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New Perspectives of a Distributed Information System for Mathematics

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Abstract

Combining electronic specialized information, such as electronic information retrieval from central databases, with the new means of communication opens up new perspectives for mathematics in Germany. Based on the current Fachinformationsprojekt (Specialized Information Project) run by the Deutsche Mathematiker-Vereinigung (DMV) and supported by the Federal Minister for Research and Technology (BMFT), the DMV is planning a new infrastructure activity for mathematics. This activity will not only include mathematical university departments and research institutes, but also partners from mathematical research laboratories in industry as well as suppliers of mathematical information, in particular, scientific publishing houses, the Technical Information Library (TIB) Hannover, university libraries and – last but not least – the Fachinformationszentrum (FIZ) Karlsruhe with the Zentralblatt für Mathematik.

On the technical basis of the Internet and its worldwide information services (Gopher, WAIS, World Wide Web, Hyper-G, ftp and e-mail), a distributed mathematical information system is to be created, whose partners make their local resources available both to other partners and to the worldwide Internet community. These aims can be achieved by means of the consequent use of software that is structured according to the client-server model and distributed and accepted within the Internet.

Providing the technical equipment, however, is by far not enough. Without the creation of a personal, technical and organizational infrastructure, realization of such a project will not be possible. For every partner the realization of the following measures is envisaged:

* Establishing an *Information Coordinator* at every participating institution
* Creation of a *Forum for Mathematical Information*
* Installation and maintenance of *Mathematical Information Stations*
* Participation in national and international *Standardization Activities*
* Regular workshops and training courses, public relations

The following activities (carried out by all partners or within pilot projects by special groups) focusing on mathematical and mathematics-related information are planned:

* Set up of *Electronic Information Systems* by all partners
* *Distributed* electronic offer of *Preprints* and scripts (full texts) by all partners
* *Distributed* electronic offer of *Software and Data Collections* by all partners
* Access to *Global Information Systems in Mathematics*
* Organization of a *Living Museum of Mathematics*
* Access to *Electronic Library Catalogs,* esp. to libraries of university departments
* Electronic offer of *Scanned Historical Books and Documents*
* Creation and management of *Electronic Mathematical Journals*
* Creation of a framework for various kinds of *Electronic Reviewing*
* Testing of new methods for *Electronic Document Delivery*
* *Electronic Project Organization*

The project aims, at its beginning, at the creation of an information infrastructure for database retrieval, e-mail, electronic conferencing and subject-specific information networks. Its focus is on mathematics in Germany. The general scope, however, is broader. The project is open for discussion, coordination, and cooperation with partners in other areas of science, industry or in other countries. It is also hoped that this project may form an example along which other models of electronic information and communication can be developed. Moreover, the project is also meant to enhance the offer from German mathematics to the worldwide "give and take" within the Internet community.

1. Introduction

In 1992 the "Deutsche Mathematiker-Vereinigung" (DMV) together with the "Konrad-Zuse-Zentrum für Informationstechnik Berlin" (ZIB) started a project supported by the German Federal Minister for Research and Technology (BMFT) "Improving access to subject-specific online databases and CD-ROM for mathematical institutes in Germany" (short: DMV Project "Specialized Information"). The aim of this project is to supply mathematicians, scientists and students at mathematical departments and research institutes with the possibility to search in the major mathematical databases, especially the databases MATH, MATHDI, PHYS and CompuScience offered by the "Fachinformationszentrum Karlsruhe" (FIZ Karlsruhe) [Grötschel 93a].

In the course of this project, in which 51 mathematical departments and research institutes are participating, it has become clear to us that, today, specialized electronic information must be seen in a much wider context than that of online search possibilities in databases that mainly contain bibliographic information, abstracts and reviews on scientific publications; see also [Grötschel 93b].

For mathematical research, for applications in mathematics, but also for teaching purposes, electronic access to full texts, to mathematical software and data collections and to other information systems is gaining more and more importance. In Germany, similar to the United States, there is an increasing need for electronic access to local information with an organizational character, such as contact addresses, institute and project descriptions and information about scientific conferences.

Another, probably even more important perspective is the fact that questions arise that are relevant not only for the sciences, but will be of great importance for German industrial companies in the future. Electronic call for tenders and the free flow of information about the support of research are but one example in this context.

We will mention some highlights of the technological change that originates from the United States and has taken shape in the installation and dissemination of fast and efficient networks. First of all, there is the Internet, the network of networks [Internet 94], which today provides access to more than 35,000 networks and well over 3 million hosts [Press 92], [Time 93]. Thousands of subject-specific information networks and electronic conferences have become established in the Internet. The Usenet News (a collection of several thousand single conferences), which is the most important of these information networks, has more than 6 million readers a day.

In the Internet, numerous (over 500) electronic journals can be found: three examples from mathematics are the "Electronic Journal of Differential Equations", which can be read free of charge via the E-math server of the "American Mathematical Society" (AMS) from any (Internet) workstation [AMS], the "Electronic Transactions on Numerical Analysis" of the University of Kent, which can also be read at no cost at least for a trial period of three years [Kent 93] and the "Electronic Journal of Combinatorics" [EJC]. In the past six months, six further electronic journals with similar characteristics have been founded in the field of mathematics alone. Some of them have high-ranking editorial boards, their contributions are peer-reviewed, they have an ISSN number and they are archived by the Library of Congress.

