The LIFE Model v1.1

The LIFE Team, October 2007

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1 Introduction

The LIFE Model provides a view onto the typical processes applied to digital objects throughout their lifecycle, by an organisation acting as the custodian of those objects. The processes are loosely organised in a chronological order, from their creation through to eventual access. It should be noted however that processes can, in practice, overlap with each other or execute in a different order. The model aims to capture common processes found in most digital lifecycles. While some processes may not be applicable to all lifecycles the intention is to provide meaningful placeholders for the majority of typical lifecycle processes.

1.1 About this document

This document draws together feedback, discussion and review of the LIFE Model from a number of sources:

1. The LIFE and LIFE2 Project Teams, and the staff of their institutions
2. Feedback from review by independent economics expert[1]
3. The LIFE Project Conference[2]
4. Early adopters of the Life Model (particularly the Royal Danish Library, State Archives and the State and University Library, Denmark)

The result is a revision of the LIFE Model which was first published in 2006 by the LIFE Project[3].

In line with the objectives of the LIFE2 Project, this revision aims to:

1. fix outstanding anomalies or omissions in the Model
2. scope and define the Model and its components more precisely
3. facilitate useful and repeatable mapping and costing of digital lifecycles.

1.2 Reading this document

This document provides a revision of previous LIFE Project work and is thus best understood in the context of the reports from that project. The LIFE Project Summary provides a good introduction to the aims of the project, the issues addressed and the

[1] Bo-Christer Bjork, independent economics expert employed by LIFE2 to review LIFE1 work.

[2] The LIFE Project Conference, 20th April 2006, The British Library, London, http://www.life.ac.uk/1/conference.shtml

[3] McLeod, R. and Wheatley, P. and Ayris, P. (2006) *Lifecycle information for e-literature: full report from the LIFE project.* Research report. LIFE Project, London, UK. http://eprints.ucl.ac.uk/archive/00001854/01/LifeProjMaster.pdf

solutions developed. Documentation and further information can be found on the LIFE website[4].

1.3 Feedback

The LIFE Team are very keen to receive feedback on this document, which can be directed to life@bl.uk or posted to the LIFE Blog at http://www.life.ac.uk/blog/.

[4] http://www.life.ac.uk

2 Lifecycle Processes and Costs

The following table provides an update to the LIFE Model. Section 4 provides notes and explanation on the justification for changes made. Section 3 provides a more detailed description and definition of the lifecycle elements.

Lifecycle Stage	Creation or Purchase[5]		Acquisition	Ingest	Metadata Creation[6]	Bit-stream Preservation	Content Preservation	Access
Lifecycle Elements	....		Selection	Quality Assurance	Re-use Existing Metadata	Repository Administration	Preservation Watch	Access Provision
	....		Submission Agreement	Deposit	Metadata Creation	Storage Provision	Preservation Planning	Access Control
	....		IPR & Licensing	Holdings Update	Metadata Extraction	Refreshment	Preservation Action	User Support
	....		Ordering & Invoicing	Reference Linking		Backup	Re-ingest	
			Obtaining			Inspection		
			Check-in					

[5] This stage may be beyond the scope of some costing activities. Creation may occur outside of the view of the costing institution. It should therefore be considered to be optional. Where considered within scope, elements will need to be tailored to the specific lifecycle case in question.

[6] Metadata Creation is often considered to be part of the process of Ingest. Due to its significance within the lifecycle, it has been represented within the Model as a distinct lifecycle stage.

2.1 Non-lifecycle Processes and Costs

The following table provides a summary of non lifecycle costs. Scoping of lifecycle and non-lifecycle costs is discussed in more detail in the following section.

Non-Lifecycle	Management and Administration	Systems / Infrastructure	Economic Adjustments
Non-Lifecycle Elements	Management	Repository Software	Inflation
	Administration		Discounting

2.2 Lifecycle Scope

2.2.1 Aims and challenges of defining the scope of lifecycle costs

Defining the scope of "Lifecycle Costs" and "Non-lifecycle Costs" is essential if costing activities are to be precise and repeatable, and the results of costing activities are to remain comparable across different lifecycles and different institutions. Decisions in scoping must be practical, ensuring that costing activities are not unduly complicated. They should ideally reflect common sense in what should and should not be included and be consistent. Enabling a meaningful comparison between analogue and digital lifecycles requires careful consideration[7].

