A Virtual Knowledge Market-Place

M. Engelhardt, A. Kárpáti, T. Rack, TC. Schmidt

Fachhochschule für Technik und Wirtschaft Berlin

Key words: *Tele-learning, Hypermedia Modelling, Multimedia Application, Knowledge Management*

Abstract:

Networked multimedia presently revolutionises teaching as once did the invention of blackboard and chalk. Distribution and roll out of complex multimedia objects however suffers from significant efforts any author has to fulfil in production. This paper presents a prototypic implementation of a virtual marketplace for multimedia teaching objects, which by a simple user policy allows for trading knowledge material between teachers. Knowledge entities thereby are considered as adaptable, compound objects consisting of media data as well as annotations, background information and meta descriptors. Our Knowledge Marketplace is based on the more general Multimedia Information Repository MIR. The MIR system consists of an intelligent media database with Web-authoring tool and is based on a hypermedia data model of reusable object components. Further educational applications of our architecture are presented, as well.

1 Introduction

Web-based components for teleteaching and distant learning are more and more considered a serious application framework within today's educational systems. Many attempts are made to establish on the one hand administrative or virtual community environments for organising classroom equivalents in the net. On the other hand document- or content-management-like systems are employed to deliver hyperlinked, linear pieces of educational material to the students. Frequently concern focuses on presentational schemes and standardisation of content distribution.

In contrast to those common efforts it is our believe that hypermedia techniques may mainly enrich teaching, if they are grounded on a multitude of individually styled highly interactive educational applications. Specific didactic tasks presented in a joy-oriented fashion oppose any standardisation process in knowledge presentation. Consequently our work presented here concentrates on a high-level framework, concepts, technologies and tools, for easy and rapid development of specific applications. This framework under discussion we call the Multimedia Information Repository, MIR [1]. All applications introduced further on are based on MIR technologies.

The support of different types of multimedia data in a teleteaching environment appears of course to be of significant relevance. A frequent shortcoming, however, results from the reduction of sight on pure media content. Media Objects form entities of knowledge as soon as we restrain from the simple vision of purely binary content data such as texts, images, sounds, videos etc. As information entities they are subject to structural classification regarding thematic aspects, topic, key words and related fields., didactic annotations concerning complexity, order, relevance to related objectives, and intrinsic meta information regarding format, author, access rights etc, as well. Possible further dimensions of structural annotations, e.g. rhetorical and narrative structuring, are discussed in [2]. An appropriate multimedia information system should offer media content and the corresponding descriptive knowledge, referentialy related but independently stored.

Learning modules request for a coherent design of its contributing portions of information. The information entities, being complex compositions themselves, need to be set into semantic relations in order to form a teaching module or application. The meaningful shaping of such structural overlays depends on the application and belongs to the author. Therefore a desirable information system not only should exhibit capabilities of embedding its contents into flexible structuring but also needs to strongly support the process of authoring in accordance to its abilities, unique points of source editing being the most prominent feature under request. The Multimedia Information Repository System MIR summarised in this paper tries to cope with all the above mentioned aspects.

In the following section 2 of the present paper we describe a knowledge market-place as a lightweight application of our Multimedia Information Repository, reflect on the ideas of the media object model and including some references on related work. Section 3 presents the underlying MIR system in short. Further applications of the multimedia environment are discussed in section 4. Finally, section 5 is dedicated to conclusions and outlook of the ongoing work.

2 A Knowledge Market-Place

2.1 Exchanging Media Objects

In recent times it has been widely understood that the preparation of qualitative advanced multimedia material ranges far beyond the scope of individual lecturers. The access to many different types of media such as text, images, animations interplaying with time-based material i.e. audio, video or online data processing, however, is fundamental to multimedia enriched teaching. It though requests for a specialised treatment which for the non technical oriented author is hard to fulfil. Facing the demand for good multimedia supplements in teaching on the one hand and recognising the difficulties in the production of such material a 'market-place'-type idea to archive, exchange and reuse the valuable material meets a quite natural demand.

