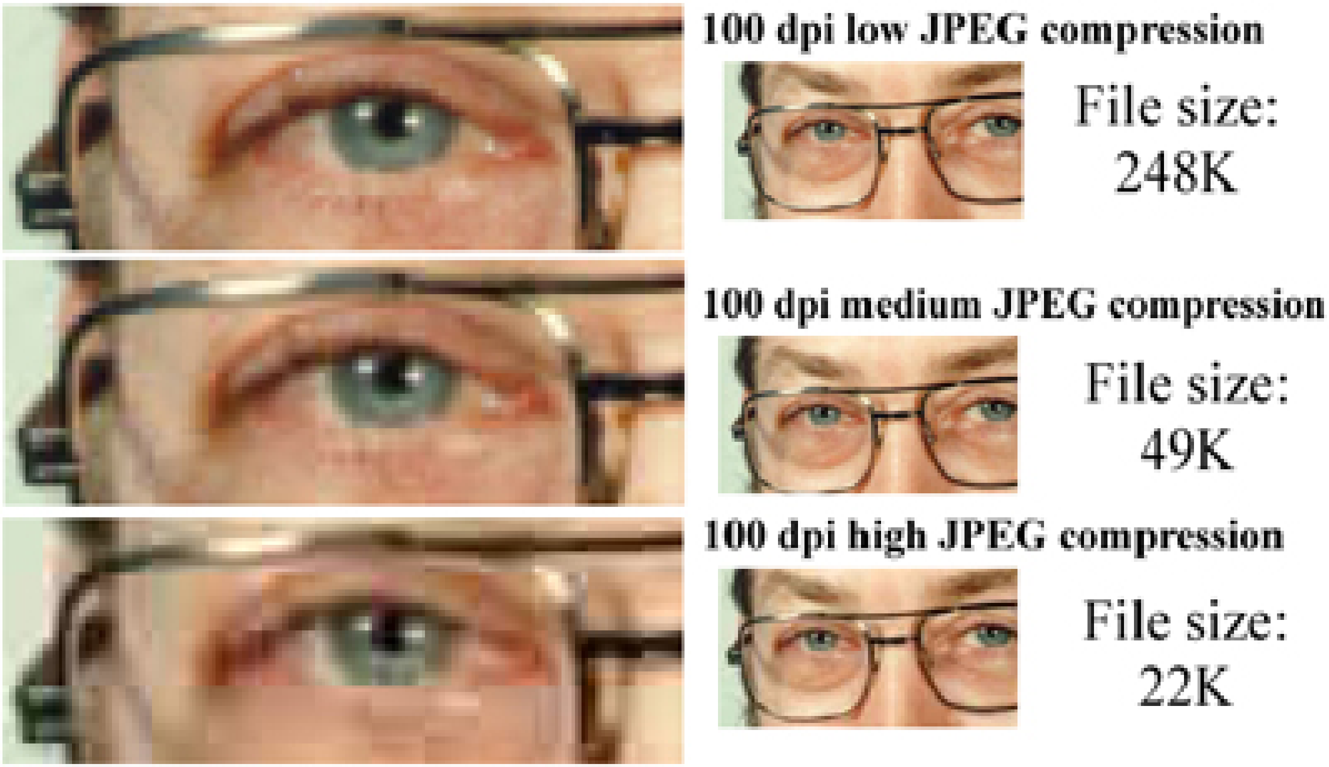
- **TIFF** - Tag Image File Format
  - Most common standard for archiving
  - TIFF – G4 (group 4 fax compression – lossless) – for black & white images
- **PDF** - Portable Document Format
  - Most common standard for electronic publishing
- **JPEG** – Joint Photographic Experts Group
  - For colour images (allows lossless option)
- **JPEG2000**
  - New wavelet technology
- Many others

PDF - Portable Document Format

- **PDF/A**
- **PDF/X**

- Text/Hypertext
- Image
- **Image + Text**

Output Formats and Data Compression


100 dpi low JPEG compression
File size: 248K
100 dpi medium JPEG compression
File size: 49K
100 dpi high JPEG compression
File size: 22K