The Springer-Verlag in Heidelberg, too, now has its own electronic server [Springer].

Prepublications of books can also be found in the Internet. An example in the area of computer science is the book "An Introduction to Tcl and Tk" by J. K. Ousterhout [Ousterhout 93]. Addison-Wesley was obviously not afraid of sales losses from making this book (which has meanwhile appeared in print) available in the Internet – on the contrary. Publishing houses offer their own products on information servers working with high-quality graphic environments [O'Reilly].

For quite some time now, the *netlib*, a very comprehensive collection of research software, has been offered free of charge [AT&T] (organized by J. J. Dongarra of the Oak Ridge National Laboratory and E. Grosse of AT&T Bell Laboratories). This software is classified according to the GAMS Index, which is defined by the National Institute of Standards and Technology (NIST) in the USA. The NIST has its own server [NIST] that allows a problem-oriented retrieval in the *netlib* and other mathematical software libraries.

In addition, O'Reilly's "Network Information Center" also offers a great number of links to other important information servers and catalogues (also from libraries) [O'Reilly], for instance, it provides access to the Library of Congress USA [LOC], which is presently conducting an electronic exhibition of coloured (scanned) historical manuscripts, books and maps of the Vatican Library in the Internet, which can be "visited" free of charge and from which copies of the exhibits can be retrieved. In Germany, too, many libraries have their on-line catalogues connected to the Internet [Braun 93]. Last but not least, an increasing number of renowned research institutes, such as the Argonne National Laboratory, offer their preprints and technical reports in the Internet [ANL].

Electronic mail (e-mail) plays an important role in this context. In the field of high energy physics, e.g., today all publications are offered early on a preprint server in the USA (that is mirrored in Italy) [LANL], [Taubes 93]. Electronic mail not only makes it possible to transmit letters quickly and organize electronic conferences efficiently. In the United States it has become a commonly-used tool, not only in the field of science, but also in industry: submissions of offers and order placements can often be settled within one day, whereas the same process may well take weeks in Germany (or in Europe). Even the President of the United States today can be reached by e-mail. On the average, he receives 1,000 to 6,000 electronic messages a day [Internet 93].

The main problem, however, is that these developments have not been sufficiently noticed in Germany (nor in Europe) and that their importance has not been realized, which may result in a real location disadvantage for the German (or European) economy. We will mark this important topic with the key word

"Electronic Information and Communication",

which is to be understood as the creation of an adequate infrastructure for scientific institutes in the field of mathematics and their partners in industry and – of course – the traditional suppliers of specialized information, i.e., publishing houses, libraries and the Fachinformationszentrum Karlsruhe. In concrete terms, our proposal is to create a "Distributed Information System for Mathematics" in Germany.

Our aims are the following:

* Enhancement of the traditionally central supply of information by a decentralized, wide-spread and interactive information and communication system for science and industry.

* Full accessibility of all forms of specialized electronic information (full texts, software, data collections, contact offers), partly by means of international cooperation.
* Active participation of mathematicians from science and industry in the electronic supply of specialized information.
* Increased efficiency of current research by intensifying the electronic exchange of information.
* Improved studying conditions, increased transparency for students, reduced duration of university studies.
* Speeding-up and cost reduction in the general supply of information.
* Testing of new models of electronic information distribution.

We consider this project, which is only a small step in this direction, as an examplary contribution to overcome the current backwardness as well as the lack of acceptance towards electronic tools, also in industry. In additon, we consider it as an example for other fields of science. Scientific societies, such as the

* "Deutsche Physikalische Gesellschaft" (DPG)
* "Gesellschaft für Informatik" (GI)

are also preparing similar [DPG 94] or even more comprehensive [GI 94] programs on the subject "information and communication". Although our project aims may be slightly different from those of these two societies, we are in close cooperation with DPG and GI.

2. Pilot Project: "Distributed Electronic Information System for Mathematics in Germany"

We propose the creation of an organizational and technical infrastructure for a distributed information system. Besides extending the use of electronic specialized information at the partner institutes (as a further development of the aims of the DMV Project "Specialized Information"), local, but also worldwide resources for subject-specific mathematical information are to be opened up. The electronic specialized information available shall be further established and, in addition, the methods and techniques for setting up one's own offer of subject-specific information shall become part of the scientist's work.

In this context, central concepts for the supply of information shall be supplemented by decentral ones. Partners in this process of distributing the supply of information could be

* Mathematical university departments and research institutes
* Mathematical laboratories in industry
* Fachinformationszentrum Karlsruhe and Zentralblatt für Mathematik
* TIB Hannover and scientific libraries
* Museums with scientific-technical departments
* Scientific publishing houses and possibly software companies.

The objective of this project is an integrated and coordinated realization of the following infrastructural measures at the partner institutions:

* Creation of the function of an *Information Coordinator*, who is in charge of all responsibilities attributed to the "Specialized Information Coordinator" in the current DMV Project "Specialized Information" plus the organization of the offer of information in his/her institute.

* Creation of a *Forum for Mathematical Information* with representatives from all partner institutes.
* Initiation, approval and control of single activities and special projects – platform for funding activities of the BMFT and other institutions.
* Implementation of *Information Stations* (servers) and *Clients* with the aim of access from all workstations at the partner institutions (and worldwide) to information offered by other partners.
* National and international cooperation in order to coordinate and standardize the distributed offer of information.
* Joint and local workshops and special training courses.