The Knowledge Market-place (s. fig 1) collects fundamental information entities in the sense of our introducting remarks: Media content is accompanied by a basic set of annotations, e.g. *field, subfield, topic, title, keywords, author, date, access-rights, mime-type, etc.*, where semantical descriptors need to be provided by

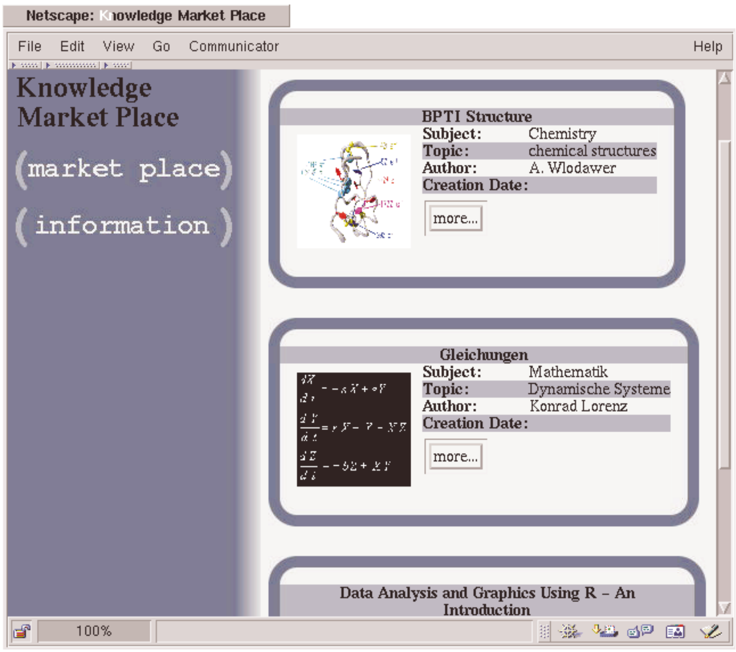

Figure 1: The Knowledge Market-Place

the authors. By use of a Web-frontend entries can be supplied, searched and retrieved, previewed and extracted for external use. Within the system media objects are ready for immediate access and display in a classroom facility ("Get and show the periodic table when needed") and – by means of a powerful MIR object model – may be flexibly reused in further applications. Indeed, grounded on easy accessibility and a simple user policy ("Get as many objects as you donate") one major objective of the market-place is to aquire a profound archive of media objects to be reused in additional educational applications.

2.2 The Media Object Model and related Works

The Knowledge Market-place application was built on top of the MIR environment, thereby enheriting its strong, adaptable object model. Media Objects here may be seen as the central constituents to comprise the data structure of our model. As the basic design idea a Mob is a neutral container which may carry a configurable set of descriptors (properties) as well as references on subordinate Mobs or data. Defining an application at first requests for turning the Mob structure into a meaningful formation, i.e. configuring an appropriate Mob class.

Semantics can be brought onto Mobs in a twofold fashion: A predefined set of (mandatory) attributes assignes an information structure on the data which may serve directly as user interface input or as steering quantities for dynamic content processing. The powerful approach however lies in interpreting the active references native to Mobs. An application designer not only can choose from arbitrary interelations such as trees, Petri-nets, circuits, …, but can dedicate operative instructions to those data links ranging from a simple automated Web-link generation over spatial and temporal construction policies up to conditional interactions within arbitrary scenes.

Object class definition in our market-place application remains quite simple: As we are dealing only with first-step informational units, Mobs carry their basic set of annotative properties accompanied by a single data reference. Even though information structure suffices for this purpose future applications of arbitrary complexity may reuse all basic object components by stuffing them into appropriate Mob hulls. In the contrary, a simple reuse-by-reference of media content data remains possible, of course, since all content data stays kept in separated data objects.

Enumerous activities rank around document structuring and authoring of more complex information models than HTML-formatting. From the educational area we exemplarily mention the group of Maurer [3],[4], who propose and implemented the Hypermedia Composite Model as a semantic container for learning documents. Even richer research is going on in the area of multimedia database systems. For an excellent overview we refer to [5]. As an interesting, elaborate approach to modeling hypermedia structures we like to mention the Nested Context Model (NCM) of Soares et. al. [6]; see [7] for a comparative discussion of the NCM.

2.3 Lightweight Implementation using XML

The implementation strategy chosen for the Knowledge Market-place application is caracterised by its extraodinary leightweightness, why we like to draw attention to it. As mentioned in the introduction the objective of the MIR system is to provide a high-level framework for an easy and rapid development of hypermedia applications. To achieve this goal MIR offers all functionalities for data access, retrieval and manipulation with respect to the underlying media object model. In this way specific implementation efforts may be reduced to a minimum.

