



**Starting Point  
Migration Research**  
*Working document*

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National Library of the Netherlands (Koninklijke Bibliotheek)  
Digital Preservation Department

# Starting Point Migration Research

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## History of Starting point Migration research

Document version	Date of modification	Author	Summary of modifications
0.1 Concept	5 April	Caroline van Wijk	
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## Related documents

*Project Initiatie Document – Migratieonderzoek, C. van Wijk (2006)*

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## 1 Introduction

### 1.1 Purpose of this document

The information described in this working document will be the starting point for the migration research project of the KB. The information consists of an overview of international migration research projects and an overview of the variations of migration discussed in international publications.

The overviews in this document are based on information available on the internet and may be incomplete.

Additional remarks and suggestions are welcome and can be sent to the author ([caroline.vanwijk@kb.nl](mailto:caroline.vanwijk@kb.nl)).

### 1.2 Sections in this document

#### Overview of institutions and their migration research projects

In the overview of executed projects a distinction is made between practice-based projects and theory-based projects. For each project in the overview a description, its results are described, when the project was carried out and by which institution it was carried out.

#### Overview of various methods of migration

The overview “various methods of migration” shows different kinds of variations of migration (conversion) discussed in the research area of digital preservation. For each method of migration a description and a list of advantages and disadvantages is presented.

#### Preliminary evaluation

A brief preliminary evaluation of the information discussed in this document is presented.

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## 2 Overview of institutions and their migration research projects

### 2.1 Introduction

This chapter will present the theoretical and/or practical (file format) migration research projects in the research area of digital preservation. The projects are divided into two groups. The first group consists of institutions that carried out practical migration research projects. The second group consists of the institutions which executed migration projects limited to theoretical results.

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### 2.2 Overview

#### Practically-oriented projects

In the overview below projects and the institutions that carried them out are presented. The projects have in common that migration for digital preservation purposes has been tested in practice.

Name institution and contact person	Project	Period	Activities	Results
Public Record Office Victoria (Australia)	VERS (Victorian Electronic Records Strategy)	1998 first version, 2002 second version	Development of a tool that makes a wrapper of XML around the digital object to be archived (PDF).	Is being used. I haven't found information about the amount of digital files that have been archived in this way.

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Name institution and contact person	Project	Period	Activities	Results
National Archives of the Netherlands - Remco Verdegem	Testbed	2000-2003	Testing migration and conversion of text documents to different file formats (e.g. normalisation to XML)	<ul style="list-style-type: none"> <li>• Backward compatibility is not suitable for long-term archiving and permanent access (long-term archiving refers to a period of fifty or a hundred years).</li> <li>• Conversion of text documents to XML is thought to be the best strategy when document layout is explicit (templates have been used for layout of the document).</li> <li>• Conversion of text documents to PDF is considered the best strategy when document layout is implicit (no templates have been used for lay out of the document).</li> </ul>
			Testing migration of databases	Conversion of databases to XML is considered the best strategy for databases
			Testing migration of spreadsheets	Conversion of spreadsheets to XML is considered the best strategy for spreadsheets.

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Name institution and contact person	Project	Period	Activities	Results
			Classification of “migration” as: <ul style="list-style-type: none"> <li>• Backward compatibility</li> <li>• Interoperability</li> <li>• Conversion to standard file formats</li> </ul>	
University of Leeds- Phil Mellor, Paul Wheatly, Derek Sergeant	CAMiLEON	2002 (6 <sup>th</sup> ECDL proceedings)	Testing of “Migration on request” (conversion of a digital object performed only at the time when it is requested) and “reversible migration” (converting a converted digital object back to the original file format). These concepts have been tested with a developed tool specifically for conversion of vector graphics.	The modular migration on request tool has converted vector graphics successfully. Carrying out reversible migration has been harder in practice than foreseen.

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Name institution and contact person	Project	Period	Activities	Results
Swiss Federal Archives - Stephan Heuscher, Stephan Järman, Peter Keller-Marxer, Frank Möhle	SIARD: Software-invariant Archiving of Relational Databases	2002 (first publications)	Experiments with converting relational databases to: <ul style="list-style-type: none"><li>• SQL 3 (data logic)</li><li>• Flat text files (the content of the tables)</li><li>• XML for the description of the context of the database</li></ul> Subsequently this data was imported in a relational database using a developed reload tool specifically developed for imports.	The databases have been converted to SQL 3, flat text files and XML successfully. Importing this data into a relational database has been successful too.

