DELIVERABLE

Project Acronym: **EuDML**

Grant Agreement number: **250503**

Project Title: **The European Digital Mathematics Library**

Deliverable 2.4 – External cooperation and interoperability model

Revision: 1.0

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Revision History

Revision	Date	Author	Organisation	Description
0.1	20/12/2012	Thierry Bouche	UJF/CMD	Document structure and layout
0.2	10/01/2013	Thierry Bouche	UJF/CMD	SAB info + external coop.
0.3	17/01/2013	Thierry Bouche	UJF/CMD	Interoperability + web take off report
0.4	17/01/2013	Thierry Bouche	UJF/CMD	First version with all topics addressed
0.5	23/01/2013	Jiří Rákosník	IMAS	Chapter 3 added + revision of the text
0.6	24/01/2013	Thierry Bouche	UJF/CMD	SAB report included + minor edits
0.7	24/01/2013	Michael Jost	FIZ	Feedback from Zentralblatt added
0.8	25/01/2013	Jiří Rákosník	IMAS	Executive Summary, Introduction
0.9	28/01/2013	Romeo Anghelache	FIZ	Updated Zentralblatt test description
1.0	29/01/2013	Thierry Bouche Jiří Rákosník	UJF/CMD IMAS	Revision, corrections, editing, SAB report appended

Abstract

This is the final report on activities carried out in Work package 2 – Policies, exploitation and dissemination of the EuDML project.

The first part is focused on Task 2.5 – External cooperation and interoperability. We describe the model of cooperation with various stakeholders based on variety of specific tools. On one side, these tools help partnering content providers to validate, upgrade and contribute their digital content to EuDML; on the other hand they allow third parties to enrich their services thanks to the availability of collections in the EuDML system.

Outcomes of an ongoing discussion about the business model for sustainable development of the EuDML after project's end are presented.

Executive Summary

The EuDML project was explicitly envisioned as a pilot project addressing two intimately intertwined challenges:

1. *setting up the technical infrastructure to create a unified access point for the digital mathematical content hosted by different organizations across various countries;*

2. *defining a cooperation model with a variety of stakeholders that would allow building a reliable and durable global reference library, aiming to be eventually exhaustive.*

On both sides the project reached clear successes and modified the state-of-the-art. The basic infrastructure is up and running, with a critical mass in content, and a number of possible partners have declared interest in the initiative.

A number of tools have been developed and deployed to ease **contributing new content** to the EuDML system and to offer many useful ways of exploiting the EuDML content, or creating specific views for different communities.

The preferred mechanism for contributing content to EuDML is through OAI-PMH harvesting of XML metadata records structured according to the EuDML schema version 2.0, with the mandatory elements and best tagging practices as specified in deliverable D3.6.

Alternative methods have been set-up to cover all cases found during the project, and are ready to be extended to more content providers.

We have also started to build the second tier of the EuDML network, where a EuDML partner "sponsors" an associated partner by getting hold of its relevant metadata, doing the necessary transformations, and posting them to EuDML from its own OAI-PMH server.

External interoperability is needed to allow third parties to enrich their services thanks to the availability of collections in the EuDML system. This provides more visibility to and more usage of the EuDML collections. We developed a number of specific tools for machine interaction with the EuDML corpus: batch download of public elements in descriptive metadata available through the EuDML public OAI-PMH server, machine query the EuDML database with Opensearch using Contextual Query Language syntax, machine calls to EuDML functions through REST services which are tailored for real-world use cases such as deep linking to EuDML items from an existing bibliographic database. Users can also embed some EuDML data or query form as a widget in a Web page.

We notified many putative linking partners of the availability of these external services. The associated partner BDIM has started to batch link to EuDML items from articles' citations. Zentralblatt MATH also tested it and will expose the generated links on its own service interface, once some more accuracy analysis has been carried out.

Beyond the dissemination activities a number of specific measures have been taken **to engage with possible new partners** and enlarge the initial basis of content providers, technical partners, and supporters. On the technical front, we got expression of interest in the form of attracting new partners in some follow-up to the current project. On the political front, we got awareness and support from several mathematical societies. On the content front, we engaged a large number of discussions, but had to wait for a full-featured Web presence of the project in order to actually attract most new partners.

- The Italian project BDIM was the first external content provider fully associated to EuDML, having contributed two series to the EuDML.

- Among other associated content partners that are currently preparing data for contributing collections to EuDML are: the EMS publishing house, Cornell University's project Euclid and project Math-Net.Ru of the Steklov Mathematical Institute RAS.

- We got the explicit invitation to register content from the digitized proceedings of the International Congress of Mathematics and the European Congress of Mathematics.

- Other non-conclusive discussions have taken place with the eLibrary of the Mathematical Institute of the Serbian Academy of Sciences and Arts, Springer Heidelberg (Open access journals), Elsevier Science and the Swiss Electronic Library project. In 2012 a contact was initiated with Cornell University's project Euclid and project Math-Net.Ru of the Steklov Mathematical Institute RAS; both agreed to join EuDML by posting JATS metadata. A contact has been also made with JSTOR in the hope to acquire their public domain content and make it visible in EuDML. In all these cases, the technical work is ongoing or has not yet started on partners' side.

While establishing all these contacts, we had always in mind that EuDML aims to be a long-standing, reliable and open source of trusted mathematical knowledge. This implies **EuDML policies**, that mostly boil down to the following:

1. *The texts in EuDML must have been scientifically validated and formally published.*

2. *EuDML items must be open access after a finite embargo period. Once documents contributed to the library are made open access due to this policy, they cannot revert to close access later on.*

3. *The digital full text of each item contributed to EuDML must be archived physically at one of the EuDML member institutions.*

These rules ensure that the reference library system we built is on a sound base, with ingested content available for perpetuity and openly accessible eventually.

Based on the above policies, we drew a **model of sustainable EuDML** operation on the basis of the EuDML Initiative, a consortium of EuDML core members being scientifically and organizationally strong not-for-profit institutions that take care of the system's activity, maintenance, and of the collections both in terms of preservation and eventual open access provision. The consortium will form an association without legal personality. Three of the initial eleven members will assume particular roles. The EMS will provide an umbrella using its institutional authority to secure the association's internal functioning and its external representation with respect to partners, other institutions and, in particular, to ensure that the DML services shall remain under control of organizations representing the public interest. For the first period of at least three years, FIZ/Zentralblatt MATH and ICM will provide human resources and machine capacities for hosting, system and service maintenance, and basic technical operations. During this period the possibility/necessity of transforming the Initiative to another model involving legal personality and financial issues will be investigated.

Document index

1.   Introduction

Most of activities in Work package 2 – Policies, exploitation and dissemination have been carried out along the whole project's lifespan, in particular, formulation of EuDML policies and continuous intensive publicity and presentation of the goals and achievements in the project. The progress in some of the tasks in this Work package has already been described in deliverables D2.1, D2.2 and D2.3.

In this document we survey results of our effort to set up a technical environment, a model for external cooperation and interoperability and an organizational framework for the EuDML to be a reliable, truly vivid, ever growing and durable digital archive of mathematical publications useful for a variety of stakeholders with different intertwined interests.

On users' side it is important that EuDML represents a successful technical infrastructure working as a unified access point for the digital mathematical content hosted by a number of different organizations across various countries in Europe with the ambition to expand far beyond these limits.

For the digital content holders and producers the EuDML offers a number of tools to facilitate contributing new content to the EuDML system, exploiting the EuDML content in many useful ways and creating specific views for different communities. The content providers are assisted in tuning and validation of their (meta)data. A model has been explored where publishers can contribute to EuDML by selecting a EuDML member that would host a copy of their content, and make it available to EuDML. A set of specific tools allows third parties to take advantage of availability of collections in the EuDML system and thus enrich their services. These aspects are addressed in Chapter 2.