The project will be realized under the auspices of the Deutsche Mathematiker-Vereinigung. The Konrad-Zuse-Zentrum für Informationstechnik is willing to participate in the "Forum" with a scientific-technical working group.

3. Distributed Offer of Information

In the following we will give a short illustration of the term "distributed information system", which has different connotations in different fields of computer science.

We do not see this term with the eyes of a database specialist, who might have in mind a distributed database offered centrally. We do not take up the role of a communication specialist either, who might think of a "distributed service" (or a "communication protocol"). A computer scientist will possibly take it as the development of a new information system integrating several workstations with a common windows environment. A librarian will probably understand it as the access to several catalogues in his/her library with a central lending system. Each of these perspectives has its own legitimacy, however, none of them reflects our aim properly.

3.1 Distributed Information System

As a matter of fact, mathematicians want to use the latest communication tools without having to develop them. Our special purpose is to create a platform in the Forum for Mathematical Information where the latest tools available at no cost and distributed in the Internet and in the open domain can be used as components for the distributed information system. By using servers and clients that are widely accepted in the Internet (presently Gopher, WAIS, WWW, Hyper-G and Mosaic [Krol 92], [Berners 92], [Kappe 93], [Andreessen 94]), an opening of the distributed information system and, as a consequence, worldwide, easy and mutual access to locally available subject-specific information is aimed at. Today, the use of local information servers makes it possible, for instance, to make full texts available in a suitable and inexpensive form.

We see a distributed information system from the perspective of the scientific field mathematics. Relevant information that is locally available shall be opened up for the community of mathematicians;

* Preprints, also prepublications of books (full texts, LaTeX, postscript)
* Lecture notes and other teaching materials (LaTeX, postscript)
* Mathematical software and documentation (ASCII, online manuals)
* Data collections, e. g. concrete data of important application cases (ASCII)

* Connections (Electronic Links) to other information systems (Gopher, WAIS, WWW, Hyper-G).

In addition, subject-specific information with organizational contents shall also be made available:

* Contact addresses (WhitePages, whois, find) with fields of interest
* Latest project news and new project tenders (conferencing, mailing lists)
* Information on research funding (national & international).

In this context, a model for an organizational framework for the offer and distribution of electronic journals is to be developed, which is suitable for the electronic publishing of mathematical contents. This "tool", however, shall also be used for general messages in the "Forum".

The partners of the project and, possibly, the special interest groups of the DMV offer their local resources of information via their own mathematical information stations (servers) in the Internet. They make use of the resources made available by other partners with corresponding clients, which, in principle, can be installed at any of their workstations (not only at their actual information servers). The utilization offer can be made in the Internet – worldwide – as it is made up according to the client-server model and, for the time being, only Gopher, WAIS and WWW and Hyper-G server and clients will be used. As a universal browser that integrates the services of several clients at present Mosaic is to be considered.

Technically speaking, one of the main tasks will be the coordination of data exchange formats and, in this context, the participation in national and international standardization committees.

3.2 Advantages of a Distributed Information System; Example: Preprints

A research result has a long way to go from being written down by the author, accepted, e.g., by a university department, submitted to the editor of a journal to publication by a publishing house in a journal and, finally, entry and review in a database. First, the author compiles the results in the form of a preprint of his/her university department or institute. The preprint is then submitted to a publishing house for publication. The publishing house, i.e., the editor of the journal, carries out a complex refereeing procedure before the article is printed in order to guarantee high-level quality standards. The reviewing publication can only prepare a review when the article has been published in a professional journal. Normally, 1 to 3 years pass between preparation and publication of an article, and another 6 to 12 months until entry in a database.

In research, preprints have, to a large extent, taken the role of publications in journals, in particular due to the above mentioned delays in the publishing process. From the author's point of view, preprints secure the right of discovery. From the reader's point of view, preprints are available much earlier than the final publications.

If an author makes his/her preprint available on the information server of his/her institute, "readers" with a workstation will not only have access to

* the full text of a preprint, but also
* immediate access

provided they are informed of the availability. Indeed, all partners in the project can be informed of each new preprint via e-mail. A central information service, such as the (Internet) Archie service or a WAIS server could also inform external partners of new offers.

Within a few days, the Fachinformationszentrum Karlsruhe and the Zentralblatt can now integrate either the abstract of the mathematical preprint that is available on-line (with reference to the local server) or a related review that could also be obtained electronically from the reviewer.

Thus, searchers in the MATH database, which is the online version of the "Zentralblatt", not only find references to an article or a review within very short time, but also have immediate access to the full text.

3.3 The Importance of a Distributed Information System for Research, Teaching and Application

The distributed information system can become a new and powerful tool for mathematicians. The retrieval of information is extremely complex today. Mathematicians have to use a broad repertoire of sources for this purpose: publications and reviews, personal messages, preprints, conferences etc. In this context, the distributed information system can extend and improve the electronic offer of information. With a distributed information system mathematicians can make their own contribution to an efficient supply of information to their colleagues.

As results of the project we expect

* access to mathematical information that has usually been of limited availability
* relocation of information to electronic media at the expense of print media
* synergy effects due to immediate access
* a simple and intelligent user environment.

The distributed information system will not only provide mathematicians with more information, but also with new means to extract those bits of information that are relevant for them.