The minimalistic ansatz especially accounts for our market-place which entirely relies on XML technology [8]. The application logic could be defined by addressing the XML API of the MIR system. Briefly stated this API allows for a mapping of predefined XML command tags on our JAVA middleware (see below) by means of XSP logic sheets. The MIR-XML API is contructed as nested command stack,

```
<mir:[command1]>
     <mir:[command2]>
          …
          <mir:[commandn]>
               <param*> [value] </param*>
          </mir:[commandn]>
          …
     </mir:[command2]>
</mir:[command1]>,
```

with the ability to process chained logical operations. Resting on this fundament the implementation tasks merely reduce to the standard definition of XML structure- (DTD) and stylesheets.

3 The Media Information Repository

In the present section we intend to give a brief overview of the MIR system fundamental to our work. For a more detailed description we refer to [9].

3.1 The Media Object Database

The core of our multimedia environment is formed by a media object database system. It combines all operations related to data storage and at the same time keeps track of information structuring ensuring referential integrity. Although MIR fully implements the media object model it remains neutral with respect to applications built on top of the database layer. The intention in designing the media repository was to provide a robust, powerful basis, on which a multitude of educational systems may be established with rather limited effort.

The MIR database divides into two functional groups: The Media Object Lattice and the Data Store (s. fig 2). Objects in both repositories may be addressed by symbolic names embedded in a virtual file system. Besides administrative information concerning owner, group and access rights, entities from the object lattice can carry arbitrary annotations by means of an property list defined through object class membership. Technically only distinct by data type definitions properties may contain any kind of meta information, e. g. content descriptors such as subjects and keywords, didactic annotators concerning presentation order or information depth, and technical markers being specific to the educational applications on top of the database, as well.

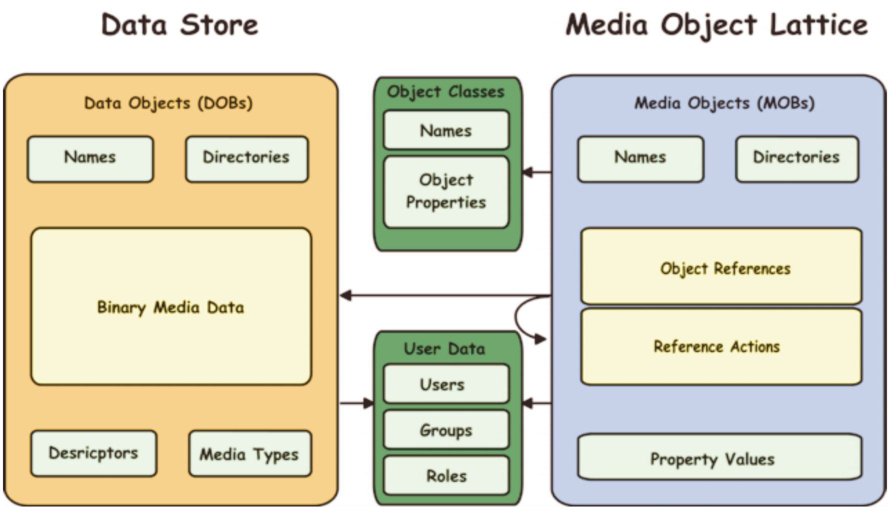

Figure 2: Media Object Database

3.2 The MIR Authoring Environment

Easy access for authors the system grants through a Web authoring tool (s. fig. 3). It is designed to guide through the different levels of object complexity by means of several adapted views and editing components. The user interface ranks around a class sensitive object browser, which reflects the file system view of our database. Mir authoring was designed following a toolbox concept, the MIR Authoring Framework, which allows for inplugging of application- or media-specific editors and previewers.