The system is based on a good and mostly voluntary but responsible cooperation of various partners and to keep it alive after project's end and assure its long term sustainability is a serious task. The ongoing debate on the suitable business model was held among the project partners. The first framework was presented in deliverable D2.3 – EuDML business model leaving some important questions for deeper investigation, namely the legal status, financial stability and external authority of the future arrangement. The principles of the future EuDML Initiative are presented in Chapter 3.

2. External Cooperation and Interoperability

The EuDML project was explicitly envisioned as a pilot project addressing two challenges that prevented previous attempts towards a global digital mathematics library based on a top-down approach to succeed:

1. Setting up the technical infrastructure to create a unified access point for the digital mathematical content hosted by a number of different organizations across various countries;

2. Defining a cooperation model with a variety of stakeholders that would allow building a reliable global reference library meant to run over the long term, and to be eventually exhaustive.

The two challenges are intimately intertwined as the quality of the technical infrastructure and the array of production and interoperability services provided are the main argument to convince possible partners to join the initiative, which in turn is the best way to enlarge and enrich the content available, thus to reach a critical mass in users.

During the three years of the project, these two goals have been pursued in parallel with stubbornness. On both sides the project reached clear successes and modified the state-of-the-art. The basic infrastructure is up and running, with a critical mass in content, and a number of possible partners have declared interest in the initiative. However a lot remains to be done in order to secure these results and set the basis of a strong and inclusive infrastructure.

2.1. The API and the interoperability model

In order to enable many interoperability scenarios, a number of tools have been developed and deployed. The goals pursued are, on one side to make it easy to contribute new content to the EuDML system, and on the other side to offer many useful ways of exploiting the EuDML content, or creating specific views for different communities.
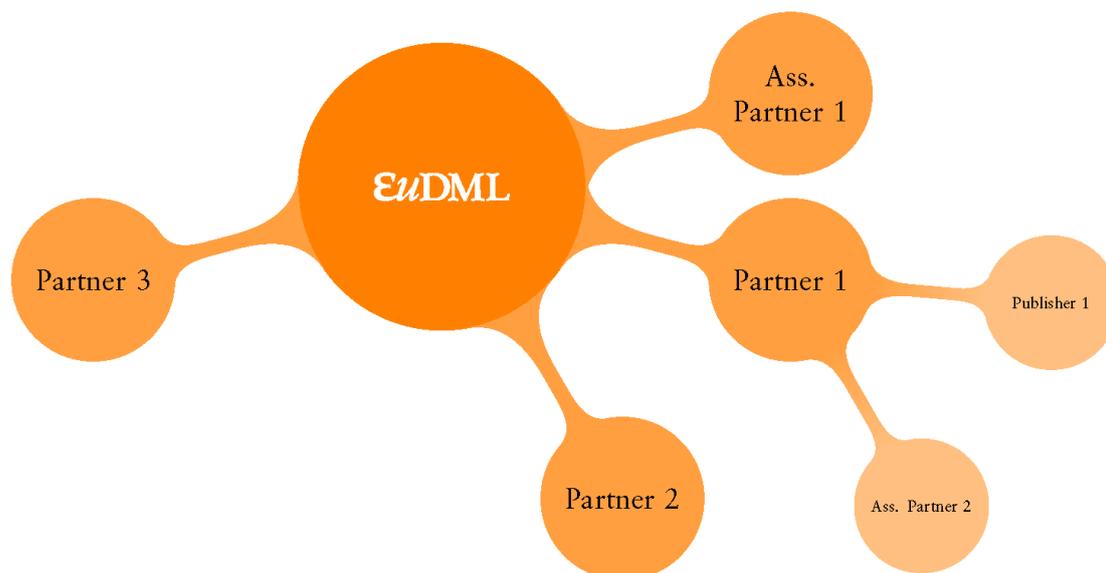
Contributing content to EuDML

The preferred mechanism to contribute content to EuDML is to set-up an OAI-PMH server to export XML metadata structured according to the EuDML schema version 2.0, providing the mandatory elements and tagged according to the best practices that are specified in deliverable D3.6 – The EuDML metadata schema, final version. These specifications have been designed so as to impose minimal technological barrier to content providers yet to enable the transfer of highly detailed and accurate metadata. Many publishers already export JATS files to interoperate with services such as Portico, JSTOR, PubMed Central, etc. To help content providers tweak their EuDML metadata, we provide them with an online validation tool [1], which is also applied in the ingestion workflow. This model is the preferred one as it requires almost no work on EuDML side to ingest or update new content, thus will be available after the project funding expires.

For those content providers who are not able, or not willing, to export metadata prepared according to our recommendations, we developed a number of transformations from the various flavors of OAI-DC, which are performed on-the-fly at ingestion time.

For those content providers who cannot set-up an OAI-PMH server delivering the expected metadata (missing mandatory elements, e.g.) but do have it in some supported format, it is in many cases possible to harvest files through FTP, then run on-the-fly transformations, so that the ingestion process looks transparent to the central system.

Finally, we have started to build the second tier of the EuDML network, where a EuDML partner "sponsors" an associated partner by getting hold of its relevant metadata, doing the necessary transformations, and posting them to EuDML from its OAI-PMH server. UJF/CMD had this role for the collections from GDZ, DML-E for instance, as reported in deliverable D3.5 – Final report on external imported metadata.

After the initial pilot period of EuDML, it is envisioned that publishers should contribute to EuDML in this way: selecting a EuDML member that would host a copy of their content, and make it available to EuDML (in fact, this is the scheme already in use for most of the digitised collections).

Our impression at the end of the project is that this model works pretty well. Some "second tier" partners at the beginning of the project (DML-CZ, e.g.) are now "first tier". It is however an open problem to tell to what extent this model can scale from the current 200+ thousand items to the 1.5 million items in the scope of DML estimated to exist currently in digital form, or even to the 3.5 million mathematical items published worldwide since Euclid. Probably the main barrier here is not technical and will be discussed in § 2.3. But there are lots of small collections out there that would be eligible to EuDML but wouldn't enter into one of the above tiers. Examples of such collections are numerous. Typically this can be a large digital library holding a very tiny portion of mathematical content for which no dedicated work or resources can be allocated, or a very amateur digital library set up by a small group of unskilled people, the extreme version of this being an author's own works digitised or collected on his own web page (the IMU called all mathematicians worldwide to do so). In fact these collections would require some pro-active action from a EuDML partner to be exploitable by EuDML. It is not obvious to tell what portion of the content that could be available that way would ever reach EuDML through another path, but it is clear that breaking this barrier would enlarge considerably the content. This challenge was not addressed in this project but should be investigated later. As always, the low hanging fruits were caught first, and resources needed grow exponentially with height!

External interoperability

While a smooth ingestion procedure is the guarantee for EuDML to register an up-to-date critical mass of quality metadata, fuelling powerful discovery services and a rich user interface, external interoperability is needed to allow third parties to enrich their services thanks to the availability of collections in the EuDML system. This in turn provides more visibility to and more usage of the EuDML collections.

We developed specific tools for targeted scenarios of machine interaction with the EuDML corpus.

1. Batch download of public elements in descriptive metadata is available through the EuDML public OAI-PMH server [2]. In order to maximize interoperability, three formats are supported: basic OAI-DC, European semantic elements [3], and EuDML schema [4]. Apart from some sensitive data that can have been contributed to EuDML under the condition that it is not re-served (author's email addresses, copyrighted full texts, e.g.), all information that EuDML harvested or created (EuDML IDs, links to other databases, e.g.) are exported under the last format. It is thus also a way for EuDML content providers to get back the project's added value for their own sake.

2. Machine query the EuDML database with Opensearch [5] using Contextual Query Language syntax. This would allow a third party to automatically query the EuDML database and present EuDML hits together with other sources, for instance.