While the significance of such a system for research work is evident, we would like to add a word on its significance for teaching and application. In teaching, for instance, the offer of electronic lecture notes is an interesting supplement and alternative to the usual offer of lectures. In particular students may obtain additional information about special branches and centers of their discipline etc. If several departments offer lecture notes on the same topic, they are in competition with each other. Thus, students not only have a wider choice (transparency of offer), but we also expect the better lecture notes to become more generally accepted. Information on job advertisements spread nationwide can increase motivation to reduce the duration of studies.

The distributed information system is a qualitatively new kind of link between mathematicians at universities on the one hand and in industry on the other hand. The information servers make it possible to obtain straightforward information on every institution and its profile. In this way, fears of contact are mitigated and contacts between partners intensified.

4. The Information Station

The partner institutes shall realize both access to the other partners' offer of electronic information and implementation of their own offer of information. In this context, the partners will create the technical and organizational preconditions by carrying out the following measures:

* Provision for an information server plus suitable responder software for the Internet ftp and telnet services as well as the installation of suitable server software for the Internet Gopher, WAIS, WWW or Hyper-G.
* Connection of the server to the Internet to make access of external partners possible.
* Implementation of information clients on all workstations of the local net with suitable access to the Internet services ftp, telnet and e-mail as well as installation of suitable client software for Gopher, WAIS, WWW or Hyper-G and the use of the integrated browser Mosaic.
* Furnishing of all workstations for access to servers of external partners in the Internet.

Due to the different conditions at the partner institutions, the decision on technical equipment will be left to themselves. The use of Unix is not a necessary precondition. Today, the relevant Internet server and client software are available for all major machine platforms: PC, Mac, and, of course, Unix-based machines.

We are proceeding on the assumption that access to the host of the Fachinformationszentrum Karlsruhe (FIZ) via telnet will soon be possible. The FIZ is presently working on the realization of a connection to the Internet. The required access coordination (password splitting etc.) can be carried out analogously to the DMV Project "Specialized Information".

5. The Information Coordinator

Making suitable techniques and tools available for the retrieval and offer of electronic information, however, is not enough. Experiences made in the course of the DMV Project "Specialized Information" have shown that imparting knowledge about how to use the new facilities to other colleagues seems to be even more important. This role shall be taken up by the "Information Coordinator", who will be appointed by every partner and who will pass on his/her technical know-how to his/her institute, possibly with the inclusion of further colleagues ("multipliers").

The central task of the information coordinator is – in addition to the tasks of the Specialized Information Coordinator in the DMV Project – to structure the offer of information and to participate in the Forum for Mathematical Information. He/she is the – internal and external – contact person and creates, coordinates and accompanies the realization of all measures carried out at his/her institute. In detail, these tasks include:

* Organization of the supply of information in his/her institute (retrieval and offer)
* Installation and update of the technical and organizational infrastructure for searches and on-line retrieval of information
* Technical accessibility of the offer of information (via Gopher, WAIS, WWW, Hyper-G, ...)

* Participation in the coordination of standards for the exchange of information
* Cooperation with the central project management.

This continuation of the function of the Specialized Information Coordinator will ensure the continuity of electronic specialized information in the field of mathematics. Each partner, i.e., the Fachinformationszentrum Karlsruhe as well as libraries, museums and publishing houses, too, will appoint a scientist for an adequate proportion of his working hours.

6. The Forum for Mathematical Information

Under the auspices of the DMV a *Forum for Mathematical Information* will be created consisting of the *Assembly of Information Coordinators* of all partners. The partners will pursue their common aims in the Forum on the basis of written cooperation agreements.

Scientific societies, organizations and institutions working in the field of research funding may participate in the Forum as associated members.

The Information Coordinators will meet at regular intervals (twice a year) to carry out joint workshops and will constitute working groups for special tasks. To this aim, cooperation will also take place electronically (installation of special mailing lists or electronic conferencing systems).

The Forum is the platform for the realization of the partners' activities (special tasks) and major special projects with a pilot character, which may be carried out by a group of partners. In particular, the Forum is the appropriate body to realize related BMFT support activities.

For the evaluation of new special tasks and pilot projects a *Scientific Technical Committee* will be created within the Forum, which will also analyse project results. To support the Scientific Technical Committee in fulfilling its tasks, the partners may also delegate specialists that do not belong to the group of information coordinators.

In order to fulfill the administrative tasks a *Central Project Management* will be set up within the Forum, which will also be responsible for the control of special tasks and pilot projects. The *Central Project Management* organizes joint workshops and is responsible for cooperation on national (DMV, DPG, GAMM, GI, KMathF, DFG, BMFT, ...) and international (Euromath, Internet Committees, standardization committees, ...) level. Its tasks will include central project reporting and public relations.

The Konrad-Zuse-Zentrum is willing to provide a scientific-technical working group to support the Forum in its technical responsibilities. This group's tasks will include the installation and testing of reference servers, the use of central mailing lists and a central information server as well as the organization and realization of corresponding training courses.

7. Special Tasks and Pilot Projects

This chapter contains a first summary of special tasks and pilot projects, which does not claim completeness. Which activities and which projects will be realized in the Forum will mostly depend on the partners' initiative and, of course, on the financial and technical means the Forum will be able to acquire.