Defining a clear scope is a difficult problem and there are a number of grey areas. LIFE2 is seeking to define the scope as tightly as possible, and it is expected that the development of the case studies will considerably assist in this area.

2.2.2 The LIFE Lifecycle Scope

Lifecycle Costs are considered to be the costs that are directly associated with the processes necessary to preserve some specific digital objects. The scope can be illustrated with the example of an established digital repository, with existing streams of digital objects coming into the repository. In this case, Lifecycle costs could be considered to be the costs of whatever additional processes will need to be performed in order to add a new digital object stream to the digital repository.

Examples of Lifecycle costs: Selection policy, ingest of digital objects into a repository, creation or extraction of metadata, storage hardware, backup, provision of access.

Examples of Non-lifecycle costs: Management, inflation, digital repository software.

Hardware or software that supports a specific digital object stream is considered to be within the scope of lifecycle costing. Hardware or software that provides general support across all digital object streams is considered to be outside of the scope of lifecycle costing.

[7] Comparison between analogue and digital lifecycles is a key focus for LIFE2, particularly with regard to the Burney Newspaper Collection case study.

3 Stage and Element definitions, with suggested Sub-elements

Stages represent high level processes within the lifecycle which group related lifecycle processes together. Elements represent the next level down of lifecycle processes. They are still relatively high level and but are focused on a distinct process within the lifecycle. The LIFE model attempts to describe a standard set of elements to which most digital lifecycles can easily be mapped. Sub-elements represent the specific components of a lifecycle element. At this level of detail, lifecycles are expected to vary considerably from one to another and so the detailed sub-elements are provided here for guidance only.

The breakdown of components within the Life Model:

Lifecycle level	Explanation
Lifecycle	The process from creation to access for a particular digital object, which can be broken down further into a number of distinct processes.
Lifecycle Stage	A high level process within a lifecycle. Provides a way of grouping related lifecycle elements. Processes within a Lifecycle Stage typically occur or recur at the same point in time.
Lifecycle Element	A distinct and significant lifecycle process that will provide useful costing information for organisations to perform planning, evaluative or comparative exercises.
Lifecycle Sub-element	A suggested key component of a lifecycle element. Not significant enough to warrant inclusion as a distinct lifecycle element.

3.1 Creation or Purchase

There are three main sources for digital objects which might be acquired and preserved by and organisation:

1. Creation (where the objects are created by or within view of the preserving organisation)
2. Purchase (where the objects are bought or licensed for use by the organisation)
3. Donation (where objects are donated to the preserving organisation at no cost)

This lifecycle stage is a placeholder for these different processes or costs that may be encountered by the preserving institution. Given the tremendous variations in cost that may be encountered that depend on the digital object stream in question, this lifecycle stage should be considered optional within the lifecycle costing process. It is therefore represented graphically within the LIFE Model with a separation from the other lifecycle stages.

Where a particular lifecycle involves creation within the preserving institution, particular lifecycle processes will need to be identified and defined. Examples of Creation processes might include: e-book authoring, scholarly publishing/authorship, and digitisation.

3.2 Acquisition

Acquisition represents the initial stages of acquiring and processing digital objects prior to ingest into a digital repository. Acquisition processes relate to collection management, administration and the operations of receiving or obtaining the objects themselves.

3.2.1 Selection

Selection is the key collection management process of deciding what materials should be acquired. This typically involves the development of a Collection Policy which will capture factors such as the mission of the organisation, the purpose and strengths of the collection and existing agreements influencing selection[8]. A selection process will then consider issues such as the value of the material, expected use and expected costs of preservation against the drivers of the Collection Policy and decide whether to proceed with acquisition or not. Selection is typically conducted by a mix of collection management specialists, content specialists, operational staff and preservation staff.

Suggested Sub-elements	Explanation / notes
Selection Policy (policy/procedure)	Development of the Selection Policy for the collection
Selection (action)	The application of the selection process, guided by the Selection Policy
Selection Metadata (metadata)	Recording of metadata describing the scope, results and justification for the selection decisions

3.2.2 Submission Agreement

This is the process of establishing a submission agreement with the supplier of the digital objects being acquired. Requirements for the producers/depositors are established and agreement on the conditions of the submission will be negotiated with the producers/depositors. A submission agreement will define the details and conditions of the relationship between the acquiring organisation and the producers/depositor. This might include: the expected file formats of the digital objects, the packaging of the digital objects and expected medium of transport, the frequency of delivery of objects, and the procedures for mitigation should expected or agreed quality levels not be met.