3. Machine calls to some EuDML functions through REST services [6]. These services have been tailored for various needs, and should probably evolve depending on feedback or as new needs emerge.

    a. The Batch Ref service allows an external party to upload a reference list with citations of mathematical documents, and get back the identifiers of matched EuDML items. This is a critical added-value for a reference library as this allows many stakeholders dealing with mathematical references to enhance their assets by adding links to the full-texts.

    b. The Reverse Ref service makes it possible to find all EuDML items citing a given EuDML item. This service was an explicit request of a putative content provider in order to get an added value from participating in EuDML, as it would generate more valued links to their assets.

    c. The Similar Items service makes it possible to use the EuDML website's "Find similar documents" feature from a distance.

    d. The Batch Ids service allows third parties knowing one ID for a given item to query the EuDML databases for all IDs pertaining to this item known to the database. It turns EuDML into a mathematical hub connecting relevant databases. Together with the All Pointers service, it opens new pathways in the mathematical corpus.

    e. Finally, the Metadata via REST service makes it possible to download an item's internal metadata in two XML formats.

4. Embed some EuDML data or query form as a widget in a Web page. For instance, users can monitor their EuDML activity or add some dynamic view on EuDML in their Web site.

These tools open a wide range of possible applications, from adding the EuDML corpus to an external search engine to enriching existing content with deep links to EuDML.

Producing Linked Open Data and creating a SPARQL end point was considered during the project, but the technology didn't seem mature enough for a production system, real-world application still lacking to exhibit a clear benefit within the short time frame for development. We also have in principle the possibility to set-up a full-text hub as the central system does store quite a lot of full texts from EuDML content providers, in quite many formats (original PDF, extracted text with or without math as MathML or LaTeX, accessible formats) and we also have licence declarations from the content providers whether this texts can be used internally only for indexing or can be re-served openly. However, these services won't be developed in this project. There is still quite a lot of room for improvement and exploration beyond this pilot!

The mathematical community is always doing what you wouldn't expect, so we are rather confident that these interoperability tools whose public availability happened somewhat late in the project will take off steadily and will open new ways to interact with this corpus. For instance, the first systematic use of the Batch Ref service we were made aware of was by one mathematician who participated in the user panel evaluating the EuDML website in December 2012. When he learned about this service, he wrote a python programme to match all references in his BibTeX bibliographical database!

We talked of the expected REST services (especially the Batch Ref) with many putative linking partners, especially in Washington DC (see below) with Math. Reviews, Math-Net.Ru, Wolfram Encyclopedia, and they showed interest. After the REST services were released (late 2012), we informed them of their availability. We know Math-Net.Ru has performed tests and reported satisfaction. But, to our disappointment, we got no feedback from the other ones so far (although adding full text links in their databases or reference lists would be an obvious added-value for their users). However, we monitored the use of the service, and noticed that, not counting the use of the service's online demo at https://project.eudml.org/api-tester/batchRef, 4280 references had been fed into the service, out of which 939 matches were obtained (recall that EuDML content amounts to about 7% of the mathematical corpus).

Our BDIM associated partner started to use the service, though, and has already generated 214 links from its bibliographies.

Zentralblatt MATH also tested the service. In particular, the complete set of Zentralblatt MATH records (>3.200.000 items) was fed into EuDML's Batch Ref service. Due to the size of the collection, no accurate analysis was carried out yet, however, based on a similar analysis with ELibM records (1000 items), we observed 96% effectiveness. At the time of writing, around 100,000 items in EuDML have been matched, and after some QA, they will become generated links on the Zentralblatt MATH's own service interface.

Regarding less organized collections of mathematical references that could also benefit from automated linking to EuDML, it was not obvious how to provide a facility making this transparent (or at least more integrated into the system and easier for the contributors to use). A similar facility exists in Wikipedia to create DOI links, but no-one in the consortium knew enough to adapt it to our context. What we have done in this direction is to provide a public manual interface where one can copy-paste reference lists and get back the matches [7]. We can't tell how useful this was perceived as it was one of the last features added to the public Website.

2.2. Contacts with external stakeholders

Beyond the dissemination activities reported elsewhere (scientific publications, presentations in various events, news items on the project's Web site, etc.) a number of specific measures have been taken to engage with possible new partners and enlarge the initial basis of content providers, technical partners, and supporters.

Three events were specifically organized by the project, in line with its work plan:

1. The Workshop with content providers [8], held in Prague (Czech Republic) on 15 October 2010. It was an opportunity to present and discuss the first version of the project's policies on interoperability and cooperation model once they were drawn.

2. The EuDML open workshop [9], which was scheduled as an embedded session within the DML workshop, held in Bertinoro (Italy) on 20–21 July 2011 during the series of Conferences on Intelligent Computer Mathematics (CICM 2011). The operative model and a first public demo were presented and discussed with a panel of experts.

3. The EuDML round table at the 6th European Congress of Mathematics in Kraków (Poland) [10] on 2 July 2012.

Moreover, given the tight connection between the EuDML project and the Digital Mathematics Library community, an important EuDML delegation was present at each DML workshops and CICM conferences during the duration of the project, as well as at the symposium "The Future World Heritage Digital Mathematics Library: Plans and Prospects" which was organized by the Committee on Electronic Information and Communication (CEIC) of the International Mathematical Union (IMU) and took place on 1–3 June 2012 at the National Academy of Sciences in Washington DC (United States of America).

The creation of EuDML's Scientific Advisory Board was also a mean to foster interest in the project's goals and results among a selection of distinguished experts in the relevant fields.

These occasions together with the normal networking activities of partners of EuDML opened a large number of possible cooperation.

On the technical front, we got expression of interest, but rather in the form of attracting new partners in some follow-up to the current project as access to this project's funding is restricted to project partners. Meetings were organized with Mathematical Linked Open Data specialist Christoph Lange to evaluate the feasibility of LOD in EuDML, e.g.

On the political front, we got quite some awareness and support from mathematical societies (The International Mathematical Union, the European Mathematical Society, the London Mathematical Society, and the Czech Mathematical Society were represented in Prague, e.g.).

On the content front, we also engaged a large number of discussions, but had to wait for a full-featured Web presence of the project in order to actually attract most new partners, which left us with a very strict time frame as the releases of fundamental features were quite delayed compared to the initial plans. This explains why, while a large number of discussions are currently open, few of them have yet come to a conclusion.

The first external content provider to join EuDML was the Italian project BDIM who expressed its interest in partnering with us already at the Paris DML workshop, July 2010. The technical work on actual integration started at the end of 2011 and the collection (the BUMI journal) was finally posted online in March 2012. From that date, BDIM has been a fully associated to the project, upgrading in due time to the new EuDML 2.0 schema and contributing another series (RLIN).

In Prague, contact was made with Belgrade's eLibrary of the Mathematical Institute of the Serbian Academy of Sciences and Arts [11] and eLibrary of the Faculty of Mathematics, University of Belgrade [12], but the technical work has not yet started on their side. Other possible partners that expressed interest on various occasions but never started any actual work for it are: Springer Heidelberg (Open access journals), the Swiss Electronic Library project (SwissDML).

On a more optimistic side, we got the explicit invitation to register content from the digitized proceedings of the International Congress of Mathematics [13] and the European Congress of Mathematics [14], but here the trouble we faced is the very limited metadata available and the

lack of proper landing page for articles. However, this is something we will take care of as soon as time and resources are available.

In Washington, a contact was initiated with Cornell University's project Euclid and Steklov Mathematical Institute/Russian Academy of Sciences' project Math-Net.Ru. Both agreed later on to join EuDML by posting JATS metadata either on their OAI-PMH server or through file transfer. This is still ongoing work. Math-Net.Ru has already submitted two test datasets and we are currently helping them for the fine tuning of their metadata export.

Another decision that has been taken after the 6ECM round table is that the EMS publishing house will contribute the *Journal of the EMS* after a 5 years moving wall. Work to achieve this has started, partly handled by our IMAS partner acting here as a sponsor for EMS-ph.