7.1 Special Task: Information Clients and Servers

Partners:	Mathematical University Departments Mathematical Research Institutes Mathematical Laboratories in Industry Publishing Houses Libraries Museums with Scientific/Technical Departments Special Interest Groups of the DMV FIZ Karlsruhe, Zentralblatt

Installation and operation of information stations (one per partner) and clients (on all Internet workstations) at the partners' institutions. Implementation of the corresponding Gopher, WAIS, WWW, Hyper-G responder and client software.

Besides scientific-technical information of the kind described in the following special tasks and pilot projects, the partners also offer information with an organizational character, such as descriptions of

* Institutes and Departments
* Research Programs and Projects
* Service Facilities and Departmental Libraries
* Lectures
* Seminars and Practical Courses
* Current Publications
* Contact Addresses and Functions

Technical Contents:	Connection to the Internet an its distributed information services
Options:	WWW-interface to STN-databases Electronic information services (discussion lists as in Opt-Net [Lügger 93]) for special interest groups of the DMV
Effect:	Technical infrastructure for information services of the partners Efficient transfer of information for special interest groups of the DMV, Presentation of the partner institutions Transparent description of services offered.

7.2 Special Task: Distributed Preprints

Partners:	Mathematical University Departments Mathematical Research Institutes FIZ Karlsruhe, Zentralblatt Publishing Houses Libraries

Availability of preprints, prepublications of books, lecture notes etc. in the distributed information system (information for students to improve studying conditions).

The Zentralblatt integrates the abstracts into the MATH database – with reference to where the full text can be obtained electronically.

The Zentralblatt prepares reviews on selected preprints.

Technical Contents:	Data exchange formats Standardization Organization of accessibility
Effect:	Speeding-up of the reviewing process Cost Reduction Improvement of studying conditions Increased transparency for students Reduced duration of university studies

7.3 Distributed Software and Data Collections

Partners:	Mathematical University Departments Mathematical Research Institutes Mathematical Laboratories in Industry International Software Suppliers

The offer of mathematical software and data collections available at the research institutes (e.g., concrete data of important applications) will be opened up to the community. The offer will be made available in the distributed information system – together with test data and relevant documentation.

Software libraries at the partner institutions and software that is available in the electronic library eLib of the Konrad-Zuse-Zentrum (e.g., CodeLib) [eLib], in the NetLib of AT&T [AT&T] and the REDUCE Network Library [RedLib] will be WAIS-indexed.

These software collections also include algorithm databases (including comparative test results) as well as example and model databases (including open problems). The data collections also contain fact databases (including logical relations between these facts), collections of mathematical formulas and tables, such as computer-readable collections of results from number theory (whose compilation may well have taken months of intensive, interactive work with a symbol manipulation system).

Options:	Cooperation with further international partners offering relevant information in the Internet
Technical Contents:	Central entry of distributed software WAIS-database
Access:	Internet Gopher, WAIS, WWW, Hyper-G
Effect:	Offer of mathematical software and data collections * for mathematics * for other fields of science (natural sciences, engineering etc.) avoidance of double development work

7.4 Special Task: Global Information Systems in Mathematics

Partners:	Forum for Mathematical Information Special Centers of Competence (e.g. Euromath)

Compilation of mathematical information systems – worldwide – in a web of hypertext documents.

Technical Contents	On-line selectibility (by mouse-click) of major "external" mathematical infofmation systems
Options:	WAIS-index for external information systems
Effect:	Opening of the distributed information system towards European and North American regions

7.5 Pilot Project: Electronic Reviewing

Partners:	FIZ Karlsruhe, Zentralblatt Reviewers Akademie der Wissenschaften in Heidelberg Publishing Houses Special Interest Groups of the DMV

Installation of an electronic conference system and an electronic reviewing organization for reviewers of the Zentralblatt. Reviewers with e-mail access write their reviews in a TEX-form that can be directly integrated into the MATH database of the Zentralblatt.

Option:	The Zentralblatt editors send articles to its reviewers in electronic form wherever possible
Precondition:	Cooperation with publishing houses, which may supplement the editors of the Zentralblatt by electronic announcements of their products
Technical Contents:	Standards for reviews (TEX, format of the MATH database) SGMG exchange format
Cross Reference:	Special Task: Distributed Preprints
Effect:	Speeding-up of the reviewing process Cost reduction

7.6 Pilot Project: Electronic Mathematical Journals

Partners:	Publishing Houses Mathematical Research Institutions Forum for Mathematical Information DMV

A technical and organizational model for the electronic offer of mathematical journals is to be developed.

The model for this journal shall not only be usable at the developing institution itself, but also externally (exportability).

Distribution:	via Internet
Questions:	Data exchange formats Copyright Costs Access control, if necessary
Effect:	Model testing of new electronic distribution concepts Cost reduction

7.7 Pilot Project: Historical Books and Documents

Partners:	University and Technical Information Libraries Museums Publishing Houses FIZ Karlsruhe, Zentralblatt Forum for Mathematical Information

Valuable mathematical books and historical documents will be scanned and, in this way, republished electronically (in the Internet).

The Zentralblatt prepares special reviews on these reprints.

Options:	CD-ROM "Printing on Demand"
Technical Contents:	Data exchange formats Access control, if necessary
Questions:	Copyright Costs
Effect:	Inexpensive access (by electronic reprints) to valuable documents from the libraries' treasuries. Model testing of new distribution channels.