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Name institution and contact person	Project	Period	Activities	Results
National Archives Australia - Andrew Wilson (is a contact person for the KB, he has not specifically been involved in this project)		2002	Prototyping for a normalisation process (the normaliser and the viewer). Normalisation (to XML) and XML encapsulation using the tool Xena. <a href="http://xena.sourceforge.net/download.html">http://xena.sourceforge.net/download.html</a>	The tool is used in the processing before ingest into the archive.
Florida Center for Library Automation / DAITSS – Priscilla Caplan		2003	Normalisation of objects before ingest into DAITSS. PDF 1.x is converted to XML and TIFF files. DTDs and XML files that refer to external files are converted to DTD_NORM_1 and XML_NORM_1.	Normalisation is used in the processing of digital objects. Per 16th of March 2006 73,383 files have been stored (1,3 TB). <ul style="list-style-type: none"> <li>• Archived material consists of Florida Heritage and West Florida Photo history material from UWF</li> <li>• Electronic dissertations and theses (ETDs) from UCF</li> </ul>

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Name institution and contact person	Project	Period	Activities	Results
Lister Hill National Center for Biomedical Communications / National Library of Medicine Bethesda, Maryland – Frank L. Walker, George R. Thoma		2004	Development and testing of a tool (Amorph) that converts different file types (BMP, TIFF, JPEG etc.) to PDF/A.	Digital images and documents are archived in the PDF/A file format.
Stanford University Libraries – David S. H. Rosenthal, Thomas Lipkis, Seth Morabito, Thomas Robertson	LOCKSS	2004	Implementing “migration on access” conversion of GIF files in a website to PNG files when the website is requested. For the proof of concept the conversion mechanism was placed in the LOCKSS system.	The project successfully converted GIF files in a website on the fly to PNG files. The file conversion was not noticeable for the requester of the website.

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Name institution and contact person	Project	Period	Activities	Results
The National Library of the Netherlands / IBM – Hilde van Wijngaarden	Universal Virtual Computer for digital images	2004	Implementation of UVC concept (R. Lorie). Development of: <ul style="list-style-type: none"><li>• UVC</li><li>• JPEG decoder, LDS</li><li>• GIF decoder, LDS</li><li>• Viewer</li></ul>	The UVC for images can be used as a “safety net” for publications in the e-Depot. Publications consist mainly of files in the Portable Document Format. This format is quite complex. Development of an LDS and PDF decoder takes a lot of time. To keep the scope of the UVC project workable, a UVC for digital images was developed. The publication (PDF) will be converted to JPEG before it can be rendered by the UVC. Periodical mass migrations are not necessary.

### Theoretically-oriented projects

In the overview below projects and the institutions that carried them out are presented. The projects all have theoretical results concerning migration as a digital preservation strategy and could be of interest for the KB.

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Name institution and contact person	Project	Period	Subject	Remarks
CEDARS: Consortium of University Research Libraries University of Leeds- Paul Wheatly, Derek Sergeant	CEDARS	1998 - 2001	Migration on request: conversion of a digital object will be carried out when the object is requested.	During the CAMiLEON project a practical test of “migration on request” was carried out.
Council on Library and Information Resources – Gregory W. Lawrence, William R. Kehoe, Oya Y Rieger, William H. Walters, Anne R. Kenney		2000	Risk management: check list for migration processes	Usable for setting up my tests?
University of Pennsylvania - John Ockerbloom	Typed Object Model	2000-2001	Formalisation of conversions, the properties of a file type. Respectful Type Converters Links are not working!	Too formal to use at this moment

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Name institution and contact person	Project	Period	Subject	Remarks
University of Pennsylvania – John Ockerbloom		2001	Archiving and preservation of PDF in parts: <ul style="list-style-type: none"><li>• Static images of a page in a PDF</li><li>• Text (content) of the PDF</li><li>• Structure (table of content) in the PDF</li><li>• Dynamic parts</li></ul>	Tools mentioned: Ghostscript for conversion to images, Pstext or Prescript for conversion to text.
University of Leeds - Paul Wheatley	CAMiLEON	2001	Classification of different levels of migration based on complexity.	Usable when setting up my tests?
Smithsonian institution archives - Dollar Consulting		2001	Recommendation for digital preservation strategy: HTML to XHTML (normalisation)	

