A 3-tier Application for Topic Map Technology

A. PAPASTERGIOU, G. GRAMMATIKOPOULOS*, A. HATZIGAIDAS, G. TRYFON
Department of Electronics, (*) Department of Esthetics
Alexander Technological Educational Institute of Thessaloniki, EPEAEK II
Sindos, 57400, Thessaloniki, Macedonia, GREECE

Abstract: In the context of this paper the design and construction of a 3-tier application system for topic map technology is presented in detail. The proposed system employs Enterprise Topic Map Server (ETMS) that manages topic maps (TM) and establishes communication with client applications and persistent database. Yellow Web Services have been customized in order to achieve communication issues and exchange of TM. A client application is addressed to TM developers for editing and visualization of TM. Furthermore, the definition of TM Schema as well as the possibility to process rules and queries are supported. Another key aspect of the present paper is to analyze how different technologies utilized to formulate such a system.

Key-words: Topic map, Server, Web services, Client, 3-tier, TM schema, Retrieval

1 Introduction

The Topic Map model describes a mechanism for representing knowledge about the structure of information and organizing it into topics [1,19]. Topics have occurrences and associations that define relationships between the topics, creating thus a semantic network over the information [8,18].

Topic maps aim to provide a powerful tool for information management and knowledge representation [10]. Recently, they are widely used for knowledge management, web portal development as well as in more complex applications like integrated information systems [1,19].

Despite the steady increase of interest towards experimenting with topic map technology, efficient tools did not exist to manipulate topic maps [1,6]. Nowadays, this situation is changing and an intensive research effort is under progress in order to build tools freely available to developers. Existing commercial and non-commercial topic map applications make use of open source tools for topic map standard [1,16,21,23].

In this framework a 3-tier application for topic map standard is presented. The proposed system employs the Enterprise Topic Map Server (ETMS) that manages topic maps and coordinates communication issues with client application and persistent database. Yellow Web services have been customized in order to achieve communication issues and exchange of TM. A client application is addressed to TM developers for creation and representation of TM. Further more the definition of TM Schema as well as the possibility to process rules and queries are also supported. In the next sections the overall architecture of the proposed system as well as technologies that are implied in order to build the system are represented in details.

2 Overall architecture

Topic Maps intend to enable better access to information and give a viable solution to the information access problems. A Topic Map system has to support the management of TM data in any corporate information infrastructure for different users and processes. Thus, Topic Map software should be able to operate both as a dynamic information server and as tool for processing information in conjunction with the Topic Map data [1,10,11].

Following this spirit, the proposed system implies a 3-tier architecture. The 3-tier is a client-server architecture in which the user interface, the functional process logic and the data storage and access are developed as independent modules, usually on separate platforms. Typically, the user interface is a standard graphical interface, process logic may consist of one or more separate modules running on an application server, while database server contains the data storage logic [3,22].

Scalability, deployment flexibility and improving maintainability are the main advantages of such a modular architecture. Infrastructure independence is enhanced since any of the three tiers can be upgraded

or replaced independently. Finally, 3-tier application hides the complexity of distributed processing from the user [4,22]. Figure 1 depicts the overall architecture of the system.

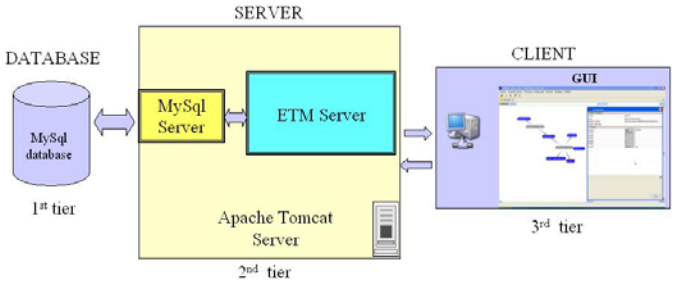

Fig. 1:Overall architecture of the system

3 Database description

The proposed system is a topic map system. As a topic map may contain thousand of topics and associations it is essential to store the data persistently in a database and retrieve only relevant fragments at execution time. Yellow-TM offers persistent storage in a relational database management system.