For voluntarily or legally deposited digital objects this element might focus on defining and communicating the conditions of deposit rather than specific communication and negotiation with the producer/depositor.

Suggested Sub-elements	Explanation / notes
Submission Agreement (policy/procedure)	Specification of submission requirements for producers/depositors
Negotiation of Submission (action)	Communication and negotiation with producers/depositors regarding submissions
Submission Metadata (documentation)	Recording of metadata relating to submission requirements

3.2.3 IPR & Licensing

IPR and Licensing is the process of researching, negotiating and agreeing on the rights to access and preserve digital objects. Research may be required in order to investigate the current IPR situation, and possibly identify and locate the rights holder. Negotiation with the rights holder may be necessary in order to agree on the right to access and preserve the digital objects. In some cases, rights may negotiated via a licensing agreement. It may be necessary to repeatedly re-negotiate agreements or re-evaluate the IPR situation at particular times throughout the digital object's lifetime.

[8] Cedars Guide to Collection Management, Cedars Project, http://www.leeds.ac.uk/cedars/guideto/collmanagement/guidetocolman.pdf

IPR and Licensing is related to the establishment of a Submission Agreement but is considered to be significant enough to be considered as a specific lifecycle element.

Suggested Sub-elements	Explanation / notes
IPR and Licensing (policy/procedure)	This might include investigating the current IPR situation and who the relevant IPR holders are.
Negotiation of Rights (action)	Negotiation of rights to preserve and provide access with producers/depositors
Negotiation of Licensing Agreements (action)	Negotiation of rights to provide access with producers/depositors
Rights Metadata (metadata)	Recording of rights metadata

3.2.4 Ordering and Invoicing

Ordering and Invoicing is the administrative process associated with ordering, invoicing and paying for digital objects, whether purchased or licensed. Following the establishment of a relationship with the producer/depositor as part of the Submission Agreement, and negotiation of rights, this element represents the more frequent and repeated communication to order, track and invoice for particular acquisitions or packages of acquired objects or titles.

This may not be applicable for voluntarily or legally deposited digital objects.

Suggested Sub-elements	Explanation / notes
Ordering and Re-ordering (action)	Ordering and re-ordering of the object, where it has been found to be of an insufficient level of quality during the Check-in or Quality Assurance processes
Invoicing (action)	Invoicing and administration for payments made
Ordering Metadata (metadata)	Record ordering and invoicing metadata

3.2.5 Obtaining

This is the process of transporting the digital object from the source via whatever means (for example by post on handheld media, by email, by ftp) to the preserving organisation. It is considered typical to utilise a checksum mechanism to guard against bit loss during the transport process, which would then be verified during the subsequent Check-in phase.

Suggested Sub-elements	Explanation / notes
Obtaining (action)	Transport of the object to the preserving organisation
Obtaining Metadata (metadata)	Record obtaining metadata

3.2.6 Check-in

Check-in is the process of ensuring that what was expected to be obtained (or ordered) actually arrives. It does not constitute a detailed Quality Assurance process that might verify that a specific digital object is what it purports to be (this can be found in the following Ingest category). Check-in is a less thorough process that might, for example, verify issues, titles or filenames match those that have been ordered. It might also include verification that bits have not been lost, by recalculating and matching checksums.

Suggested Sub-elements	Explanation / notes

Content Check (action)	Verify titles, issues, filenames
Fixity Check (action)	Verify checksums
Check-in Metadata (metadata)	Record check-in metadata

3.3 Ingest

Ingest represents the processes involved in assessing and analysing digital objects and then ingesting them into the preserving organisation's digital repository.

3.3.1 Quality Assurance

Quality Assurance is the process of examining digital objects and ensuring they are of a sufficient or expected level of quality. If the assessed quality level is not sufficient, a mitigation strategy might have to be applied. This might include applying fixes, re-acquiring objects or recording metadata describing the details of the quality issues encountered. QA typically includes the process of checking the materials for viruses, and taking appropriate action to clean virus tainted objects.