7.8 Pilot Project: Living Museum of Mathematics

Partners:	University Libraries with Mathematical Archives Staats- und Universitätsbibliothek Göttingen with its Manuscript Department (Mathematical Archive) Technical Museums with Scientific/Technical Departments University Departments and Research Institutes Mathematical Laboratories in Industry Forum for Mathematical Information Individual Mathematicians Interested in History

Creation of a core organization (in Germany) for an Electronic ("Virtual") Museum of Mathematics and expansion of the concept towards other countries.

The Living Museum of Mathematics compiles in its departments

* Ancient Mathematics
* Modern Mathematics
* Didactics of Mathematics

mathematical ideas in the form of historical documents (scanned), algorithms, visualizations of mathematical models and contemporary computer art as well as mathematical experiments ("living books") and makes them available in the context of their place in scientific history. In this connection, there will also be biographies of great mathematicians, photographies of old mathematical instruments and modern computers, descriptions of modern mathematical fields of research etc.

Options:	Mathematical experimental laboratory, such as that available in the Deutsche Museum in Munich, Electronic exhibitions on up-to-date topics (e.g. chaos theory) Fast-Algorithm Competitions in selected areas, such as the DIMACS Initiative.
Technical Contents:	Data exchange formats for graphics, photographies, video and audio (multi-media hypertext protocols and applications).
Influence:	The Living Museum of Mathematics will include interested institutions and research laboratories in Europe, if not the whole world, into its activities right from the start (as a broadly-based infrastructural project).
Effect:	Inexpensive creation of the first Museum of Mathematics.

The foundations are already available (networks, workstations and visual storage media) or will soon (in approx. 5 years) be available (high bandwidths).

With this Living Museum of Mathematics, for the first time in history, mathematics will receive a worldwide exhibition space for old and modern ideas from the mathematical cosmos.

"Visitors" in this museum will not only be mathematicians, but also appliers of mathematics (natural scientists, engineers, pupils, students, teachers etc.) as well as persons interested in the history of mathematics and mathematical education.

7.9 Pilot Project: Electronic Library Catalogs

Partners:	Technical Libraries of University Departments and Research Institutes University and Central Information Libraries Deutsche Bibliothek in Frankfurt

Access to catalogs of selected technical and central libraries via Internet. Installation of appropriate clients at all partners for access to these catalogs.

Options:	Offer of scanned titlepages of articles from journals and books, (the latter with table of contents) for retrieval at the partners
Technical Contents:	Universal dialog communication software Client-server oriented retrieval Z 39.50 protocol
Questions:	Retrieval at distributed databases (offered by selected partners) Simple formats for bibliographic information Universal access via WWW gateway

Effect:	Electronic reference to articles and books (locations) also for traditional specialized information Improvement of the information offer by deeper opening-up in terms of (regarding retrieval) contents Increased transparency of traditional publications for students and teachers.

7.10 Pilot Project: Electronic Document Delivery

Partners:	TIB Hannover University Library Bielefeld University Departments and Research Institutes Technical and University Libraries Publishing Houses

Electronic delivery of (also of scanned) articles, which (until now) have only been offered in the context of traditional publishing. Selected partners offering or handling a particular (traditional) journal or series supply single articles of these journals electronically (upon electronic request/order).

Technical Contents:	Electronic entry, order and supply syste Data exchange formats (e-mail oriented)
Questions:	Contractual realization of corresponding orgranizational regulations Copyright Costs
Cross References:	Pilot Project: Electronic Mathematical Journals Pilot Project: Historical Books and Documents Pilot Project: Electronic Library Catalogs
Effect:	Increased efficiency of the supply of documents for traditional journals Access to traditional mathematical literature Rationalization, Cost Reduction

7.11 Special Task: Electronic Project Organization

Partners:	All partners in the community

Electronic association of all partners using the most up-to-date means for electronic communication and cooperation.

Transmission of:	* Project news * Project discussions * Questions and solutions etc.
Technical Tools:	Electronic Conferencing (Mailing list or News system) "Groupworking"
Options:	Realization of electronic WhitePages with contact addresses Whois servers Project descriptions Research funding information
Effect:	Efficient project organization for a distributed project Informal (efficient) electronic exchange of information

8. Special Tasks and Pilot Projects (regarding CD-ROM)

The Internet is the main distribution medium for the electronic offers of mathematical information. CD-ROM is an alternative and also (relatively) inexpensive medium for the dissemination of specialized electronic information. This chapter contains a first compilation of possible project activities regarding mathematical inhouse databases with CD-ROM.

8.1 Special Task: New Distribution Channels via CD-ROM

Partners: Publishing Houses
FIZ Karlsruhe, Zentralblatt
TIB Hannover
SUB Göttingen

Further opening of the CD-ROM market for the database CompactMath and comparable offers by:

* decoupling of prices for electronic and printed versions
* larger circulation due to special price reductions and possibly special prices for
  - libraries
  - networks
  - university departments
  - teachers
  - students
* special conditions for developing countries
* preparation of special versions and excerpts

Support of the development of decentral databases (e.g., CompactMath) by means of

* transfer of rights to copy the data into individual databases
* installation of an inexpensive update service (via ftp or e-mail)

Effect: Creation of a broad basis for electronic specialized information
Developing countries can be supplied adequately

8.2 Pilot Project: Mathematical CD-ROM

Partners: Mathematical University Departments
Mathematical Research Institutions
External Partners in Europe
FIZ Karlsruhe, Zentralblatt
TIB Hannover
Staats- und Universitätsbibliothek Göttingen
Forum for Mathematical Information

Selected mathematical documents and preprints (of one year) are compiled on a CD-ROM, which, for instance, can also be searched by means of the STN Personal File System (STN PFS) or some comparable retrieval system. The Zentralblatt prepares reviews of selected documents, which can also be stored on CD-ROM. For mathematicians who do not have STN PFS access a WAIS index (or something comparable) can be prepared additionally.