MySQL has been selected for storing purpose. MySQL, the most popular Open Source SQL database management system, is developed, distributed, and supported by MySQL AB [12].

MySQL is a relational database management system, is Open Source, is very fast, reliable, and easy to use. MySQL Server was originally developed to handle large databases much faster than existing solutions and has been successfully used in highly demanding production environments for several years. MySQL Server works in client/server or embedded systems. MySQL can be easily run as a Windows Service [12,13].

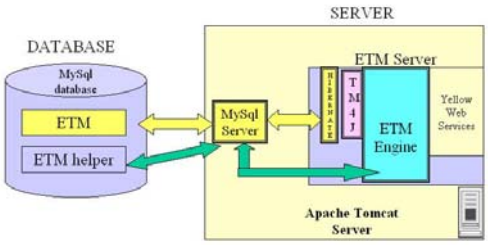

Fig. 2: Database-Server communication

In MySQL two different databases are preserved (Fig. 2). ETM holds the entire topic maps data. "ETM helper" holds data that do not have to do with topic map structure. In particular, "ETM Helper" stores information about login of users and User administration data. Finally, data that concerns TM Schema as well as Rules and Queries implemented in Tolog language are also stored in "ETM helper" database as separate tables.

4 Introducing ETM Server

Enterprise Topic Map Server (ETMS) is the core of the TM application system and coordinates all the necessary operations (Fig 3). It has been build in order to manage topic maps in account of clients, provide information requested according the rights preserved by each user and make necessary modifications in topic maps whenever needed.

ETMS is fully compliant with ISO/IEC 2002 and XML Topic Maps (XTM) standards [7,8,27]. An application server, Apache Tomcat [2], is utilized in which ETMS is installed as a service (Fig. 3). The programming language used is Java and in particular the Netbeans IDE platform and for the proper operation JRE 1.5 or latest edition should be installed on the server [14,20]. NetBeans IDE is a powerful integrated development environment for developing applications on the Java platform.

The NetBeans IDE provides to developers all the required tools in order to create professional cross-platform applications. It enables scalability and expandability through future modular extension [14].

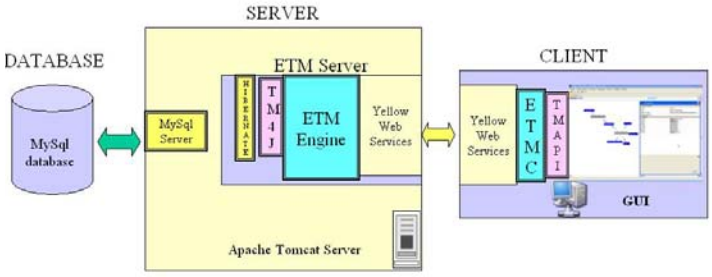

Fig. 3: Representation of implied technologies

Administration of topic maps is made from ETMS using TM4J library (Fig. 3). TM4J provides an Application Programming Interface (API) to permit programmers to create and modify topic map structures [23]. The TM4J Engine provides interfaces for querying topic maps structures using the Tolog query language and parsing topic maps from XTM syntax files or writing topic maps to XTM syntax files [5,23].

4.1 Database-Server communication

For the persistent storage of TM data, MySQL has been selected. MySQL Server is also installed in the Server side and runs as a Windows Service (Fig. 3).
Information stored in ETM database is in a format of topic maps. Since, topic maps deals with hierarchical information, in contrast to the relational information that MySQL database can handle, an auxiliary library called Hibernate undertakes to make the necessary modifications, so that the hierarchical information stored in a relational format in MySQL database can be retrieved. TM4J is used to manage topic maps that are persistently stored in the relational database using the Hibernate O-R mapping [7,23]. So, every time that topic map data has to be retrieved or to be written to the ETM database, ETMS via Hibernate asks MySQL Server to act. On the other hand, if user's request concerns data held in "ETM helper" ETMS will just ask from MySQL Server to proceed with the requested operation (Fig. 2).

