

On the Functionality of Distributed Multimedia-System Architecture for Educational Applications

D. Dochev¹, R. Pavlov², R. Yoshinov³

¹Institute of Information Technologies – Bulgarian Academy of Sciences

²Institute of Mathematics and Informatics – Bulgarian Academy of Sciences

³Computing Center - Bulgarian Academy of Sciences

dochev@iinf.acad.bg, radoslav@bgcict.acad.bg, yoshinov@bgcict.acad.bg

Abstract

The paper discusses the functionality of distributed multimedia architectures for educational applications. It reflects some developments made under the international project ARCHIMED “Advanced Multimedia-System Architectures and Applications for Educational Telematics” (part of the EC RTD program INCO-COPERNICUS). The aim of this project is to explore and implement technological methods and tools for creation and distribution of multimedia educational materials. The main elements of the architecture implementation are the project Local Internet Support Centres. The functions and structure of the Bulgarian Support Centre are presented with the adopted hardware and software platforms, the initial repository content and the pilot courses to be developed during the project.

Keywords: *educational multimedia, distributed architectures, virtual campus*

1. Introduction

The educational multimedia data management has to deal with several specific features:

- The necessity of interactive use of the multimedia materials, allowing individualised feedback and discussion.
- Extensive use of distributed multimedia resources available on WWW.
- The necessity of effective student navigation to ensure a balance between the two extremes of total constraint and total absence of constraint, according to the student’s needs and current state of knowledge.
- The necessity for versatility of composition for fast update and modernisation of educational content.
- The necessity of modular and open-system organisation.
- The need of intelligent assistance in information handling.

- The availability of a big pool of small educational content providers.

All real implementations of systems, accessing multimedia documents for a given class of tasks, have to compromise between the requirements for full functionality and the constraints imposed by the available resources. Therefore in order to create a viable pragmatically and technologically sound architecture the solutions to be applied have to consider:

- the modern tendencies in organisation of multimedia systems;
- the educational needs of the project end-users;
- the developments in the modern computer-supported learning environments;
- the current computer and communication structures of the university partners in the project and their possible development in the near future.

2. Conceptual Base of the Distributed Multimedia Educational Architectures

The architectures under discussion are build upon the following types of conceptual models:

1/ Multimedia data models, specifying the structure of multimedia data management systems and the methods applied for storing, composing and retrieval of multimedia documents. The multimedia data models have to provide useful abstractions and related mechanisms to support:

- Generalisation/specialisation hierarchy
- Attribute specification for describing the properties of a document
- Specification of operations, performed on a multimedia document
- Manipulation of composite objects
- Objects sharing
- User-oriented presentation.

The multimedia data management requires mechanisms, common for classical databases to ensure integration and integrity control, query support, privacy, version control etc. However some features are of special interest as due to huge data volumes and variety of information their achievement is more difficult - efficient data capture and access; data availability; data persistence and recovery; presentation of delay-sensitive objects etc.

2/ Pedagogical model, specifying both the structure of multimedia educational documents and various ways of their use (for teacher-centered or learner-centered organisation of the educational processes). Many current educational projects for distributed computer environments apply the principles of constructivist pedagogy and use models, based on the following leading ideas [1, 2]:

- Learning should be context based, i.e. learning experiences should be contextualised in authentic activities; learning is acquired through making links with existing knowledge.
- Conceptual learning is through active involvement: a task is understood through participation in it; learning involves creating personal meaning and understanding; experience becomes part of the meaning.
- Learning is through collaboration with others: sharing knowledge resolves misunderstandings; interaction leads to new knowledge; understanding evolves from shared knowledge constructing;
- Learner should have personal autonomy and control over learning: modern learning involves personal decision making, formulating own learning strategies and own goals; teacher mediation depends on needs and skills of the learners.
- Learning is personal growth - argument leading to reflection helps refine concepts; outcomes are unique to the learner;
- Learning outcome is a perspective and an understanding: specific content and learning outcome should not be prescribed; multiple perspectives of the learning task and different approaches to understanding are needed.