A contact has been also made with JSTOR in the hope to acquire their public domain content and make it visible in EuDML. This is currently going through various steps in JSTOR's bureaucracy: We don't expect a binding statement before the end of this project.

Finally, let us report on the most puzzling contact we had, which will prepare the transition to the next section: Elsevier Science emitted a series of letters to the mathematical community [15], the latest of which announces that they offer free access to all available articles, back to Volume 1/Issue 1, from a set of journals in the "Mathematics Archived Journals Collection". They claim that "more than 155,000 articles are now freely available to the mathematics community". When we contacted them to learn whether this could mean partnering with EuDML, we got a positive answer, at the express condition that we wouldn't mirror the actual content but would only serve as an indexing database. As this breaks one of our principles (safe archive of the actual content in a not-for-profit scientific organization for the sake of long term preservation and availability of EuDML items), we have so far rejected the offer and decided that we would try to convince them to comply with our views. This task is postponed to the EuDML Initiative to be formed after the end of the current CIP project.

Associated partnership status

At the end of the project, the situation of associated partnership is the following.

Two associated partners were mentioned in project's DoW and have been actively involved in EuDML.

- The European Mathematical Society (EMS) acted as expected as a strong link between the project and the European mathematical community. Three members of its Electronic Publishing Committee were partners of the project, two of them acting regularly as liaisons. Ari Laptev (president 2007–2010) was present in Prague workshop; Marta Sanz-Solé who took over EMS presidency in January 2011 has been kept regularly informed, appointed the Scientific Advisory Board, and had an important role in the definition of the statutes of the EuDML Initiative, a major item in EuDML's sustainability plan. EMS also facilitated EuDML dissemination by publishing papers in its Newsletter (distributed to all its members worldwide) and hosting the round table at 6ECM.

- Göttingen University–State and University Library Göttingen (SUBGoe) was one of the main content partners, contributing the Mathematica and RusDML collections from the Göttinger Digitalisierungszentrum (GDZ): 1,549 monographs, 747 volumes from 295 multi-volume works, 73,931 journal articles from 52 journals. Integration of these collections required a nontrivial amount of work for UJF/CMD who acted as a sponsoring partner, harvesting, enhancing and consolidating metadata from the public API services available at GDZ. IST also harvested the scanned full texts and ran the MATHviaOCR service in order to get indexable text+MathML versions of these

documents. All this was made possible thanks to the commitment of SUBGoe, as all technical enquiries were always promptly answered: A lot of insider knowledge on the collections and some of their technical oddities were needed in order to complete this integration task. SUBGoe also participated in various events and contributed to the evaluation of the EuDML services and of the sustainability plans.

One external partner joined as an associated partner early in the project.

- The Italian Digital Mathematics Library (BDIM), a project of the Italian mathematical societies UMI and SIMAI run at Napoli University contributes 2,138 articles from 2 journals. All technical work required was done by them and integration was a model of smoothness.

All three associated partners above have declared their intention to be part of the EuDML Initiative.

One more European project has started actual work to join EuDML: the Math-Net.Ru project (81 journals with finite moving wall).

Agreements have been met with EMS-ph (1 journal), EMS (ECM proceedings), IMU (ICM proceedings), SANU eLib (11 journals), project Euclid (60 journals with finite moving wall), but it is not likely that these will formally join before the end of the project. Together with the launch of the project studying a "Planning a Global Library of the Mathematical Sciences" at the US National Research Council, this suggests that EuDML has really brought new impetus towards a transnational and more comprehensive Digital Mathematics Library, and that many stakeholders from various continents would not like to stay apart.

2.3.   The external cooperation model

Let us recall the DML Vision that drove most of our efforts:

The Digital Mathematics Library should assemble **as much as possible** of the **digital mathematical corpus** in order to

- o help **preserving** it over the long term,
- o make it **available online**,
- o possibly after some embargo period (**eventual open access**),
- o in the form of an **authoritative** and **enduring** digital collection,
- o **growing** continuously with publisher supplied new content,
- o **augmented** with sophisticated search interfaces and interoperability services,
- o developed and curated by a network of **institutions.**

Except possibly on the preservation side, we made advances in each of these directions.

EuDML aims to be a long-standing, reliable and open source of trusted mathematical knowledge. This implies some policies, that mostly boil down to the following three:

1. *The texts in EuDML must have been scientifically validated and formally published.*

    This is needed to ensure that EuDML works as an **authoritative** library, holding the version of a piece of mathematical knowledge that can be further built upon, and permanently referred to.

2. *EuDML items must be open access after a finite embargo period. Once documents contributed to the library are made open access due to this policy, they cannot revert to close access later on.*

    This is the so-called "**moving wall** policy" as in general the published items become freed from a pay wall after a certain embargo period (typically ranging from 0, aka open access publishing, to less than 10 years). This **eventual open access** policy try to

accommodate the fact that not all mathematical publishers can afford to publish everything as open access immediately (notice that the author-pay model of open access publishing is not very much accepted by the mathematical community, see for instance [15], [16]), but that the value of mathematical knowledge is to foster new developments in any fields and at any time after publication, so that this should become public knowledge after a not-too-long while (much shorter than current copyright duration, indeed). This policy is strongly supported by the International Mathematical Union [17].

3. *The digital full text of each item contributed to EuDML must be archived physically at one of the EuDML member institutions.*

This is for the sake of **preserving** the mathematical corpus as an **enduring** collection, which in turn is the only way to secure its **online availability** over the **very long term.**

We noticed during this project that these rules are strong and will limit our ability to reach an exhaustive mathematical corpus (the Elsevier archived math journals would comply with the first two of them, for instance, while not all project Euclid journals would comply with the second one). However we felt that these rules ensure that the system we built is on a sound base, and that what has been achieved so far cannot be reverted by some external fortune.

Our Scientific Advisory Board commented on these policies at the very end of the project and suggested that we relaxed them somehow, in order to maximize the eligible content (see § 2.4 below). However, the project's participants felt that they could not take the risk to touch to fundamentals of our business model a few weeks before the end of the project.

Based on the above policies, we drew a model of EuDML operation that feeds the sustainability plan described later in this document and the design of the EuDML Initiative. It is based on a consortium of EuDML core members being scientifically and organizationally strong not-for-profit institutions that take care of the system's activity, maintenance, and of the collections both in terms of preservation and eventual open access provision.

The EuDML content members should

- o be aligned with the project's goals,
- o keep committed over the long term,
- o select collections to be contributed to EuDML on sound scientific grounds,
- o develop a preservation policy for the full texts,
- o acquire new items in a timely manner (retrodigitisation or direct from publishers),
- o sort out rights and licences of contributed collections,
- o take care of data and metadata curation,
- o manage communication with the central registry.

The EuDML technical members should

- o be aligned with the project's goals,
- o keep committed over the long term,
- o manage communication with the content members,
- o run and maintain parts of the system's infrastructure,
- o develop new services as the need emerges and to the extent their resources permit.

External partners are expected to contribute to the EuDML Initiative using our interoperability model. We identified the following typical scenarios.

External content partners should

- o adhere to the project's goals,
- o select one content member (aka local DML center: LDC) as entry point to EuDML,

    o set up transfer and update mechanisms for new items,

    o determine the moving walls' durations,

    o license at least one local LDC to store transferred files for ever.

External technical partners should

    o adhere to the project's goals,

    o sign non-disclosure agreement of data they could get hold of for their technical work,

    o develop technology over subsets of the corpus and make it available to the project,

    o provide technology to the project preferably under open source licenses.

External linking partners should exploit the linking opportunities delivered by the project to enrich content and user experience while searching, browsing, or accessing the reference mathematical corpus.

The Scientific Advisory Board, in line with its previous comment on policies, advocated for a "second level partnership" with relaxed implications.