Part 4

Review of Main IAEA Knowledge Preservation Projects

Main Preservation Activities

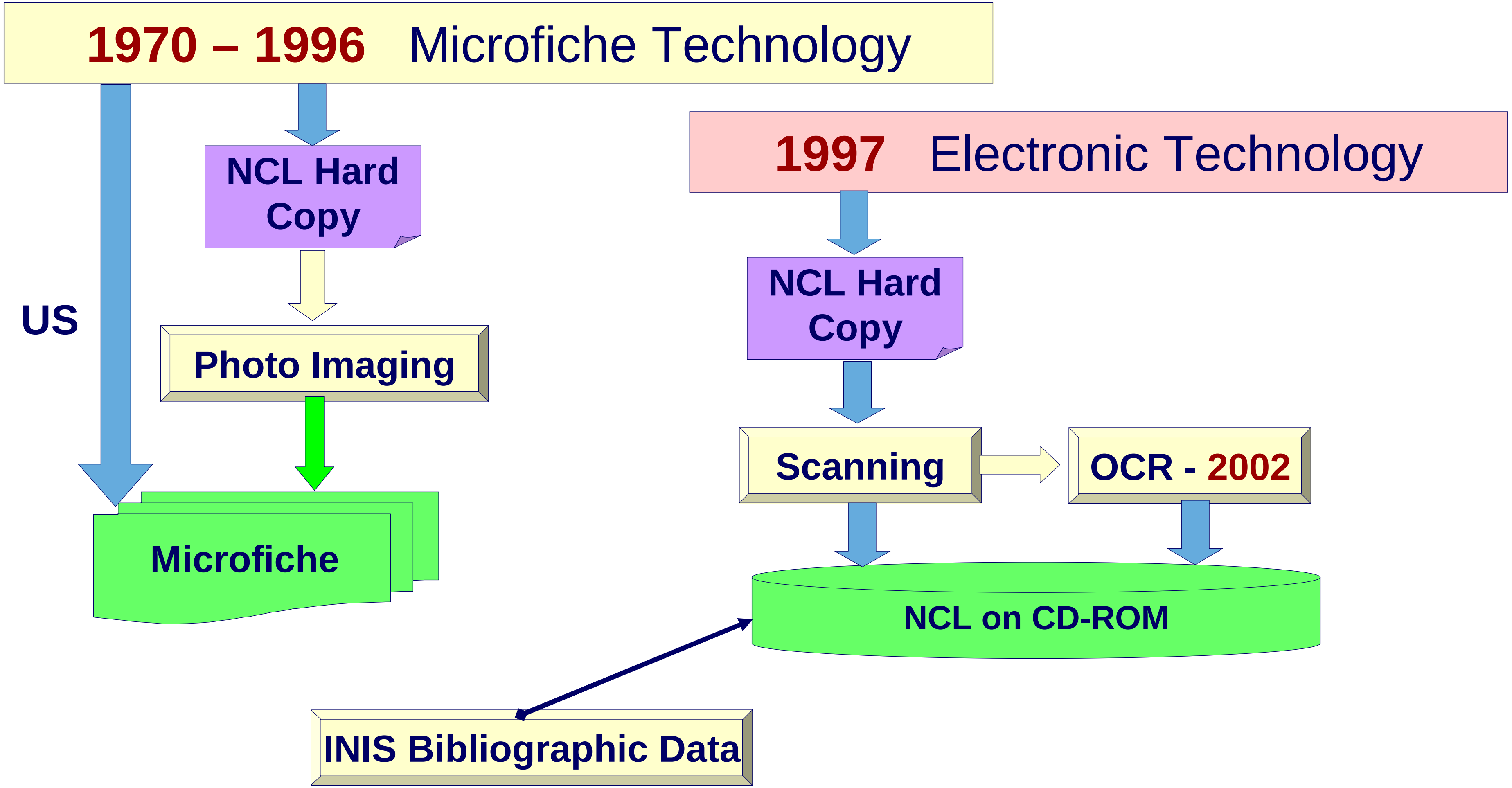
- INIS NCL Production
- Digitization of INIS NCL Microfiche
- Digitization of older IAEA and Member States Information
- Preserving Web-based information resources (evaluation project initiated)

INIS NCL (Non-Conventional Literature) full-text collection

- Contains knowledge about peaceful nuclear sciences&technologies (collected by Member States for over 30 years)

- Contains ~ 700 000 documents (many of them can’t be found anywhere else!)