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Name institution and contact person	Project	Period	Subject	Remarks
Department of Software Technology and Interactive Systems, Vienna University of Technology - Carl Rauch, Andreas Rauber	DELOS- Testbed and Utility Analysis	2004	<ul style="list-style-type: none"><li>• Designing a framework for a digital preservation decision model.</li><li>• Designing a test bed application that archives several digital files and their file properties.</li></ul>	During the project several case studies were carried out applying the framework to audio and video files and text documents using migration as the digital preservation strategy. No practical migration tests were carried out.
DAVID - Filip Boudrez		2005	Guidelines for conversion to standard file formats for archival purposes (normalisation)	
University of Minho, Portugal - Miguel Ferreira (Ph D student)		2005 (ECDL)	Proposal for a pilot project. Subject is Automatic Evaluation of Migration Quality in Distributed Networks of Converters	

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## 3 Overview variations of migration

### 3.1 Introduction

In the literature on migration the terms “migration” and “conversion” are frequently used to describe the same process. This migration research project will also use both terms to describe the same process.

This chapter describes the types of migration that can be filed under the term “transformation”. This term is used in the OAIS Reference Model <sup>1</sup>. Transformation is defined as a migration (conversion) of a digital object that changes the Content Information (PDI bits) to archive the complete information content of the object. This description fits in with the definition for the digital preservation strategy migration: the conversion of a digital object in a specific software and hardware environment to another software and hardware environment. This conversion is carried out to keep permanent access to the digital object. In the OAIS Reference Model four types of migration are described: refreshing, replication, repackaging and transformation. Only transformation changes the Content Information. The KB migration research project will not be focussed on the other types of migration (such as migration of the carrier). During the project the term “migration” will be used and not the term “transformation”.

Transformation defines migration as a process that changes the digital object to keep it accessible. Conversion of the digital object can cause errors in the digital object or the loss of properties of the original digital object. The severity of errors and the amount of loss of properties depends on the type of migration used. The fact that converting a digital object can cause corruption of the object and/or loss of functionality is a disadvantage of migration as a digital preservation strategy in general and will not be part of the descriptions of types of migration in this chapter. The overview shows the advantages and disadvantages for each type of migration, the extent to which errors can occur will be described as an advantage or disadvantage.

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<sup>1</sup> Reference Model for an Open Archival Information System (OAIS), Blue Book, Consultative Committee for Space Data Systems, January 2002  
[http://ssdoo.gsfc.nasa.gov/nost/isoas/ref\\_model.html](http://ssdoo.gsfc.nasa.gov/nost/isoas/ref_model.html)

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## 3.2 Overview

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Variations of migration	Description	Advantage	Disadvantage
Migration to a newer version	“Migration to a newer version” is the process of migrating a digital object in file format A to a newer version of file format A. This process will have to be repeated when the newer version of the file format starts to become	<ul style="list-style-type: none"><li>• Known process (used in practice already, although not specifically for digital preservation purposes)</li><li>• Properties of a document are</li></ul>	<ul style="list-style-type: none"><li>• The process of migration will have to be repeated indefinitely.</li><li>• The number of digital objects that need to be migrated will grow</li></ul>

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Variations of migration	Description	Advantage	Disadvantage
	<p>out-of-date and the migrated object is threatened with inaccessibility.                      The process can be carried out step by step or by leaps.                      A step by step process means that the object in version 1.1 is converted to 1.2 etc. Carrying the process out by leaps means the object in version 1.1 is directly converted to 1.4 without conversion to the intermediate versions.                      When the process is carried out by leaps less migrations will have to be executed.</p>	<p>maintained well in the migrated version of the original digital object.</p> <ul style="list-style-type: none"> <li>• Possible new functionality present in the newer version of the application that is used to render the digital object.</li> </ul>	<p>when the depot content grows. Migration projects will have a longer duration.</p> <ul style="list-style-type: none"> <li>• Probably not usable for long-term digital preservation because of accumulation of the chance mistakes will occur. This chance is bigger when step by step migration is used.<sup>2</sup></li> <li>• The results of the migration processes A &gt; B &gt; C could be worse than the migration process A &gt; C with hindsight.</li> <li>• Existing functionality in the application used for the original digital object can disappear when the user renders the migrated object in a newer version of the old application</li> </ul>

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<sup>2</sup> See the results of Testbed (Den Haag, 2003), carried out by the National Archives of the Netherlands.