3/ Model of communications, organizing the information exchange of multimedia information in distributed computer environment. The model of communications has to ensure proper multimedia environment in networking inside and between the partners. The partners networks normally include Proxy servers, Cache servers, WWW servers, Name servers (DNS, WINS and DHCP servers), Mail servers, FTP servers, Terminal servers, Application servers,

Database (SQL) servers. The new quality of the network model is achieved through appropriate mechanisms for cooperation of these servers and the extension of their capabilities using protocols and standards (e.g. ActiveX, specific plugins etc.) recommended for exchange of multimedia information.

3. End-User Groups and Generic Services

The ARCHIMED architecture is meant to serve two different groups of end-users:

A. Learners, accessing and learning with multimedia educational materials: university students, students in specialised schools, participants in vocational training educational forms, non-formal and life-long learners. The architecture to be developed has to ensure sufficiently rich environment, relevant to the modern pedagogical approaches and tendencies for teacher-assisted and learner-centered education in local and global computer networks with some collaborative learning possibilities.

B. Authors of multimedia educational materials: university lecturers, high-school teachers, lecturers in specialised training courses. As a rule the authors are not IT specialists, so it is not real to expect that they will be willing to use authoring systems and tools with high level of complexity to produce courseware. The majority of these authors are also meant to use the created multimedia educational materials directly in their teaching practice.

These two groups of end-users require two classes of generic services to be supported by ARCHIMED architecture. These services may be organised using the modern computer-assisted education metaphor of "virtual campus". In order to develop a specific detailisation of this metaphor, suitable for the needs of the project, the participants in the educational process and their main roles has to be revealed. Similarly to [3] we consider the following main actors in the educational process in the "virtual campus":

1/ Learner - transfers information into knowledge. S/he uses the courseware from the distributed repository ("virtual library") acting in the following roles: explorer of repository resources; navigator through learning scripts; self-evaluator of personal assignments; participant in collaborative learning (e.g. peer review, debates in telediscussions etc.).

2/ Trainer/advisor – assists/advises the learner in the educational process acting in the following roles: produces diagnosis; advisor; assignment evaluator; coach.

3/ Manager - manages actors and events, acting in the following roles: planner; decision-maker;

supervisor and controller; team or group organiser; director of learning assignment.

4/ Author – supplier of educational content. S/he produces courseware using the MM materials from the repository by means of “author studio” tools, acting in the following roles: document analyst; content expert; teaching materials designer; instructional scriptwriter.

5/ Mediator (“information broker”) – facilitates the navigation of the other participants through the “virtual campus” acting in the following roles: information communicator; user profiles production and maintenance; help in environment use; intelligent help in document retrieval.

Each actor is expected to assume various roles; a given role may be assigned to more than one actor. The roles are related with specific information subprocesses, which have to be supported by the educational architecture under development.

These groups of end-users require two classes of generic services to be supported by ARCHIMED architecture:

A. Services for the learners

In order to ensure interactive use of multimedia courseware by the learners the ARCHIMED architecture has provide the following components:

- Access to a distributed repository (“virtual library”), containing multimedia documents and interactive courseware with different levels of complexity;
- Tools, organising the processes of supervised learning or self-learning using multimedia courseware in a distributed computer environment;
- Tools, facilitating the navigation through the repository according to the user’s needs and profile (“information brokers”);
- Tools, organising asynchronous/synchronous group educational activities in distributed environment (e.g. link to human tutors, bulletin boards, peer reviews, discussion forums, conferencing etc.).

B. Services for the authors

These services provide means for the authors to store, maintain, archive and finally produce their educational multimedia materials. In order to cover this service class the ARCHIMED architecture has to support the following elements:

- A document directory system and a database for storing the digitized pedagogical materials;
- A web interface for uploading materials on a web server;

- A library of documents templates (generic models or scenarios) to be used by the author to create pedagogical materials;
- Secure discipline for accessing the web server with the document templates;
- An instructional methodology to guide the author in his authoring process.