Option:	Accessibility of mathematical software on the same CD-ROM
Cross Reference:	Special Task: Distributed Preprints
Effect:	Inexpensive accessibility of mathematical documents and preprints as full texts in an inhouse database. Model testing of new distribution channels, also of interest for external partners.

9. The Environment and The Chances

The economic situation in Germany has deteriorated in recent years (growing unemployment). Therefore, new and innovative ideas are particularly needed today. In this connection it seems a paradox that access to the BMFT support catalog FORKAT at FIZ Karlsruhe is as expensive as access to any other bibliographic database (presently DM 185.– per hour plus DM 1.10 for each on-line display). We are of the opinion that science and industry should have free access to information of this kind. The free and widespread dissemination of information on start and results of publicly-funded projects should be understood as a public task. In the United States, for instance, public facilities and libraries have come to see it as their natural duties to make the mission, aims and major results of their institutes available in networks free of charge [Lange 93].

Indeed, the present situation in our scientific and public libraries (cuts in library budgets) calls for new organizational approaches that are likely to induce cost reductions. It is one of the major aims of the Forum for Mathematical Information to achieve a joint course of action supported by all parties involved, at least for the field of mathematics. Library budgets must be relieved without library services being reduced. In this context, CD-ROM could play an important role as an inexpensive carrier medium in the mathematical publication process. We consider the Internet as the main medium for the distribution of specialized information that is (nearly) free of charge. These are the most important opportunities.

In terms of technical equipment and personnel, the editorial capacity of the Zentralblatt is nearly exhausted. An indicator for that is, for instance, the fact that in mid-1993 the MATH database of the FIZ Karlsruhe lagged nearly half a year behind the printed version of the Zentralblatt für Mathematik. In addition, there is an increasing number of publications to be reviewed, while the personal and financial capacity is limited. New organizational concepts and measures are needed urgently. First and foremost, a merger with the "Mathematical Reviews" should be sought and realized in cooperation with the American Mathematical Society (AMS) [Grötschel 93b]. A more intensive use of electronic tools (such as e-mail) could be a substantial contribution to the improvement of the Zentralblatt's efficiency.

Many examples could be quoted to illustrate the general backwardness in Germany in the field of electronic tools and, in particular, electronic communication. Public authorities in Germany cannot be reached via e-mail. This state may be overcome in the Berlin region in the course of 1994 due to a planned "Metropolitan Area Network" (MAN) [ZIB 94]. In Munich, a corresponding Metropolitan Area Network is under construction, which will also provide the framework for some libraries to offer information (catalogs and scanned titlepages of papers and books) in a digitalized form [Bayer 94]. The Deutsche Telekom is planning a “data highway” between Berlin and Bonn to connect the two centers of government (BRAVO Project with distributed office organization [Tagesspiegel 93]).

Nevertheless, the day when all important national authorities such as the federal ministries can be addressed by e-mail is not in sight. What is even worse, however, is that the majority of industrial partners in Germany is not available electronically. If contract proposals and assignments as well as product planning and coordination can only be carried out the slow way (via regular mail), this is likely to develop into a real location disadvantage for the German economy.

We also consider the distributed mathematical information system as a project to show how to make use of the new technological opportunities on the basis of a model:

Electronic Information and Communication
for Science **AND** Industry.

The point is to create an example of an electronic information infrastructure – also for other fields of science – for

* database retrieval
* electronic mail
* electronic conferencing
* specialized information networks.

In this context,

* libraries and museums
* publishing houses and information centers
* industry and commercial enterprises, and
* public authorities

must be included in this process.

The current backwardness compared with the United States must be overcome – not only in mathematics. In the United States, people already talk of the “data superhighway” as a national task. We consider such a “Infobahn” to be of special importance for Germany, too. However, to keep to the image, we also see the necessity to have the corresponding “traffic signs” and “road signals” (organizational regulations) for our field of science.

10. A Vision of “Electronic Prepublishing”

In the past few years, Steven Harnad (Princeton) has developed a special view of electronic publishing [Harnad 90], [Harnad 94], which has been proposed by Andrew Odlyzko (AMS, AT&T) in a similar form for mathematical publishing [Odlyzko 93] and which is of particular importance to us as well. Both authors regard the traditional publication process as extremely slow and expensive and predict that it will be revolutionized in the near future (say, in the next 5 to 10 years).

They point out that today the technical means for a considerably less expensive information dissemination, especially in the field of science, are already available and that with the development of cheap storage media and the distribution of the Internet this process of fundamental change has long since begun. The increasing offer of preprints in the Internet is only a first sign of what might have to be expected: the almost complete substitution of printed material (scientific journals) – in the field of scientific publishing – by the much more efficient and far less expensive electronic offer. The only thing still lacking today is the electronic version of editorial and reviewing structures that have the important function of "filtering", i.e., extracting high-level publications.