2.4. The Scientific Advisory Board

Creation

The EuDML Scientific Advisory Board was formed under the following terms, formalized during the Paris plenary meeting of the project in July 2010:

1. The EuDML consortium acts under the supervision of an external multidisciplinary Scientific Advisory Board (SAB) formed under the auspices of the European Mathematical Society.
2. SAB is a panel of distinguished specialists representing users and institutions active in mathematics digital libraries. It is composed of external experts recognized for their expertise in the field of the project, coming from different domains: mathematics knowledge management, digital libraries, publishing houses…
3. The board is appointed to advise on project strategic scientific direction in order to ensure the highest scientific quality. SAB will be consulted during the design phase and the evaluation periods of the project. It will monitor the networking among the partners, dealing with on specific issues such as methodology, policy, exploitation plan, and long-term sustainability, advocacy and awareness. SAB is expected to be a non-passive consulting board, but offer leading-edge expertise. It will also provide advice from users' perspective to follow the requirements of the mathematical community.
4. The EMS nominates the chair of the EuDML SAB.
5. Normally the Committee will meet electronically. Discussions of the board should be confidential. At any moment SAB can send requests or ask details regarding some points to EuDML coordinators.
6. SAB will report every half year or otherwise along the project milestones. Upon request of either the Committee or the Executive Board of the project, the chair and/or another representative of the Committee will take part in the General Council or the Executive Board meetings of the project.
7. Membership can be updated during the lifetime of the project.

After a short discussion, Ulf Rehmann agreed to chair the board, and a list of possible members was discussed. This activity somehow vanished and the EMS president formally appointed the board in October 2011. The EuDML contact person with the SAB was WP2 leader Enrique Macías until September 2011, then Thierry Bouche.

Membership

Frédéric Brechenmacher	Historian of mathematics, université d'Artois
James H. Davenport	Mathematician (computational aspects), University of Bath
Norbert Fuhr	Computer scientist (Digital libraries), Universität Duisburg-Essen
Thomas Hempfling	Math editor, Springer Basel (Birkhäuser Mathematik)
Thomas Hintermann	Math editor, European Mathematical Society Publishing House
Carol Hutchins	Librarian, Courant Institute of Math. Science, New York University
Ulf Rehmann (Chair)	Mathematician, EMS EPC chair, Universität Bielefeld
Masakazu Suzuki	Mathematician and Computer scientist Kyushu University
Günter Törner	Mathematician & math education specialist Universität Duisburg-Essen
Bernd Wegner	Mathematician and Zentralblatt editor-in-chief 1974–2011 TU Berlin

First letter and feedback

After the definition of a new revised work plan was agreed with the European Commission, a letter was sent to the SAB, May 2012. It contained a short synopsis of the project, and status, with short term plans. It concluded with a number of precise questions.

- What improvements can EuDML make to its policies so that more content-providers are encouraged to join EuDML?

- What categories of content should EuDML include beside the published literature: preprints (e.g. arXiv), grey literature in general?

- How much content should be European? In what sense (published, originated, funded in Europe) will this still be relevant to EuDML after the end of this project?

- What would be the appropriate EuDML policy towards various types of open-access publishers (gold, author-pays etc.)?

We got a very fast reply from the board's chair:

> *Dear Thierry,*
>
> *Thanks very much for the letter of the project. I have forwarded it to the committee and will collect their responses to get feedback to EuDML.*
>
> *At first glance, I am pretty impressed by the progress made since Nov/Dec, say.*
>
> *The project webpages look already pretty usable.*
>
> *Also, I was very happy with the project's intentions concerning longevity expressed in the letter. As a first comment, it would be very nice if this could be made more substantial in the sense that it is said who will be committed to do what on what material basis in the future.*
>
> *Anyway, my actual overall impression is very positive.*

No other feedback was gathered regarding our questions, even after we met many of the SAB members in various occasions (one being the Washington DML meeting organized by CEIC in June 2012), and sent few reminders.

Second letter and feedback

On 21 December 2012, a letter was sent to Ulf Rehmann who followed it up to the SAB, asking for a report on the SAB activity, and advice on the interoperability and external cooperation models as summarized later in this document. A second part was sent to feed discussion on the sustainability plans as discussed in Birmingham meeting.

The report of the SAB was received on 24 January 2013. It is attached to this document as an appendix. The main conclusions are:

- EuDML gained some kind of worldwide leadership in the international effort to build a global Digital Mathematics Library.

- The SAB supports the sustainability plan, especially the launch of a EuDML Initiative with EMS support and strong involvement.

- The SAB advocates for some relaxing of the EuDML policies regarding cooperation with external content partners (such as commercial publishers) for the sake of compre-hensiveness.

This feedback will be passed on to the EuDML Initiative to inform the initial discussion that will be necessarily conducted about revised policies and objectives compared to the EuDML CIP pilot project.

2.5. Monitoring EuDML take off on the World Wide Web

Here we list some evidence that EuDML as a mechanism to discover and link to mathematical references is slowly getting some momentum.

Stackexchange/mathematics is a question and answer site for people studying math at any level and professionals in related fields. When they need to refer to some published reference, it is quite handy to be able to rely on a EuDML permanent ID[1].

> 1   Notice that for every i, we have $\frac{1}{p_i} < \frac{1}{i}$, which doesn't help for the comparison test. – Andrew Dec 14 '12 at 0:27
>
> The convergence of harmonic subseries is related to the density of its terms. See the work of Šalát et al; for instance eudml.org/doc/118201. – lhf Dec 14 '12 at 0:43

The second example is most interesting as the main answer is mostly a commented bibliography on the subject of the question, with as many links as can be found using current Internet discovery tools[2].

> **[6]** sci.math -- *Characterization of functions having anti-derivatives* (Dave L. Renfro, 21 May 2008)
>
> http://groups.google.com/group/sci.math/msg/bc4d738500d2c961
>
> **[7]** Andrew Michael Bruckner and Jack Gary Ceder, *Darboux continuity*, Jahresbericht der Deutschen Mathematiker-Vereinigung 67 (1965), 93-117. MR 32 #4217l; Zbl 144.30003
>
> http://eudml.org/doc/146526;jsessionid=98522A06CD68A44763F32C1354F068AB
>
> **[8]** Julius Wolff, *On a function which assumes any value on a non-enumerable set of points in any interval*, Proceedings of the Royal Academy of Amsterdam Science 29 (1926), 127-128. JFM 52.0242.03
>
> http://www.dwc.knaw.nl/DL/publications/PU00015258.pdf

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[1] http://math.stackexchange.com/questions/258337/divergence-of-the-sum-of-the-reciprocals-of-the-primes
[2] http://math.stackexchange.com/questions/137986/is-there-a-different-name-for-strongly-darboux-functions

Math Overflow is a similar forum. The importance of mathematics digital libraries is underlined by the following question[3], together with the problem of proper indexing of niche resources. EuDML is cited among the comments to this post.

papers archives? (especially not indexed by google)

27

http://www.digizeitschriften.de/index.php?id=239&L=2 has many papers with free access (e.g. Inventiones Mathematicae) but when you search with scholar.google.com it does not index this site!

Are there any other archives like this?