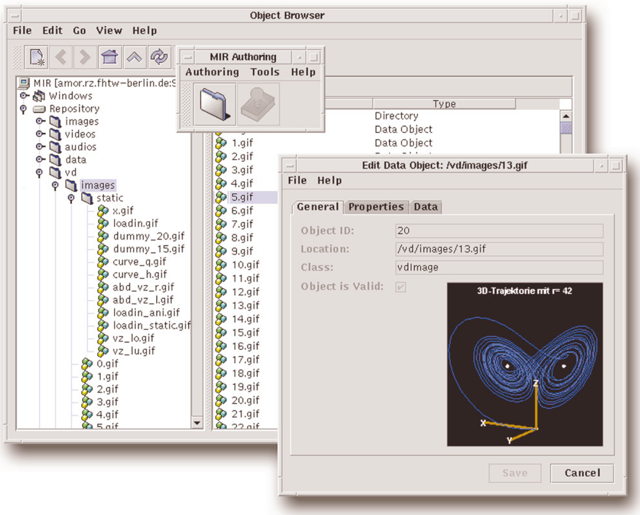

Figure 3: The MIR authoring tool

3.3 Architecture and Implementation

The technical concept of the MIR environment is formed by an open multimedia architecture designed according to a 3-tiered principle as is shown in fig. 4. Client access is granted in manyfold ways: On the standard side the natural CORBA/IIOP-exchange of objects is offered to intelligent client apps complemented by standard Web protocol http for all public entities in the database. Equivalently for leightweight apps the above mentioned XML interface is offered. As an important feature of the platform introduced here may be seen its ability to deal with pluggable subservers (s. fig. 4). Subserving not only opens up the field for application dependent media streams, but also allows for incorporation of new, complex functionality such as online data processing without fattening a thin applet client.

The current implementation of the media object database runs in a relational database management engine, a Sybase adaptive server, with special tuning applied to it. This platform we chose as a robust, very fast and lean basis. All middleware components are written in JAVA, EJBs namely, and are primarily responsible for the session and transaction management and for a buffering cache layer which allows for latency hiding. Media specific operations such as compression/decompression, streaming or synchronisation tasks are performed by the middleware components, as well, since middleware services are scalable, support load balancing and in our case accommodate caching.

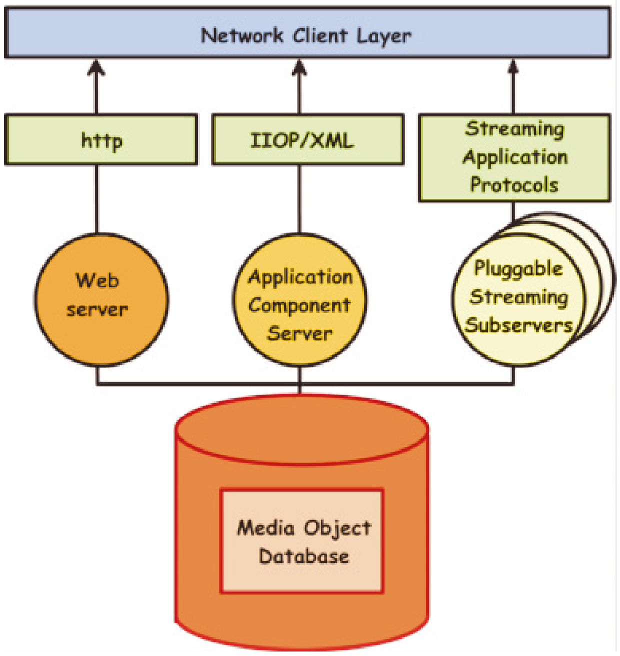

Figure 4: Networked Architecture

4 Application Examples

4.1 Media Objects in Time

As one major application the teaching and presentation system Media Objects in Time (MobIT) [10,11] centres about the idea of media objects synchronizable in time which may be linked to form fairly complex presentations (s. fig. 5). But at the same time any object remains self consistent and of independent use. Roughly speaking our basic concept consists of defining appropriate media object instances and a linking meaningful with respect to a time-line.

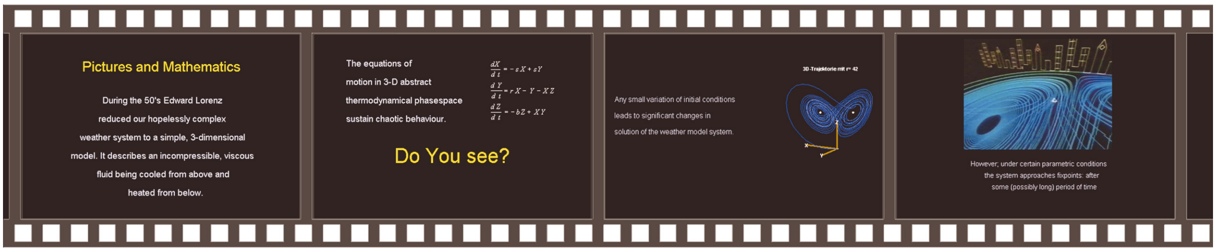

Figure 5: Time-based presentation in MobIT

In designing an educational system within our environment structuring has to be given an applicational meaning. In the context of MobIT this is done by the Compound Flow Model (CFM), which takes much care to define a simple structure of straight forward logic, intuitively appealing to document authors. The CFM organises the uniform hull entity Mob in a tree structure, where any branch reference expresses a temporal and spatial inclusion relation. As bound to the basic design idea of MIR Mobs include the subordinate object reference list and a screenplay script acting on the references, thereby describing all parameters responsible for their behaviour in time and space. The CFM concept assures self-consistency and thereby reusability of any subtree of the data structure.