Suggested Sub-elements	Explanation / notes
QA Policy (policy/procedure)	Description of quality requirements and required mitigation actions should quality requirements not be met. Policy for sampling of objects for QA (if appropriate)
QA Characterisation (action)	Characterisation of the digital object. Identification of file format, and assessment of whether the object is valid, well formed, and/or renders correctly with current access software
Content Examination (action)	Assessment of whether the content of the digital object is of an expected, agreed or sufficient level of quality. Typically, a manual process on a sample of the ingested objects
Mitigation (action)	Action to mitigate quality issues (might include virus cleaning or re-ordering or obtaining the digital object)
QA Metadata (metadata)	Record QA metadata

3.3.2 Deposit

Deposit is the process of committing digital objects to the repository, and executing any associated operations.

Suggested Sub-elements	Explanation / notes
Deposit (action)	Commit the digital object to the repository
Deposit Metadata (metadata)	Record Deposit metadata

3.3.3 Holdings Update

This element refers to the updating of holdings records (e.g. catalogue) when new digital objects are accessioned.

Suggested Sub-elements	Explanation / notes
Holdings Update (action)	Update holdings records
Holdings Update Metadata (metadata)	Record Holdings Update metadata

3.3.4 Reference Linking

Reference Linking is the process of adding to or updating information used in systems that facilitate the finding of the digital objects.

Suggested Sub-elements	Explanation / notes

Create Search Indices (action)	Creation of indices for use within search engines.
Reference linking (action)	Linking the object to entries in relevant finding aids.
Reference Linking Metadata (metadata)	Record Reference Linking metadata

3.4 Metadata Creation

This stage represents the process of identifying, extracting and recording metadata describing the digital object. Some existing metadata might accompany the digital object and can be extracted or reused. Some metadata might need to be extracted from the digital object itself. Some metadata might need to be entered manually.

The following Metadata Creation elements are suggested:

- Re-use Existing Metadata (where metadata accompanying the ingested digital object is stored, converted or re-used)
- Metadata Creation (where new metadata is created, typically as part of a manual cataloguing process)
- Metadata Extraction (where metadata is extracted from the digital object, typically as part of an automated characterisation or metadata extraction process)

No further breakdown of these elements is suggested at this time[9].

3.5 Bit-stream Preservation

Bit-stream Preservation is the process of storing and maintaining digital objects over time, ensuring that there is no loss or corruption of the bits making up those objects. Provision of storage on its own is not enough to constitute Bit-stream Preservation. Bit-stream Preservation can be achieved when storage is supported by effective management, backup, a programme of refreshment, and periodic inspection to ensure stored objects can be retrieved.

3.5.1 Repository Administration

Storage Administration represents general repository administration and other miscellaneous tasks associated with the provision of Bit-stream Preservation.

Suggested Sub-elements	Explanation / notes
System Technology Watch (action)	Monitoring for the need to upgrade or update systems or hardware due to technology obsolescence.
System Security (action)	Maintenance and auditing of repository system security
Statistics and Reporting (action)	Recording and reporting of statistics.
Disaster Recovery Planning (action)	Planning for recovery and re-establishment of the repository in the event of disaster[10].
Manage Duplicate Storage (action)	Management processes associated with effective maintenance and synchronisation of multiple node storage.
Storage Procurement (action)	Procurement of storage hardware

[9] It is worth noting that the representation of Metadata within the model was one of the most contentious topics discussed within the LIFE team and more widely. Needless to say, further feedback on this topic is very welcome.

[10] Note that this does not refer to Backup (covered in a subsequent element) or Duplication (covered in the next sub-element) as in the OAIS model.

3.5.2 Storage Provision

This element represents the process of storing digital objects, with the ability to retrieve them as requested[11]. It includes the support and maintenance of the storage hardware.

Suggested Sub-elements	Explanation / notes
Storage hardware (technology)	Costs associated with hardware purchases
Storage Maintenance and Support (action)	Maintenance and support necessary to keep the storage fully functional over time

3.5.3 Refreshment

Refreshment is the process of moving stored items to new storage hardware as existing storage hardware reaches the end of its lifetime.