☆ 34

Just in case let me list other archives (they are indexed by google as far as I understand).

http://projecteuclid.org

http://www.numdam.org/?lang=fr

http://www.math.uiuc.edu/K-theory/

PS

e.g. I cannot find:

Koszul, J (1981), "Les algebres de Lie graduées de type sl (n, 1) et l'opérateur de A. Capelli", C.R. Acad. Sci. Paris (292): 139-141

Does it mean search skills are poor or it is really not available electronically?

big-list

flag | cite

edited **Jan 30 at 22:30**
J. H. S.

community wiki
5 revisions, 3 users
Alexander Chervov 79%

Here is another typical example of internet resources in a math conversation[4]

3

Here is another perspective on your question. As $\mathbb{Z}$ is the initial object of unital (commutative) rings, one might first of all ask: **What do epimorphisms from $\mathbb{Z}$ look like?**

I.e. if $A = \mathbb{Z}$ in the original question, what can B be? The answer to this is known. In fact, these rings B and their classification seem to have been (re)invented several times, as "solid rings" by Bousfield and Kan (see this question: http://mathoverflow.net/questions/95160/), as "T-rings" by R. A. Bowshell and P. Schultz (*Unital rings whose additive endomorphisms commute*, Math. Ann. 228 (1977), 197-214, http://eudml.org/doc/162991;jsessionid=07C5F5F5BBD354C0914511776DA20F5E), and the generalisation to Dedekind domains has been done in W. Dicks and W. Stephenson: *Epimorphs and Dominions of Dedekind Domains*, J. London Math. Soc. (1984) s2-29(2): 224-228, http://jlms.oxfordjournals.org/content/s2-29/2/224.extract . (Also, by Martin Brandenburg and myself this summer, before we found these papers ...)

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[3] http://mathoverflow.net/questions/87053/papers-archives-especially-not-indexed-by-google
[4] http://mathoverflow.net/questions/109/what-do-epimorphisms-of-commutative-rings-look-like

And one where the poster kindly adds EuDML links to the ref. in a quotation[5].

In the meantime I have been able to consult Cassels's *Lectures on Elliptic Curves*. He proves Mordell's theorem in Chapter 15, which has these two interesting footnotes :

[16] This is the only place where the use of algebraic number theory is unavoidable. If she does not know the theory, the reader should take it on trust that it is very like the rational case. But see next footnote.

[17] This line of argument proves the finiteness of $\mathfrak{G}/2\mathfrak{G}$ without algebraic number theory at the expense of a fairly substantial study of binary quartic forms.

The main text says at this point:

In fact this is what Birch and Swinnerton-Dyer did in their historic computations [Notes on elliptic curves. I, II. *J. reine angew. Math.* **212** (1963), 7--25, **218** (1965), 79--108].

http://eudml.org/doc/150565

It must be added that it is this approach via binary quartic forms which has made the recent spectacular advances by Arul Shankar and Manjul Bhargava possible; see arXiv:1006.1002.

Other such EuDML links can be found in various places, and start being used in papers themselves, not necessarily written by mathematicians[6]. In any case, the most prestigious EuDML link to date is one by Fields medalist Terence Tao (shortly after he participated in the WDML workshop in Washington)[7].

I think it may be difficult to show analyticity of a sup norm; note that even the sup of two analytic functions $\max(f(t), g(t))$ is not analytic when the two functions cross (e.g. $|t| = \max(t, -t)$). The enemy here is that as one varies t, a new local extremum gets created somewhere in the interior of the triangle, and eventually grows to the point where it overtakes the established extremum on the vertices, creating a non-analytic singularity in the L^infty norm.

• • • • • • • • • • • • • • • • • •

non-degenerate (it looks like a non-zero scalar multiple of the 0th Bessel function $J_0(\sqrt{\lambda}r)$, plus lower order terms which are $o(r^2)$ as $r \to 0$). Certainly in this setting, the work of Banuelos and Pang (http://eudml.org /doc/130789;jsessionid=080D9E5423278BA5ACFC818847CA97FE) applies, and small perturbations of the triangle give small perturbations of the eigenfunction in L^infty norm at least. This (together with uniform C^2 bounds for eigenfunctions in a

• • • • • • • • • • • • • • • • • •

Comment by Terence Tao — June 15, 2012 @ 3:53 pm | Reply

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[5] http://mathoverflow.net/questions/116318/elementary-proof-of-mordells-theorem
[6] See the bibliographical references of http://arxiv.org/abs/1210.5197
[7] http://polymathprojects.org/2012/06/12/polymath7-research-thread-1-the-hot-spots-conjecture/

3. Business model

The effort of the EuDML consortium does not end with the creation a functional prototype of the Digital Mathematics Library and providing its content and services to the public. The true success of the project depends very much on sustainability and further development of the EuDML. The principal aims of sustainable EuDML services comprise

- o working toward comprehensiveness, service integration, and cost efficiency of the EuDML services,
- o assisting in exploiting the benefits of networking for integration of digital library services such as sharing and enhancing data,
- o advancing cooperation between information and service providers,
- o creating and maintaining a non-profit service in the interests of the mathematics user community.

In order to create such sustainable service from the EuDML project, important issues have been assessed, namely

- o an organizational and legal framework, which will take its roots in the EuDML consortium and further partners associated during its lifetime,
- o balancing costs and potential sources of revenue of running the EuDML services,
- o a common framework for dealing with IPR and copyright issues.

The resulting outline of a business plan was presented in deliverable D2.3 – EuDML business plan [18]. Subsequent discussion on further details and open questions in which the EMS played important role resulted in formulation of principles under which the EuDML Initiative as an association will be created and run to secure the sustainable Digital Mathematics Library. The principles form a basis for a detailed status of the EuDML Initiative.

3.1.   Principles of the EuDML Initiative

Eleven partners of the consortium declared their will to continue in efforts to maintain and develop the EuDML after project's end, representing the general mathematical community and the core content and technology providers:

1. European Mathematical Society
2. Fachinformationszentrum Karlsruhe, Zentralblatt MATH
3. Interdisciplinary Centre for Mathematical and Computational Modelling, University of Warsaw
4. Cellule Mathdoc, Centre national de la recherche scientifique & Université Joseph-Fourier, Grenoble
5. University of Birmingham
6. Institute of Mathematics and Informatics BAS, Sofia
7. Institute of Mathematics ASCR, Praha
8. Masaryk University, Brno
9. Ionian University, Corfu
10. Società Italiana per la Matematica Applicata e Industriale, Unione Matematica Italiana
11. Niedersächsische Staats- und Universitätsbibliothek Göttingen

They will form an association named EuDML Initiative where the first three of them will assume particular roles. The EMS will provide an umbrella using its institutional authority to secure association's internal functioning and its external representation with respect to partners, other

institutions and public and, in particular, to ensure that the DML services shall remain under control of organizations representing the public interest. For the first period of at least three years, FIZ/Zentralblatt MATH and ICM will provide human resources and machine capacities for hosting, system and service maintenance, and basic technical operations.

The EuDML Initiative will operate in frames of the following principles.

The EuDML Initiative

The EuDML Initiative ("Initiative") is an association without legal personality.
It has been decided that the status of an association without legal personality and financial budget will do it perfectly for the first period, during which the possibility/necessity of transforming the Initiative to another model involving legal personality and financial issues will be investigated. It has been suggested to establish the EuDML Initiative according to German Civil Code, seated in Berlin.

Purpose and Objectives

The purpose of the Initiative is to provide a Digital Mathematics Library ("DML") for the worldwide scientific community as a public service in order to

- o help scientists locate the information that is distributed in various digital repositories and discover information related to their work in an optimal way;
- o encourage the public in using it as a public knowledge repository;
- o be exhaustive and comprehensive in the field of mathematics.

The basis for such DML is provided by the EuDML.

The Initiative will

- o encourage content providers to join and integrate their content to the DML,
- o adapt to using new information technologies and invite subjects interested in contributing to research and development for the continuous evolution of DML to join,
- o search for projects of research and development aiming at improving its services to the user community and will encourage its members to get involved in such projects.

The participation of the European Mathematical Society should ensure that the DML services shall remain under control of organizations representing the public interest.

Membership

Membership in the Initiative is open to any legally and contractually competent natural or legal person willing to support the objectives of the Initiative by providing

- o digital content, i.e. integrating (at least partially) their digital collections of high-quality mathematical publications in the DML according to the DML guidelines and standards, which are based on internationally accepted standards and trends, adapted to the special needs of mathematical publications, and maintaining and expanding access to these publications through the DML service,
- o technological equipment and services for maintaining the DML central services and/or developing other technical services and tools to be used in the DML,
- o scientific, financial, strategic or political support to the Initiative and its activities.