4. Implementation of ARCHIMED architecture

Though the ARCHIMED architecture doesn’t address directly the whole set of distant learning activities, it covers an important part of the popular in the last years “virtual campus” metaphor. The virtual campus is structured in virtual spaces, organising the realisation of the abovementioned information subprocesses. A possible set of virtual spaces may include [3]:

- An information space - repository (“virtual library”) containing various types of documents or data required by the actors to fulfil their function. It contains multimedia materials (text, graphic, audio and video objects) selected thematically for the needs of the courses produced/distributed and courseware on different levels of complexity
- A learning space with the requisite tools to complete assignments and to participate to learning system.
- A communication and collaboration space with tools enabling actors to communicate, carry out group activities and participate in remote seminars and teleconferencing.
- An assistance space where actors may get support and advice or have their environment customised, by calling upon either online support personnel or computer-based help resources.
- An authors' space, containing tools permitting the authors to store, maintain, archive and finally produce their educational multimedia materials.

The models and tools in the architecture under consideration will be experimented on the following target groups - 1/ graduate students of information technologies studying courses on multimedia technologies, computer animation, web graphics and design; 2/ graduate students of journalism for courses on mass media advertising. The experimental courseware is developed considering some requirements for learner-centered and project-based learning.

Considering the current state, tendencies and traditions for hardware use in the partner's sites ARCHIMED architecture maintains the existing strong PC

orientation. The supporting operating system and **multimedia** database management system have to ensure flexibility in application interfaces, systems intercorporability, connection decisions, network protocols, routing, distributed component realization, security on all levels etc. Considering the PC domination in server and client trends, Microsoft Windows NT was chosen as an appropriate choice for system support. Windows NT server looks proper server operating system for the goals of the project and Windows NT workstation or Windows'95/Windows'98 - a proper client operating system.

For management of multimedia documents in network environment an appropriate MMDBMS seems Microsoft SQL Server which has all the capabilities, needed for such types of databases. SQL Server offers distributed security integrated with Windows NT with central control of passwords across a domain and new encryption services for logon and data stream. SQL Server remains an open, interoperable platform that works with what customers have and know.

The virtual campus of ARCHIMED relies entirely on the Internet connectivity for the communications

between the project partners. The respective transfer speeds are function of the communication policies and finances of the institutions of the project partners. Their networks will be extended by adding Cluster servers for achievement of more power and throughput running the applications and Remote Access Servers for serving remote clients (from universities, schools, SMEs etc.) who will use the developed environment (methodology, tools, templates, courseware etc.) in the frame of ARCHIMED. The connections between the Bulgarian partners from Bulgarian Academy of Sciences work at the speed of 100 Mbps, as the three institutions are situated close by. The connections are based on UTP with Switches (devices like Cisco1900, Cisco 2500, Switch-gateway Cisco3100), using TCP/IP as main routing protocol. The Local Internet Support Centres use Remote Access Servers, based on PPP and PPTP protocols for support of the remote clients.

More information about the design decisions, functions and the structure of ARCHIMED architecture may be found in [6, 7]. The overall structure of the Bulgarian Local Internet Support Centre is shown on Figure 1.