4.2 Server-Client Communication

Communication with client is achieved using Web Services [3]. Apache Tomcat enables the use of Web Services [2]. Moreover, NetBeans environment provides all the necessary libraries, in order to create Web Services calls [14]. Yellow Web Services (YWS) are customized WS that enable ETM server to realize RMI calls and achieve topic map exchange. They have been formulated with WS over SOAP and http protocols (Fig. 4). Remote communication is implemented according to TMAPI standards, a communication prototype of topic maps [24].

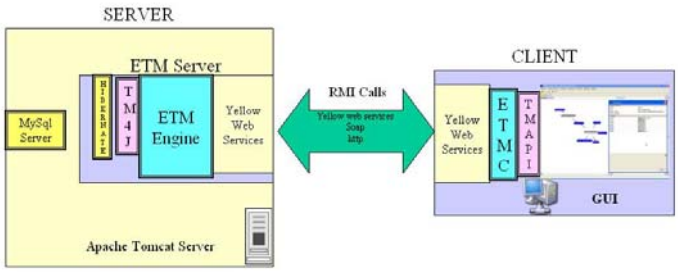

Fig. 4: Server-client communication

Application system fully supports TMAPI, a common API for TM applications (Fig. 4). TMAPI is a programming interface for accessing and manipulating data held in a topic map. TMAPI hopes to provide a single common API which all developers can code to and which means that their applications can be moved from one underlying platform to another with minimum fuss [24].

5 Client part implemenation

Client, from the other side manages communication with user, displays information taken from the server and accept commands of users in order to be forwarded to the server.
Similar to server, client-programming language is Java, and in order to function correctly JRE 1.5 or latest edition should be installed in client's computer [20]. Moreover, the use of Netbeans platform for building the client application (Yellow-TM) enables the implementation of powerful and intuitive GUIs, embodying forms and wizards [14].
Client code is structured in two parts. The first one is implementation of a library (Enterprise Topic Map Client- ETMC) that achieves communication with the server and topic map exchange. The second one is the graphical user interface (Fig. 5). The reason for this dissociation is for future ability to use the same server interface but different user interface, addressing to different users with various needs.

5.1 Enterprise Topic Map Client Library

Client communicates with server via web service calls. But Web Services do not support TMAPI directly. Thus, ETMC library (Enterprise Topic Map Client) has been developed in order to realize TMAPI for client. ETMC library converts client calls that follow TMAPI, to YWS calls. In this way, client and remote ETMS communication is established via RMI calls (Fig. 5).

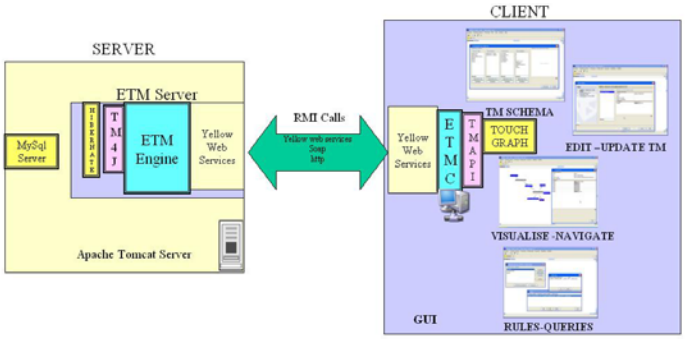

Fig. 5: Representing client application

An undesirable process in a distributed application is to transfer all the topic map information from one application to another. It has been pointed out, that the ability to send a small part, a topic map fragment, to another application is required in order to build an

effective Topic Map Server [11]. ETMS can handle client requests and retrieve only the necessary fragments of the topic map at execution time.
TMAPI works with objects, i.e TM concepts. On the other hand, Web services and SOAP protocol cannot handle objects but only strings. So, in order to work with topic map and to appear all the necessary information to the client, proxies are used. A stand-in object is used instead of the original object. When someone calls the methods of the proxy, it calls the corresponding methods of the original object.
Topic map ID is the string that passes with SOAP protocol. ETMC library creates virtual objects that represent TM concepts according to TM ID that it receives from the server. Client program that follows TMAPI specification represents TM concepts to the user.