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Variations of migration	Description	Advantage	Disadvantage
Migration to a different file format	“Migration to a different file format” is the process of converting a file format A to file format B. (file format B is not considered to be a standard file format <sup>3</sup> , but it is a more widely used format or a newer format than file format A).	<ul style="list-style-type: none"> <li>• Known process (used in practice already, although not specifically for digital preservation purposes)</li> </ul>	<ul style="list-style-type: none"> <li>• The process of conversion will have to be repeated indefinitely.</li> <li>• The number of digital objects that need to be migrated will grow when the depot content grows. Migration projects will have a longer duration.</li> <li>• Probably not usable for long-term digital preservation because of accumulation of the chance mistakes will occur. This chance is bigger when step by step migration is used.</li> <li>• Conversion to a different file format enlarges the chance that loss of information or of functionality will occur.</li> </ul>
Normalisation	“Normalisation” is the process of converting a file format A to a standard file format C.	<ul style="list-style-type: none"> <li>• Known process (used in practice already, although not specifically for digital preservation purposes)</li> </ul>	<ul style="list-style-type: none"> <li>• Migration processes will have to be repeated, using a standard file format is not a stand-alone solution</li> </ul>

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<sup>3</sup> Definition of a standard file format: A de jure standard is a widely used file format, based on open standards (it is not proprietary). A de facto standard is a widely used file format, based on a closed file format and proprietary. For archiving and digital preservation a de jure file format standard is preferred to a de facto file format standard.

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Variations of migration	Description	Advantage	Disadvantage
		<ul style="list-style-type: none"><li>• When a small amount of standard file formats is used, less effort is needed for preservation of and permanent access to digital objects.</li><li>• A standard file format is often used by many. Commercial companies have a larger incentive to maintain access to objects in a standard file format.</li><li>• Expectations are that standard file formats won't become obsolete very quickly and that standard file formats will need less migration processes than non-standard file formats do for maintaining permanent access.</li></ul>	<p>for permanent access.</p> <ul style="list-style-type: none"><li>• The number of digital objects that need to be migrated will grow when the depot content grows. Migration projects will have a longer duration.</li><li>• When a choice is made which standard file formats will be used for archiving, the risk exists that with hind-sight the chosen format turns out not to be the best format for archiving.</li><li>• Conversion to a different file format enlarges the chance that loss of information or functionality will occur.</li></ul>

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Variations of migration	Description	Advantage	Disadvantage
"Migration on request"	"Migration on request" is the process of converting a file format A to another file format B or C when the specific digital object is requested. The original digital object will be converted to a newer version or a different file format at the time when a person requests the digital object. It will not be necessary to have repeated migration processes for all digital objects that are stored in the archive.	<ul style="list-style-type: none"><li>• Conversion is only needed when the digital object is requested. Periodical migration processes are not necessary.</li><li>• Loss of (significant) properties of the original file can be minimalised by using the original file for the conversion.</li></ul>	<ul style="list-style-type: none"><li>• It is necessary to check periodically whether the conversion of file format A to file format B or C is still operational. This is a risk in the preservation of digital objects. When file formats B and C are no longer accessible, a conversion to file format D instead of B or C should still be possible.</li><li>• Conversion tools will have to be rewritten to be able to use them over a long period of time.</li><li>• Migration on request has not been tested very often in practice.</li><li>• There could be a response time issue when a digital object is converted on request.</li></ul>