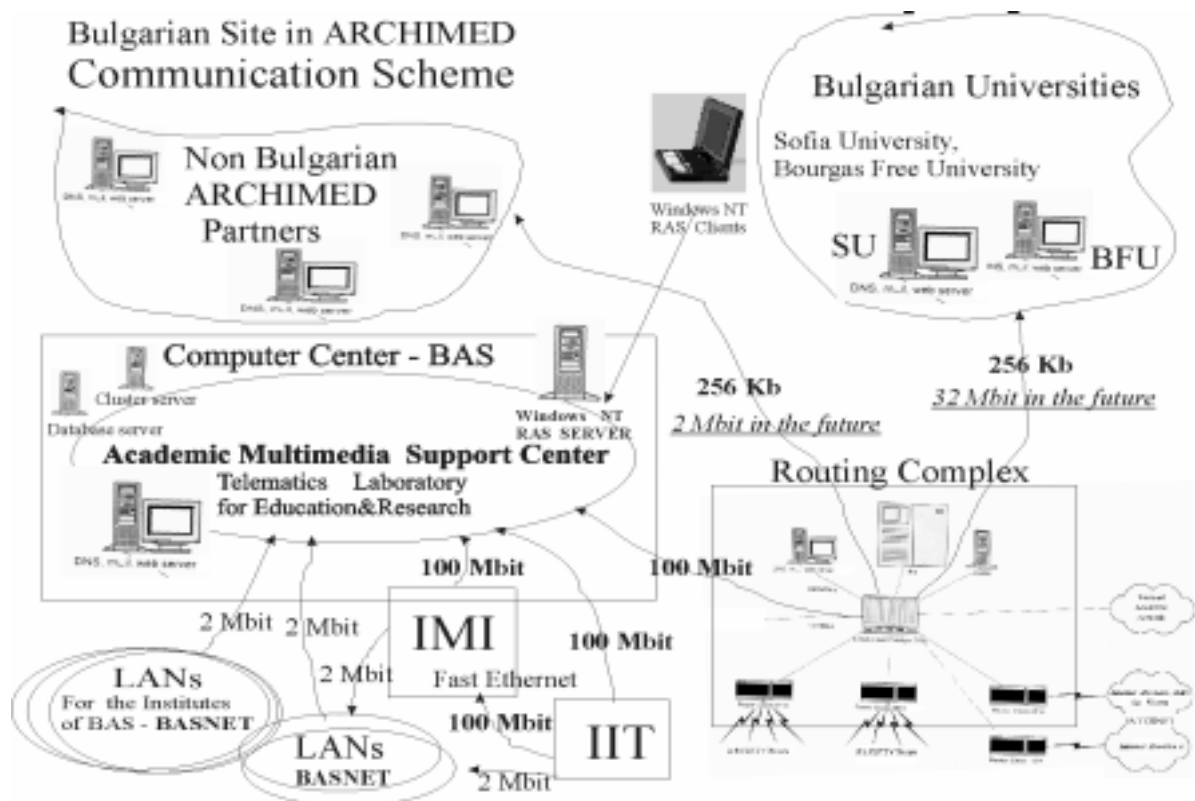


Figure 1 Structure of the Bulgarian Local Internet Support Centre

Reference

- [1] J. M. Ewing , J. D. Dowling, N. Curtis – Learning Using the World Wide Web: A Collaborative Learning Event. In: *Journal of Educational Multimedia and Hypermedia*, Vol. 8, No 1, 1999, pages 3-22.
- [2] E. B. Susman – Coperative Learning: A Review of Factors that Increase the Effectiveness of Cooperative Computer-Based Instruction. In: *Journal of Educational Computing Research*, Vol. 18, No 4, pages 303-322.
- [3] F. Henri – Designing a Virtual Learning Environment for a Graduate Course on Multimedia. In: *Davies G. (ed) Proc. of XV IFIP World Congress, Teleteaching'98 - Distance Learning, Training and Education*, Part I, pages 427-444
- [4] C. Hmello, M. Guzdal, J. Tums – Computer-Supported Collaborative Learning: Learning to Support Student Engagements. In: *Journal of Interactive Learning Research*, Vol. 9, No 2, 1998, pages 107-129
- [5] G. Paquette – Engineering Interactions in a Telelearning System. In: *Davies G. (ed) Proc. of XV IFIP World Congress, Teleteaching'98 - Distance Learning, Training and Education*, Part I, pages 19-41.
- [6] D. Dochev, R. Pavlov et al. - Modelling of Data Management. *Project ARCHIMED PL961060, Report D2.1*, 1998
- [7] R, Yoshinov et al - Modelling of Communications. *Project ARCHIMED PL961060, Report D2.2*, 1998