Harnad and Odlyzko propose to publish solely electronically (on principle) and to regard a scientific publication as a "living document". The life cycle of such a document starts with the preprint, which is made available to everybody in the "public domain". Every scientist in the same area of research shall now be given the chance to make his/her comments, which will be added to the preprint together with the author's replies. Revisions shall also be attached to the original preprint as well as "peer reviews", which are embedded in a particular organizational structure (see below). Whatever is written as a comment on this document and made available electronically shall be preserved. Nothing that has ever been made available electronically shall be withdrawn.

In this way, a global archive of research works will be set up, which will all be classified and indexed in a customary way and can therefore easily be searched for. You may picture this archive as a huge database, however, you are not bound to this notion: the "living document" may just as well be distributed over a network, however, they shall be available "forever" as to ensure continuity (and storage media are really cheap today). Harnad calls the accessibility of a scientific work in such a public, electronic archive "scholarly skywriting".

According to Harnad and Odlyzko this horizontal dimension of the archive is to be supplemented by a vertical dimension of "peer expertise", an electronic hierarchy of editorial and refereeing structure. At the bottom level of this hierarchy there are articles that have not yet been refereed. Every higher level of this hierarchy is linked to special reviews and "peer reviews", which are to ensure higher quality standards. One could imagine that a publication climbs higher from level to level in this hierarchy and that the best articles in a way reach "top level quality". Every peer review prepared against this background is attached to the "living document" in the archive. After all, it should be possible to search for documents with a certain level of quality.

One can view it that way that the editors and reviewers on a certain level of quality and in a certain field of science act like editors of an electronic journal that you can subscribe to as reader. If an article is accepted, the subscribers are informed electronically of its acceptance.

Odlyzko substantiates his considerations by an evaluation of the storage requirements for mathematical publications: all mathematical publications of one year (text and pictures), for instance, require approximately 10 GigaByte storage capacity. This means that they could be stored on a single optical disk of the new generation. Disks of this kind only cost a few hundred dollars today and their price is likely to fall even more in the near future. Thus, not the storage of mathematical information is the problem but the compilation of articles (technically: transfer of information) is the real barrier.

In his essay, Odlyzko also asks the question which role printed mathematical journals will play in the future. Surely his reflections are dominated by a technological point of view. Nevertheless, we as well as the traditional actors in the publication process (publishing houses, Fachinformationszentren, libraries) have to face the fact that fundamental social changes in the past have again and again been triggered off by technological breakthroughs.

Acknowledgement

The idea to create a distributed information system for mathematics came up when the Federal Minister for Research and Technology (BMFT) invited the project management of the current DMV Project "Fachinformation" to develop a concept for scientific-technical information with a longterm perspective (beyond the year 2000). An initial concept proposal was presented during a special workshop on "The Future of Electronic Specialized Information in Mathematics" [ZIB 93], [Grötschel 93c] and discussed among the participants.

These early ideas have, in particular, been further developed by the fruitful discussions with the Specialized Information Coordinators of the DMV Project "Fachinformation", with participants in a similar project in the field of physics [Bischoff 93], and with experts from the field of computer science [GI], e.g., Prof. R. Bayer, regarding his notion of scanning books and documents (see, e.g., [Bayer 93]). New developments from computer sciences in Austria in the field of global hypermedia systems (see, e.g., [Kappe 93] by Dr. F. Kappe, Prof. H. Maurer and their working group let the realization of the first stage of the "Distributed Information System" seem realistic in the very near future. Furthermore, there is Dr. G. Lange of the Computing Center of the Technische Universität Clausthal-Zellerfeld, who is in charge of the working group "Information Systems" at the DFN, to be mentioned [Lange 93] as well as A. de Kemp [deKemp 93] of the Springer-Verlag in Heidelberg and Dr. A. Odlyzko of AT&T and AMS, who have illustrated the highly topical subject of electronic publishing in science. We would like to take this opportunity to thank them for their valuable ideas.

The initial concept was then – in a preliminary version – widely distributed electronically (e-mail) among mathematicians, physicians and computer scientists as well as libraries and publishing houses. This has led to a great number of supplements and additions; however, it will not be possible to refer to all contributions now. In part, they came from other countries, where the discussions about the plans of the Deutsche Mathematiker-Vereinigung had become noticed during a very early phase (see, e.g., [Lügger 94a], [Lügger 94b]).

With the Gesellschaft für Informatik (GI) and the Deutsche Physikalische Gesellschaft (DPG), close cooperation was agreed, which led to an intensive, mutual exchange of information in the subsequent preparatory phase. In February, 1994 the Presidium of the DMV agreed upon the project plannings, which were then (in May, 1994) presented to the Konferenz der Mathematischen Fachbereiche (in Germany) and welcomed unanimously.

Last but not least, we wish to thank Ms. C. Schöning-Walter of the Projektträger Fachinformation (at the GMD in Darmstadt), who is not only handling the current DMV "Fachinformation" Project with great personal commitment, but has also encouraged us again and again to make a contribution to the next BMFT support programme by furnishing new ideas.

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The overall responsibility for the project planning and organization lies with the current President of the Deutsche Mathematiker-Vereinigung (DMV),

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For an electronic discussion, a mailing list has been installed, which is open to everybody interested in the subject of the distributed information system for mathematics

dmv-ug-pvefm@zib-berlin.de

and which is moderated by Dr. Sperber(**sperber@zib-berlin.de**).