Suggested Sub-elements	Explanation / notes
Refreshment (action)	Moving digital objects to new hardware

3.5.4 Backup

Backup is the process of making frequent copies of stored objects, typically on tape media, in order to provide a degree of insurance against lost, damaged or deleted data.

Suggested Sub-elements	Explanation / notes
Backup Procedure (policy/procedure)	Development of backup policy and procedure
Backup (action)	Planned backup activity
Recovery (action)	Irregular (and hopefully infrequent) recovery of data from the backups

3.5.5 Inspection

Inspection is the process of ensuring stored objects can be retrieved without loss. It includes both automated fixity checking and manual retrieval and viewing.

Suggested Sub-elements	Explanation / notes
Fixity Audit (action)	Automated auditing of stored objects ensuring matching re-generated checksums with previously stored checksums to identify changes or loss of content
Manual Inspection (action)	Manually inspection of a sample of digital objects to ensure they can be retrieved and rendered as expected
Inspection Metadata (metadata)	Record Inspection metadata

3.6 Content Preservation

3.6.1 Preservation Watch

Preservation Watch monitors the context in which the preservation lifecycle exists, and gathers requirements which will inform Preservation Planning activities[12]. These requirements will guide the decision process undertaken in Preservation Planning as to what action might be appropriate to take to preserve the digital objects.

Suggested Sub-elements	Explanation / notes
Technology Watch (action)	Focusing on technology changes in areas such as file formats, rendering tools, environments.

[11] Note that multiple-node or multiple-site storage will require the modelling and costing of each node.

[12] And may also inform processes in other parts of the lifecycle.

Monitor Institution (action)	Capturing preservation planning requirements from the preserving organisations preservation policy and broader organisational strategy.
Monitor User Community (action)	Gathering requirements influenced by the end users of the objects.
Monitor Producer (action)	Monitoring of the producer of the digital objects (if applicable).
Record Planning Requirements (metadata)	Recording of requirements for preservation planning based on information gathered by preservation watch activities.

3.6.2 Preservation Planning

Preservation Planning considers inputs to the planning process such as the profile of the objects to be preserved, contextual factors such as usage, and other planning requirements (provided by Preservation Watch). It assesses available preservation solutions and develops a plan for preservation. A preservation plan should guide preservation staff in the actions required to preserve digital objects over time.

Suggested Sub-elements	Explanation / notes
Preservation Planning (action)	Assessment of planning requirements and preservation solutions, and development of preservation plans.
Record/Update Preservation Metadata (metadata)	Updating preservation metadata, such as Representation Information, based on preservation planning conclusions.

3.6.3 Preservation Action

Preservation Action covers the process of performing actions on digital objects in order to ensure their continued accessibility. It includes evaluation and quality assurance of actions, and the acquisition or implementation of software to facilitate the preservation actions. Preservation actions will be defined and described by a preservation plan created in the previous element.

Suggested Sub-elements	Explanation / notes
Integrate new preservation solution (action)	Obtain/integrate new preservation action tool
Perform Preservation Action (action)	Updating preservation metadata, such as Representation Information, based on preservation planning conclusions.
QA Preservation Action (action)	Perform an evaluation and QA of the preservation action
Record Preservation Action Metadata (metadata)	Record Preservation Action metadata

3.6.4 Re-ingest

Re-ingest represents the ingest of migrated objects back into the repository. It might be modelled in different ways depending on the lifecycle and organisation in question, so is provided as a distinct element. Re-ingest might include the following repeated elements[13]:

1. Obtaining
2. Check-in
3. Quality Assurance

[13] These repeated re-ingest elements may be more streamlined processes than when executed for the first time earlier in the lifecycle. For example, re-ingested content might be characterised to identify and validate file format, but more extensive metadata extraction may only duplicate what has already been captured and so might be omitted.

4. Characterisation and Metadata Extraction
5. Deposit
6. Holdings Update

It should also be noted that subsequently to Re-ingest, continued Bit-Stream Preservation and Content Preservation of the new objects will also be required.

3.7 Access

3.7.1 Access Provision

This element represents the process of providing access to the digital objects for users.

Suggested Sub-elements	Explanation / notes
Access Provision (action)	Retrieval of digital objects and Provision of access to users.
Rendering and representation (action)	Provision of software and/or information to facilitate rendering of the digital object by the user
Record Access metadata (metadata)	Record usage metadata

3.7.2 Access Control

Access control represents the application of actions or technical measures to ensure access is provided to appropriate users, as per previously negotiated access rights and that those users are only able to use the content in ways which conform to those rights.