Members of the Initiative are not obliged to make any financial contributions.

Termination of Membership

Membership may be terminated by resignation, expulsion or dissolution (of legal persons*).*

Termination of membership by resignation is possible upon written notice submitted six months prior the date of termination. Within this period, the member willing to terminate membership will negotiate with the Initiative on conditions of termination, in particular, how to handle with data, services, tools or other items the member brought in the Initiative. (For the EuDML sustainability it would be important to set up a rule that upon a termination of membership the content provided by that member should be kept in the EuDML under the same conditions.)

Any member acting rudely against the interests of the Initiative may be excluded from the Initiative at any time.

Rights and Duties of Members

Without prejudice to other rights set out in the statute or in applicable laws, members have the right to:

o take part in the activities of the Initiative,

o examine the documents recording the activities of the Initiative, as well as request and obtain information on the development of such activities,

o resign from the Initiative.

Members have the duty to:

o take part in the activities necessary for the satisfaction of the objectives of the Initiative,

o contribute to the needs of the Initiative,

o comply with the decisions of the bodies of the Initiative, with the statute and the applicable legislation.

Organizational Structure

The body of the Initiative with decision-making powers is the General Assembly. The executive body is the Executive Board. It is advised by the Scientific Advisory Board and supported by the Technical Committee.

All bodies of the Initiative can meet via telecommunication if appropriate. (Videoconferencing has proved a very efficient management tool during the EuDML project and will reduce the running costs of the Initiative.)

Each body shall decide by simple majority of votes. In case of a tie the vote of the Chair decides.

General Assembly

The tasks assigned to the General Assembly include the following:

o decision on applications for membership to the Initiative,

o decision on expulsion of a member,

o election and dismissal of the members of the Executive Board from persons suggested by members of the Initiative, except for the member representing the EMS,

o election of the Chair of the Initiative from members of the Executive Board,

o election and dismissal of the members of the Technical Committee from persons suggested by members of the Initiative,

- o issuing instructions to the Executive Board,
- o decision on modification of the statutes and the dissolution of the Initiative.

The General Assembly is formed by one representative of each member.

The General Assembly shall meet regularly, at least once a year.

The Executive Board should convene the General Assembly upon written and justified demand from at least 10 % of the members of the Initiative sent to a member of the Executive Board.

Decisions by the General Assembly shall be taken by way of a simple majority of the votes. Decisions of the General Assembly with regard to the modification of the statutes and the dissolution of the Initiative shall be of no effect unless passed by a majority of three quarters of the votes cast.

The General Assembly shall meet under the chairmanship of the Chair of the Initiative, who, in case of not being able to attend the meeting, may be substituted for by one of the Executive Board members.

Extraordinary meeting of the General Assembly

Extraordinary General Assembly shall be convened if it is deemed in the interest of the Initiative. An extraordinary General Assembly may be called for by decision of the Executive Board, of the General Assembly or by written and justified demand from at least 10 % of the members of the Initiative sent to a member of the Executive Board. The meeting must take place within four weeks of the receipt of the demand.

The Executive Board

The Executive Board is composed of the Chair of the Initiative, the Chair of the Technical Committee and three other persons representing members of the Initiative.

The members of the Executive Board shall be elected by the General Assembly except for the member representing the EMS who will be nominated by the Executive Committee of the EMS. (The fact that one member of the Executive Board is always nominated by the EMS Executive Committee corresponds to the EMS particular role and responsibility in the Initiative. It is not excluded for this person to be elected the Chair of the Initiative.)

The term of office for the members of the Executive Committee is two years. They can be elected repeatedly.

In conducting legal or other affairs the Initiative shall be represented by the Chair of the Initiative.

The Executive Board shall have general charge of all matters concerning the Initiative. The tasks assigned to the Executive Board include in particular:
- o management of the current affairs including copyright and ownership management according to advices of the Scientific Advisory Board,
- o execution of the decisions of the General Assembly,
- o appointment of the subordinate committees entrusted with the special tasks within general framework of the Initiative,
- o preparation and convention of the General Assembly.

The meetings of the Executive Board shall be convened by the Chair or by any other entitled member of the Executive Board.

The Executive Board constitutes a quorum, if all members of the Executive Board have been invited to the meeting and the Chair of the Executive Board and at least two of other members of the Executive Board are present.

The Scientific Advisory Board

The Scientific Advisory Board is appointed by the European Mathematical Society of their representatives and other suitably qualified and recognized persons. It is responsible to ensure the scientific quality of the DML service, and advises the Executive Board on scientific matters, strategic orientations and priorities for development of the service, take part in the evaluation, and bring in the feedback of the mathematical community. The Scientific Advisory Board works out recommendations for the development of EuDML with regard to the content and the organization of the Initiative.

The EMS will set up the rules for the Scientific Advisory Board doing.

Technical Committee

The Technical Committee is composed of the Chair of the Technical Committee and four other members representing technological equipment and service providers or other members of the Initiative. The Technical Committee ensures the continuous technical operations of EuDML services being responsible for the technical development, technical standards and workflows, and the technical operations of the system. The Chair of the Technical Committee is member of the Executive Board.

The Technical Committee will especially take care that the following issues are handled: system-level maintenance (hosting), application-level administration (operations), technical support for information providers, content ingest and aggregation, general workflow management, including enhancers, continuous dissemination, first level end-user support, content level quality control and feedback, service level quality control and feedback, uptime monitoring, generating and reviewing statistics, software maintenance, software development.

3.2.   General Principles for Handling Data and Tools

It is important that the potential external partners understand who the EuDML Initiative is and what is to be expected of a possible cooperation. Hence, the following principles should be adopted and published.

The content providers retain all rights pertaining to their collections. They grant to the EuDML Initiative the right to keep and use copies of their provided data for the purposes of search and retrieval display in DML public services.

Each content provider may decide, whether full text will be provided to the EuDML Initiative and to which extent the full text might be used or distributed. Agreements between the Initiative and the content providers specify these and further usage and exploitation rights for each collection contributed to the DML.

The indexing and other metadata information generated by the central services of DML ("DML-enhanced metadata") is owned by the Initiative. Content providers are entitled to use and exploit copies of DML-enhanced metadata of those items for which they have provided metadata.

Copies of metadata provided by content providers and the DML-enhanced metadata shall be kept at the sites maintained by service providers. If a service provider withdraws from this role, the data and respective rights and obligations stay with the remaining service providers. Members of

the Initiative active in the research domain of Digital (Mathematics) Libraries are entitled to use (copies of) the DML-enhanced metadata for their research purposes. However, usage of a particular subset of the metadata for this purpose may be restricted by the respective information provider. Results of such research activities will be made available to the Initiative and its members. Exploitation rights for software and tools developed by the Initiative stay with the originator. However, Initiative advocates an open-source policy for software, and encourages developers to put their developments for DML in the public domain. In case of dissolution of the Initiative, all (meta)data and related rights are to be transferred to the European Mathematical Society.

4. Conclusions

The EuDML project reached clear successes in addressing the two main challenges: (i) the technical infrastructure for a unified access point for the digital mathematical content hosted by different organizations across various countries is set up and running with a critical mass in content, and (ii) a cooperation model with a variety of stakeholders has been defined for building a reliable and durable global reference library and a number of possible partners have declared interest in the initiative.

A number of tools have been developed and deployed to ease contributing new content to the EuDML system and to offer many useful ways of exploiting the EuDML content, or creating specific views for different communities.

For external interoperability a number of specific tools have been developed to allow third parties to enrich their services thanks to the availability of collections in the EuDML system. This provides more visibility to and more usage of the EuDML collections.