History



1970 – 1996 Microfiche Technology

US

NCL Hard Copy

Photo Imaging

Microfiche

1997 Electronic Technology

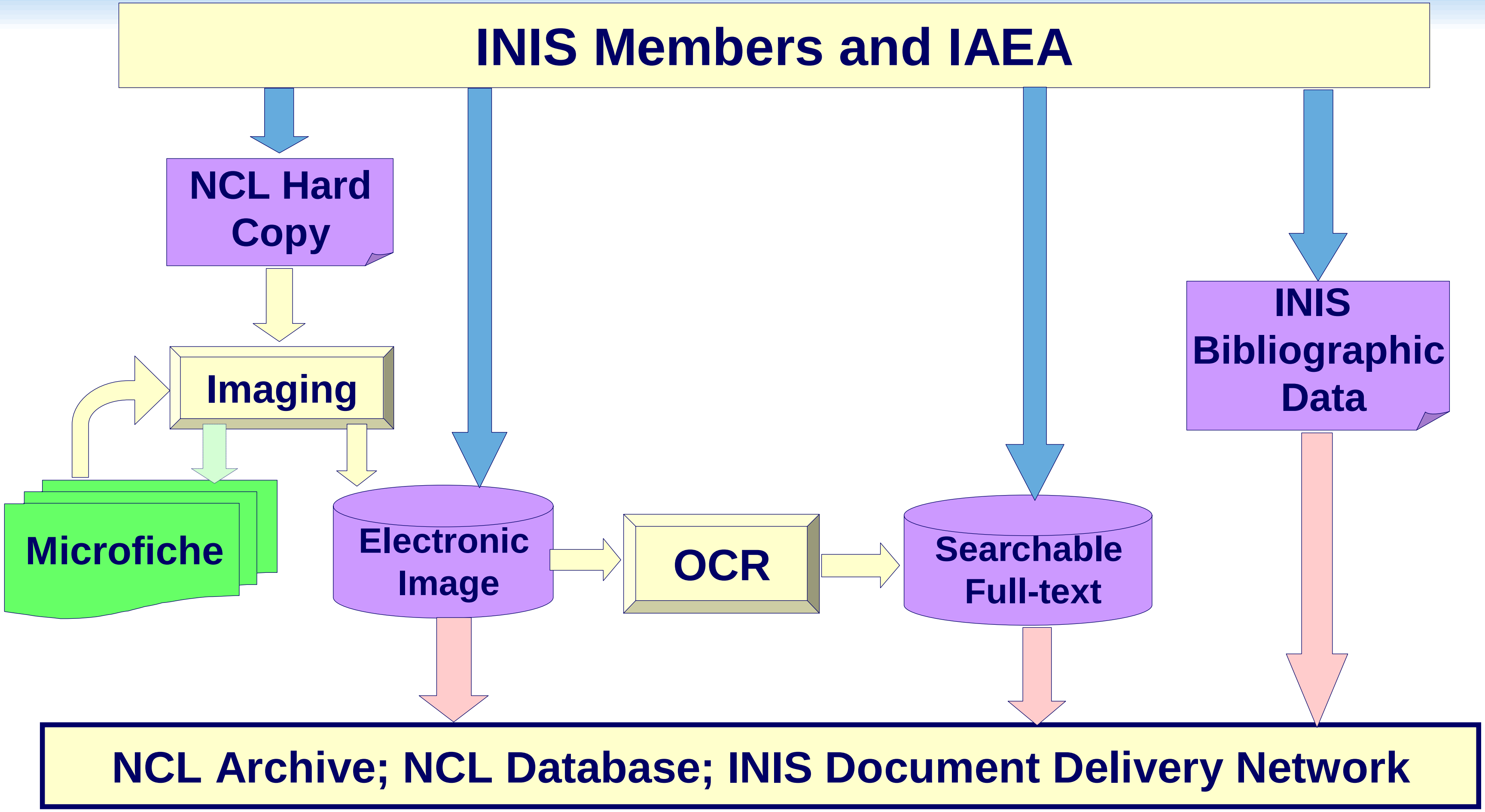
NCL Hard Copy

Scanning

OCR - 2002

NCL on CD-ROM

INIS Bibliographic Data



INIS Members and IAEA

NCL Hard Copy

Imaging

Microfiche

Electronic Image

OCR

Searchable Full-text

INIS Bibliographic Data

NCL Archive; NCL Database; INIS Document Delivery Network

Statistics

Total NCL	791,642
NCL available from INIS	614,971
NCL in electronic form	183,298
Pages (electronic)	> 4,000,000
Total NCL pages	~25,000,000

Statistics

- 63 languages
  - Western languages - 83%
    - English - 70%
  - Cyrillic and Slavic – 12%
    - Russian – 10%
  - Asian languages – 4.5%
    - Japanese – 3.5 %
  - Arabic – 0.4 %

INIS NCL Microfiche Archive Digitizing

- **2002 – 12,000 documents**
- **2003 – 13,000 documents**
- **2003 – 45,000 documents**

Total NCL in electronic form: **183,298**

Format

- ***PDF (image + hidden text)***

Digitization of Older IAEA and Member State Documents

- **Documents and Records of the IAEA Board of Governors (~5,000; 1957 – 1996)**
- **IAEA Technical Documents (~1,500)**
- **IAEA Technical Reports Series (~3,000)**
- **Nuclear Data Reports (~3,500)**

Digitization of Older IAEA and Member State Documents

- IAEA Nuclear Safety Series
- IAEA Bulletin
- IAEA Conference Proceedings
- Legal Documents (~1,000)
- French CEA-R Collection (~4,500; 1946-1970)