5.2 Describing client GUI

Yellow-TM has been designed and implemented aiming to provide a functional and easy to use environment for TM manipulation [17].
Authorized users may connect to TM server and open a topic map or create a new one using wizards that are provided by the program. Netbeans platform enables the provision of advanced GUI enhanced with windowing interfaces to end-user [14].
TM Schema visual editor support the definition of TM schema. Employing Touchgraph library [26] visualization and navigation functionalities are provided. TM information that user has asked is represented as graphs with arcs and nodes (Fig. 6).

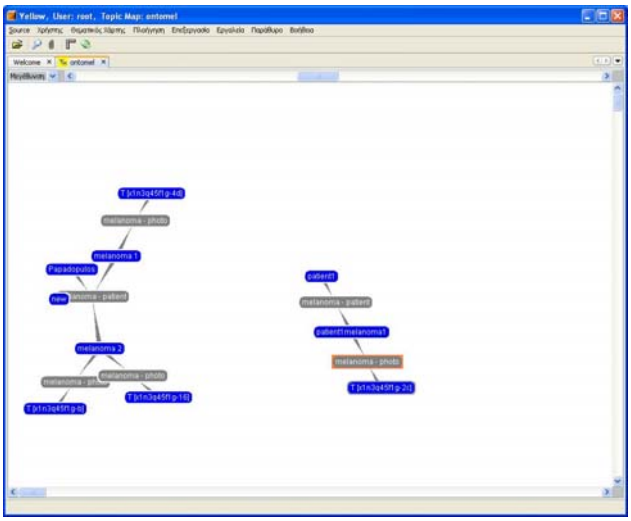

Fig. 6: Visualisation of TM data using Touchgraph library

Moreover, users have the ability to edit and update the topic map objects while they are represented visually. Finally, the capability to express and process inference rule and integrated queries using easy to use wizards, enables advanced retrieval of TM information and reasoning support [5,15]. Import and export of XTM files as well as of Schema files is supported [17]. Small screenshots of the prototypes GUI that are provided for TM Schema definition, editing, visualisation and expression of rules and queries are represented in Figure 5.

6 Conclusions

The aim of this work was to present the design and formulation of an effective TM application system for TM technology. An important issue in this paper was to exploit how different technologies could be utilized to build such a system.
In the heart of the system Enterprise Topic Map Server (ETMS) runs in the Apache Tomcat Web Server as a service. Enterprise Topic Map Server (ETMS) manages topic maps and establishes communication with client application and MySQL database. Yellow Web Services have been customized in order to achieve communication and exchange of TM data. On the client, Yellow-TM is addressed to TM developers for editing and visualization of TM. Moreover, the definition of TM Schema as well as the possibility to express rules and queries are supported. The implementation of the Enterprise Topic Map Client (ETMC) library accomplishes communication with the server and topic map exchange. ETMS handles client requests and when is required it retrieves only the proper fragments of the topic map at execution time. ETMC library creates virtual objects that represent TM concepts. Finally, ETMC library based on TMAPI specifications represents the requested TM concepts to user visually.
The provision of a functional application system for TM standard may offer important help to anyone that would like to experiment with topic map technology and develop a distributed real world topic map-based application. In the framework of the research work that is conducted in our laboratory, an application based on the proposed system is currently under development. The aim is the creation of an application that handles TM-encoded dermatoscopic images and related medical information in order to create a diagnostic support tool for dermatologists and consequently explore potential benefits of encoding information using topic map technology. Hence, during this research effort, the feasibility and efficiency of the proposed 3-tier application system for topic maps is under evaluation and directions for future work and improvements may be identified.