4.2 Virtual Design

The design studio of tomorrow will not contain a computer anymore, but will consist of the computer network. Guided by this maxim a completely different idea of computer based educational system has been developed in collaboration with Bildo Akademie für Kunst und Medien Berlin. Interactive picture networking has been adopted as a basic co-operative internet platform for designers of digital images [12,13]. The project has been honoured in the meanwhile with the “New Talents Award” at the direct marketing congress DIMA in Düsseldorf 1998 and the special price Multimedia Transfer at Learntec 2000.

People from art and design communicate through their visual products. As it is rather difficult to circumscribe representational and aesthetic contents in standard language terms, a specific way of expression needs to be utilized: A Language of Pictures. Like any stream of statements such a visual speech needs basic order principals, a timeline and thematic assignments at minimal.

The Virtual Design project started from the idea of supplying a networked communication platform which allows for creation of visual dialogs. Starting from a “white canvas” each participant is enabled to contribute data sets consisting of an image, a title and a textual commentary to the system. The system itself requests such contributions to be a reaction of a former entry. It thereby links entities and lines pictures in time chains, optionally branching at nodes which invoked multiple reactions. As time evolves the Virtual Design system will give

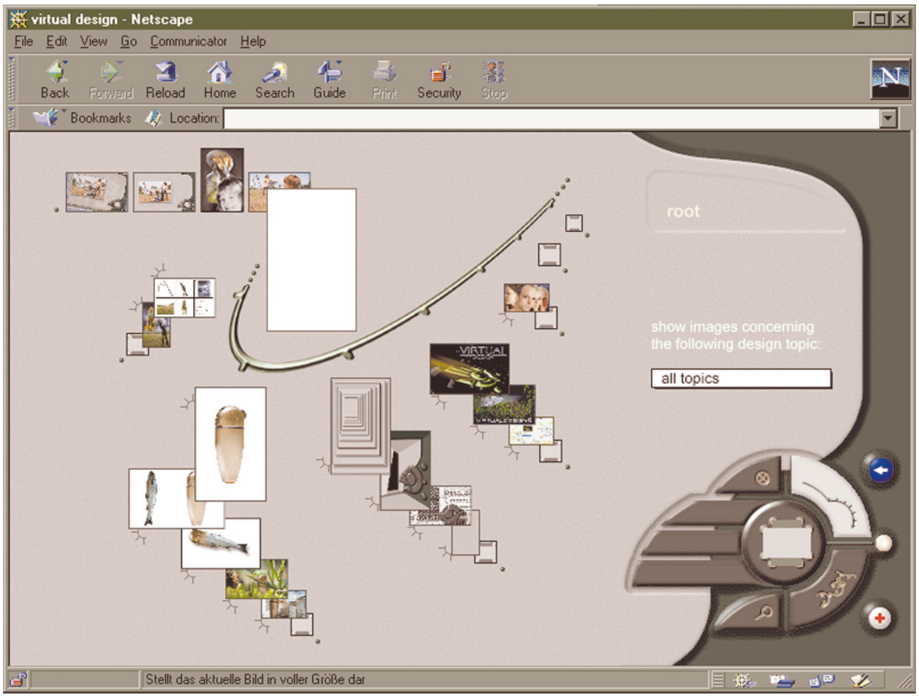

Figure 6: Virtual Design Visual Navigator

rise to a tree of pictures with each branch representing a visual dialog between authors (s fig. 6).

Relying on MIR basic environment Virtual Design MOBs enclose images, thumbnails and textual complements. The media object structure in the virtual design application is defined by the virtual dialogs performed by using the system and is assigned automatically as part of the work process. Note that no separate authoring is needed since VD combines workspace and presentation.

5 Conclusions and Outlook

Having started from the observation that networked mutlimedia telelearning is much more than a standardised collection of flat html-pages we tried to present counter examples: A market-place type exchanger for multimedia knowledge entities, a time-based web streaming system and a virtual design studio could scetch a variety of possible educational applications. All our work is grounded on the open, high-level multimedia architecture MIR which is ment to grant for rapid development in the future.