The EuDML policy was developed stating three main principles: (i) the digital content must be scientifically validated, (ii) eventual open access, (iii) physical archiving of the content at one of the EuDML member institutions. The Scientific Advisory Board commented on these policies at the very end of the project and suggested that we relaxed them somehow, in order to maximize the eligible content. However, we felt that these rules ensure that the system we built is on a sound base and that we could not take the risk to touch to fundamentals of our business model a few weeks before the end of the project. Refining our policies from the input so far gathered will be one of the first tasks of the EuDML initiative following-up the project in February 2013.

Several workshops and round tables organized by the EuDML partners and other subjects were used to engage with possible new partners and enlarge the initial basis of content providers, technical partners, and supporters. The Italian project BDIM has been fully associated to the EuDML.

Contacts were made with several possible external partners (eLibrary of the Mathematical Institute of the Serbian Academy of Sciences and Arts, Springer Heidelberg, Swiss Electronic Library project, Cornell University's project Euclid and project Math-Net.Ru of the Steklov Mathematical Institute RAS, JSTOR, digitized proceedings of the International Congress of Mathematics and the European Congress of Mathematics) to ingest their digital content in EuDML. In some of these cases, the technical work has started and will be finished after the end of the current project. Some of the issues had to be postponed without a negative impact on the final result because they go beyond the original scope of the project.

Based on the above policies, we drew a model of sustainable EuDML operation on the basis of an association without legal personality formed by EuDML core members being scientifically and organizationally strong not-for-profit institutions that take care of the system's activity, maintenance, and of the collections both in terms of preservation and eventual open access provision. Three partners, EMS, FIZ/Zentralblatt MATH and ICM will assume particular roles provide an umbrella securing association's internal functioning and its external representation, ensuring that the DML services shall remain under control of organizations representing the public interest, and providing human resources and machine capacities for hosting, system and service maintenance, and basic technical operations during the first mid-term period after the project end. The possibility/necessity of transforming the Initiative to another model involving legal personality and financial issues will be investigated during this period.

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Appendix – Advices to the EuDML project by its Scientific Advisory Board

(Date: 23/01/2013)

This document does contain five sections:

1. Activity of the Scientific Advisory Board:

2. Advice on the EuDML sustainability plan:

3. Advice on the EuDML fundamental policy:

4. Advice on possible criteria for selecting new EuDML partners:

5. Further advice to EuDML

1. Activity of the Scientific Advisory Board:

The board has observed and discussed the activities of the project and given comments and hints by email and/or personally on various other occasions, e.g., on the occasion of personal meetings at the workshop "The Future World Heritage Digital Mathematics Library: Plans and Prospects" in Washington D.C. on June 1–3 2012 (cf. http://ada00.math.uni-bielefeld.de/mediawiki-1.18.1/index.php/Main_Page).

In particular, on the occasion of that workshop, the SAB got a pretty positive impression about the work of the project, which was presented there in a convincing manner, see the talk given there by Th. Bouche:
http://ada00.math.uni-bielefeld.de/mediawiki-1.18.1/index.php/Thierry_Bouche:Talk

That impression was shared by the workshop as a whole, which was reflected within the final report of the workshop, where it was said that

> "During the symposium, the existing European Digital Mathematics Library (EuDML) was often cited as a prototype for building a truly global DML. Consequently, the question of whether such a WDML is feasible is, in principle, resolved. The eventual WDML can capitalize on the accumulated expertise and accomplishments of the project EuDML. One potential strategy would be to merge and extend the EuDML with an as yet unrealized US-DML, as well as include heritage material from other countries, such as Australia, Canada, China, India, Japan, Korea, Russia, etc., in order to form the core of the WDML."

(cf. http://ada00.math.uni-bielefeld.de/mediawiki-1.18.1/index.php/Final_report)

This certainly puts the EuDML project into some kind of worldwide leadership within the international efforts to build up a usable and well organized Digital Mathematics Library (DML).

2. Advice on sustainability plan:

The SAB supports the plans of the project to launch the EuDML initiative as a non-registered organization, governed by a specific board to be set up by the EMS. In particular it welcomes the commitment of two of its partners to run the system for 2–3 forthcoming years.

Concerning the involvement of the European Mathematical Society (EMS), we recommend the following: The EMS should continue to nominate a scientific advisory board for the project, but should also, via its Executive Committee, nominate a representative for the Executive Board of EuDML, in order to help the project establishing connections, building up strategies for the development of the project, undertake concrete actions to increase its content, to publicize the Initiative, to be involved in searching funding, etc.

This is also an advice to the EMS to do everything to maintain and develop the role of the EuDML project as a worldwide leading project for building the world digital mathematical library.

3. Advice on the EuDML fundamental policy:

Basically it should be desirable to have partners fulfilling these requirements:

A. a full text stored at one of the partnering institutions,

B. obligatory metadata as defined in deliverable D3.2 (to appear soon in final version as D3.6 – The EuDML metadata schema)

C. a finite moving wall (i.e. its full text becomes freely accessible after a certain delay)

However, insofar as there are potential partners with important content who don't want to agree to transfer their content the project should define means to incorporate them as well. E.g., there is the possibility to have "dark archives" which already has been established for some academic partners in cooperation with commercial publishers. The project should cooperate with partners like this by establishing a kind of "second level partnership" and either try to establish a kind of "dark archive" by its own or seek for cooperation with partners for which such a "dark archive" has already been established. (This may possibly require to extend the EuDML scope to non European partners.)

4. Advice on possible criteria for selecting new partners:

We recall the fundamental idea for the content of a worldwide Digital Mathematical Library, as it was formulated by Keith Dennis in his influential talk "A global mathematics library" given on the occasion of a workshop on Retro-digitization in Essen (Germany) in the year 2000 (see http://www.math.uni-bielefeld.de/~rehmann/Washington_2012/math_literature.html for the slides):

Such a library should ultimately contain "Everything" dealing with mathematics, represented in EuDML by either original data or by links or, at least, by bibliographic data. In the talk this list was given:

– Journals (current or old)

– Books

– Theses

– Preprints

This list above may be considered as ordered by importance.

Every provider offering material like the above should be welcome.

The SAB explicitly recommends to deal positively with the offers received by

– The Serbian virtual library in Belgrade http://elibrary.matf.bg.ac.rs/

– The Russian academy of sciences and Steklov institute in Moscow Math-Net.Ru

– The EMS publishing house (offering Journal of the EMS)

– Springer Open access journals

– project Euclid

Here even more should be considered: In the SAB it was said that

> "...a EuDML without, say, Inventiones is scarcely credible as THE PRIME resource. Hence EuDML needs some way of incorporating them."

This could be achieved by maintaining a central registry for all digitized mathematical literature, see section 5 below.

Also, the offer from Elsevier (concerning indexing their primary math journals, but refusing to allow local copies) should be considered seriously, perhaps via the above mentioned concept of a "second level partnership", and by pursuing the idea to rely on dark archives in order to ensure permanent access to the sources.

Further, for example the lists at

> http://www.math.uni-bielefeld.de/~rehmann/DML/dml_links.html

give possible participants, even European providers containing substantial mathematics which are not yet considered by EuDML.

5. Further advice to EuDML:

Further advice for the development of the worldwide DML were given at the Washington workshop on "The Future World Heritage Digital Mathematics Library: Plans and Prospects" in the initial talk by Ulf Rehmann:

cf. http://www.math.uni-bielefeld.de/~rehmann/Washington_2012/to_do.html

The SAB proposes to EuDML to take these into account for its further development.

The SAB proposes as well to set up a registry of mathematical literature containing titles which are not yet digitized but should be so in the future, allowing the worldwide mathematical community to add suggestions (e.g. by maintaining a mediawiki based list or so). Also, it is proposed to offer an upload facility for digitization provided by members of the community.