Suggested Sub-elements	Explanation / notes
Access Control (action)	Restriction of access to those users allowed to use the digital objects
Technical Protection Measures (action)	Restriction of uses of the digital objects
Record Access metadata (metadata)	Record usage metadata

3.7.3 User Support

This element represents the support of users who access the digital objects. It includes enquiry services, reference services and general user support and correspondence.

Suggested Sub-elements	Explanation / notes
User Support (action)	No further suggested breakdown below the element level.

3.8 Non-lifecycle Processes and Costs

Non-lifecycle Processes and Costs are attributed to the preserving organisation but are not directly associated with the lifecycle of the digital objects in question. These might include staff management, administration (including financial and human resource), financial (including pension costs), facilities and their support (such as office space), and a range of economic factors (such as inflation and discounting). Costs that are not directly related to lifecycle processes should be considered as optional in terms of analysis and recording.

By isolating overhead costs from the costs directly related to lifecycle processes the ability to compare different lifecycles (where one accounts for overheads and the other doesn’t) is retained.

In his review of the LIFE 1 Model and Methodology, Bo-Christer Bjork noted that in the MLA sector, it does not typically make sense to use discounting or to account for inflation[14]. However, there may be exceptions where these economic factors may need to be taken into account (for example, if a commercial company utilised the LIFE Model in costing digital preservation activity). Note that common trends in costs should still be covered in the lifecycle stages (eg. increasing staff costs and decreasing storage hardware costs).

4 Brief notes on the changes to the Model

1. Creation or Purchase stage added. This wasn't of relevance to the case studies covered in LIFE1 but is clearly going to be needed in some cases. For example, the Burney Digitisation case study in LIFE2. It may be possible to provide sets of standard elements for different creation scenarios.
2. Acquisition has been expanded with an additional element: Submission Agreement. IPR and Licensing have been collapsed into one element.
3. Ingest remains relatively unchanged, other than the move of Reference Linking to here from Access.
4. Metadata has been renamed as Metadata Creation. Elements are now categorised by process rather than metadata type.
5. Access has been moved to the end of the lifecycle. While this is not a change of great significance it gives preservation a greater emphasis, with the implication that to achieve access you need to address preservation. Access Control has been added.
6. An attempt has been made to scope lifecycle and non-lifecycle costs, recording them in separate tables. This is a difficult area and will require further attention and review. It is hoped the application of the Model as part of the case study work will illicit useful feedback in this area.
7. Storage has renamed to Bit-stream Preservation. Previously we had only one element here which needed expanding. This stage has now been broken down into more specific elements.
8. Preservation has been renamed as Content Preservation. This is useful as the word Preservation on its own can be ambiguous.
9. The elements within (Content) Preservation have been refined. These are all subject to further change depending on developments to the Generic Preservation Model:
    a. Technology Watch changed to Preservation Watch to reflect the wider range of external entities and changes that need to be monitored.
    b. Preservation Tool Cost has been removed and is subsumed into Preservation Action.

[14] See "EVALUATION OF THE COSTING ACTIVITIES AND ECONOMIC MODELS FOR DIGITAL CURATION USING THE LIFE METHODOLOGY", Bo-Christer Bjork, 2007, www.life.ac.uk. (will be published shortly)

c. Preservation Planning has been added. It was previously covered by Technology Watch but is seen to be important enough to warrant a specific element.

d. QA is subsumed into Preservation Action, as an integral part of that process.

e. Re-Ingest added. This is really a placeholder for repetition of Ingest (and other) elements following a migration action.

5 Next Steps

The Model will continue to be refined throughout the LIFE2 project, and a new version will be published at the end of the project. A number of specific activities will provide feedback or input to this process:

1. Perform detailed mappings to related standards or work, including OAIS, Cedars, Interpares and DRAMBORA. While this has been done on an ad hoc basis as part of this review, performing and recording formal mappings is likely to be a useful exercise
2. Application of the Model as part of the new LIFE2 case studies, and perform a mapping to the LIFE1 case studies.
3. Continue to gather feedback from the wider preservation community and early adopters of the model.

6 Acknowledgements

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