Much work, however, has to be done in this ongoing project. The prototypic runtime environment needs a reviewing and stabilization process. Much additional functionality is needed in the environmental middleware and the authoring toolset. Finally the system opens the field for a new interaction model, far beyond simple content linking as html provides. Work on this is under implementation, now. Our efforts remain simple, but in the long run wish to help answer the question stated in [14].

References:

[1] Engelhardt, M.; Feustel, B.; Kárpáti, A.; Rack, T.; Schmidt, TC.: *The MIR Homepage;* www.rz.FHTW-Berlin.de/MIR, Berlin 2001.

[2] Rutledge, L.; Davis, J.; v.Ossenbruggen, J.; Hardman, L.: *Inter-dimensional Hypermedia Communicative Devices for Rhetorical Structure;* Hashimoto, S.: Proc. Multimedia Modeling 2000; World Scientific, Singapore 2000, pp. 89-105.

[3] Helic, D., Maglajlic, S., Schaerbakov, N.: *The HC-Data Model: A New Semantic Hypermedia Data Model*; Proc. WebNet'99; 1999; Charlottesville, VA, USA; AACE; 493 – 498.

[4] Helic, D., Maurer, H., Scherbakov, N.: *Authoring and Maintaining of Educational Applications on the Web*; Proc. ED-MEDIA'99; 1999; Seatle, USA; AACE; pp. 1792 – 1797.
[5] Aberer, K., Timm, H., Neuhold, EJ.: *Multimedia Database Management Systems*; Borko Furht: Handbook of Internet and Multimedia Systems and Aplications;Boca Raton, Florida; CRC Press LLC; 1999; 285 – 310.
[6] Soares, LFG., Casanova, MA., Rodriguez, NLR.: *Nested Composite Nodes and Version Control in an Open Hypermedia System*; Intern. Journ. on Information Systems; 20; 1995; 6; Elsevier; pp. 501-519;
[7] Antonacci, M.; Muchaluat-Saade, D.; Rodrigues, R.; Soares, LFG.: *Improving the Expressivness of XML-based Hypermedia Authoring Languages;* Hashimoto, S.: Proc. Multimedia Modeling 2000; World Scientific, Singapore 2000, pp. 71 – 88.
[8] *Extensible Markup Language (XML) 1.0;* W3C Recommendation, Feb. 1998; www.w3.org/TR/REC-xml.
[9] Feustel, B.; Kárpáti, A.; Rack, T.; Schmidt, TC.: *An Environment for Processing Compound Media Streams;* accepted for publication in Informatica, 2001.
[10] Feustel, B.; Schmidt, TC.: *Time Directed Internet Teleteaching;* Proc. of ICL2000; Kassel 2000.
[11] Feustel, B.; Schmidt, TC.; Marpe, D.; Palkow, M.; Cycon, HL.: *Compound Media Streaming in Time*; Vaclav Scala: Proc. 9-th Int. Conf. Comp. Graph., Visual and Comp. Vision WSCG'2001; Plzen; 2001.
[12] Kárpáti, A.; Löser, A.; Schmidt, TC.: *Interactive Picture Network*; IEE Electronics & Communications; 99; 1999; 109; London; 1999; pp. 18/1-18/8.
[13] Born, T.; Hannecke, T.; Heine, A.; Kárpáti, A.; Kemnitz, T.; Löser, A.; Schmidt, TC.; Vestner, J.: *Virtual Design Update*; 27-99; FHTW-Transfer; Berlin 1999.
[14] Maurer, H.: *Can WWW be succesful?;* IFIP – DS8; Jan. 1999.

Author(s):

Michael Engelhardt
FHTW Berlin, Hochschulrechenzentrum
Treskowallee 8, D-10318 Berlin, Germany
engelh@fhtw-berlin.de

Andreas Kárpáti
FHTW Berlin, Hochschulrechenzentrum
Treskowallee 8, D-10318 Berlin, Germany
karpati@fhtw-berlin.de

Torsten Rack
FHTW Berlin, Hochschulrechenzentrum
Treskowallee 8, D-10318 Berlin, Germany
rack@fhtw-berlin.de

Thomas Schmidt, Dr.
FHTW Berlin, Hochschulrechenzentrum
Treskowallee 8, D-10318 Berlin, Germany
schmidt@fhtw-berlin.de