References:

[1] Ahmed, K., Topic Maps For Open (Source) Developers, *XTech 2005: XML, the Web and beyond*, 2005, http://www.idealliance.org/proceedings/xtech05/papers/04-03-04

[2] Apache Tomcat, http://tomcat.apache.org/

[3] Coone, P., Understanding Web Services, 2002, http://alistapart.com/ articles/ webservices

[4] Gallaugher, J. & Ramanathan, S., Choosing a Client/Server Architecture. A Comparison of Two-Tier and Three-Tier Systems, *Information Systems Management Magazine* Vol. 13,No. 2,1996, pp 7-13.

[5] Garshol, L.M, .TOLOG, a topic map query language,2001, http://www.ontopia.net/

[6] Hatzigaidas, A. Papastergiou, A., Tryfon, G. Maritsa, D. Topic Map Existing Tools: A Brief Review, *Proceedings of the International Conference on Theory and Applications of Mathematics and Informatics - ICTAMI 2004*, 2004, pp 185-201

[7] Hibernate, http://www.hibernate.org/

[8] ISO 13250, Guide to the topic map standards"; ISO/IEC JTC1/SC34, 2002

[9] ISO 13250, Topic Maps", 2nd ed., ISO/IEC JTC1/SC34, 2002

[10] Moore, G, Topic Map technology - the state of the art, 2000, http://www.infoloom.com/gcaconfs/WEB/paris2000/S22-04.HTM

[11] Moore, G. Semantic Web Servers, Engineering the Semantic Web, 2003, http://www.ontopia.net/topicmaps/materials/semantic-web-servers.ppt

[12] MySQL tutorial, http://dev.mysql.com/doc/refman/5.0/en/what-is.html

[13] MySQL, http://www.mysql.com/

[14] Netbeans IDE Organisation,http:www.netbeans.org

[15] Ontopia, Tolog tutorial, Ontopia AS, 2001, http://www.ontopia.net/omnigator/docs/query/tutorial.htm.

[16] Ontopia: The Topic Map company, www.ontopia.net/

[17] Papastergiou, A., Grammatikopoulos, G. Hatzigaidas, A., Zaharis, Z. Lazaridis, P., Kampitaki, D. and Tryfon, G., Introducing an advanced Topic Map software tool towards the deployment of a TM-based system for managing melanoma cases images.,2006, *Submitted to journal WSEAS TRANSACTIONS ON INFORMATION SCIENCE AND APPLICATIONS*

[18] Pepper, S., The TAO of Topic Maps. Ontopia: http://www.ontopia.net/topicmaps/materials/tao.html.

[19] Pepper, S. The TAO of Topic Maps Seamless Knowledge in Practice, *2005 OntopiaAS*, http://www.ontopia.net/topicmaps/materials/Towards%20Seamless%20Knowledge.ppt

[20] Sun Microsystems, Inc.: Java programming language. An interpreted language, http://java.sun.com/

[21] Techquila's Topic Map World Topic Map http://k42.empolis.co.uk/home.html

[22] Three-tier http://en.wikipedia.org/wiki/Three-tier_%28computing%29

[23] TM4J: Topic Maps for Java, http://www.tm4j.org/

[24] TMAPI, Common Topic Map Application Programming Interface, http://tmapi.org/

[25] Topic map tools, http://www.topicmap.com/topicmap/tools.html

[26] Touchgraph homepage, http://www.touchgraph.com/

[27] XTM 1.0 , XML Topic Maps (XTM) 1.0 TopicMaps.Org, 2001, http://www.topicmaps.org/xtm/1.0/

"The project is co-funded by the European Social Fund & National Resources – EPEAEK II - ARCHIMIDIS II – sub project 2.2.3"