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Variations of migration	Description	Advantage	Disadvantage
“Migration on request” (modular)	Modular “migration on request” makes use of the principle of “migration on request”: a conversion is only carried out when a specific digital object is requested. Modular migration aims to prevent the rewriting of conversion tools. The modular approach uses an “input” module, which will be static because it is used to import the original file format A. The “output” part of the conversion tool will change when the target file format B changes to format C. The articles about the modular approach of migration on request mention an “in-between” format to which original (or source) file format A is converted before it will be converted to the target file format B or C.	<ul style="list-style-type: none"><li>• Conversion is only needed when the digital object is requested. Periodical migration processes are not necessary.</li><li>• Loss of (significant) properties of the original file can be minimalised by using the original file for the conversion.</li><li>• It will not be necessary to rewrite complete conversion tools.</li></ul>	<ul style="list-style-type: none"><li>• It is necessary to check periodically whether the conversion of file format A to file format B or C is still operational. This is a risk in the preservation of digital objects. When file formats B and C are no longer accessible, a conversion to file format D instead of B or C should still be possible.</li><li>• Modules of conversion tools will have to be rewritten to be able to use them over a long period of time.</li><li>• There is no clarity about the “in-between” format. The choice for a specific format has a large impact on the possibilities of a target file format.</li><li>• The concept is still only in a theoretical research phase, it has not been tested in practice yet.</li></ul>

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Variations of migration	Description	Advantage	Disadvantage
Automatic evaluation of migration quality in a distributed network of conversion tools.	The architecture for a distributed network of conversion tools partly uses the framework of Rauch and Rauber (decision model for digital preservation strategy, based on expected Utility). The design can be used for all sorts of types of migration (normalisation, migration on request etc.)	<ul style="list-style-type: none"><li>The idea is that by access to several conversion tools, the digital aging of tools is taken care of.</li></ul>	<ul style="list-style-type: none"><li>It is still in concept phase, no practical tests have been carried out yet.</li></ul>

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Variations of migration	Description	Advantage	Disadvantage
UVC	<p>The UVC is a virtual computer analogue to the existing computer architecture. The UVC is very simple and can be used for any computer environment, also future environments. The implementation for JPEG and GIF, developed by the KB and IBM, consists of four components:</p> <ol style="list-style-type: none"> <li>1. Universal Virtual Computer (UVC)'</li> <li>2. Format decoder</li> <li>3. Logical Data Schema (LDS)</li> <li>4. Viewer</li> </ol> <p>The original object (a JPEG or GIF in this case) is transformed to a Logical Data View (LDV) using a Format decoder (this equals a conversion to a platform independent "standard" format). The LDV uses the Logical Data Scheme to make sense of the elements in the LDV and the object can be viewed in a Viewer that translates the LDV.<sup>4</sup></p>	<ul style="list-style-type: none"> <li>• Known process (proven concept in practice for JPEG and GIF file format)</li> <li>• The Format decoder and LDS can be developed in present times. Implementation specifications of the top layer of the UVC, on which the decoder software will run, can also be written down in present times. Specifications for the Viewer application describe how the Viewer in combination with the LDS will render the digital object in future times. Not specified in present times is how the Viewer and the UVC will be implemented on future computer environments</li> <li>• A conversion process will only be needed when the digital object is requested.</li> <li>• Periodical, large scale conversion</li> </ul>	<ul style="list-style-type: none"> <li>• A UVC for complex file formats such as PDF hasn't been developed yet.</li> <li>• It is not known whether the specifications for the UVC and Viewer are sufficient enough for future programmers.</li> </ul>

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<sup>4</sup> For more information [http://www.kb.nl/hrd/dd/dd\\_onderzoek/uvc\\_voor\\_images.html](http://www.kb.nl/hrd/dd/dd_onderzoek/uvc_voor_images.html)

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Variations of migration	Description	Advantage	Disadvantage
		processes are not needed.	

## 4 Preliminary evaluation

### Evaluation

Many institutions declare that migration is their main digital preservation strategy. It is, however, not easy to find out whether any concrete migration tests have been performed and what is considered “migration” by the institutions when using the internet as the main source of information. The number of institutions that have published about migration projects is smaller than expected at the beginning of this migration research project.

The PLANETS project is a good opportunity to work within an international coalition on digital preservation strategies and (concrete) tests.

### Continuation

Based on the information described in this document, the possibilities of migration as a digital preservation strategy for the KB will be defined. Subsequently, several variations of migration will be tested on a small scale.

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