I-WEST 2009

José Cordeiro, Ivan Ivanov and
Boris Shishkov (Eds.)

Enterprise Systems and Technology

Proceedings of the
3rd International Workshop on
Enterprise Systems and Technology
I-WEST 2009

Sofia - Bulgaria, July, 2009

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Ivan Ivanov
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Volume Editors

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Foreword

This volume contains the proceedings of the Third International Workshop on Enterprise Systems and Technology (I-WEST 2009), held on July 29-30 in Sofia, Bulgaria.

The I-WEST workshop is a scientific event of IICREST, the *Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology*. I-WEST provides a platform to researchers and practitioners, from academia and industry, to discuss challenges, solutions, ideas, and experiences that relate to the broad field of enterprise systems and technology. Each year, a special theme is chosen within this broad field, in order to make presentations and discussions more focused. The theme of I-WEST 2009 is: **Emerging Enterprise Technologies: Catalyst for Creativity**.

Emerging enterprise technologies are profoundly changing the way we think of IT - from economics and efficiency to process and usage models. Many organizations consider "externalized" IT systems and services as a potential cost savings advantage by moving internally hosted IT services to external providers. Other organizations view the "external" IT as potential disaster recovery systems or as on-demand capacity to boost business continuity and customer service levels. We need to take a closer look, discerning what emerging enterprise technologies are and how they can catalyze creativity and produce a competitive advantage. The two-day I-WEST'09 event is expected to bring together researchers and innovators for discussing the transformative technological innovations intended to better our lives, create business opportunities, and stimulate economic growth.

Hence, the contribution of I-WEST 2009 is inspired by the goal of advancing enterprise technologies and applying them in new ways, to create solutions for the dynamic and networked enterprises of the future. Spontaneous collaboration, context awareness, adaptive behavior, and economic sustainability are just some desired properties of future enterprise systems. Such systems have to be realized in distributed, heterogenous, and dynamic environments. Further, creative solutions grounded in enterprise technologies are needed. Inspired by this purpose, I-WEST 2009 has the intention of uniting researchers from various communities, including researchers working on enterprise computing, enterprise interoperability, context-aware systems, IT infrastructures, model-driven engineering, and service-oriented architectures.

Following the I-WEST'09 Call for Papers and received submissions, 7 papers were selected for a 30-minutes oral presentation during the workshop and for publication in these proceedings. The selected papers are a good illustration of different relevant topics that are currently under research: some papers are more oriented towards enterprise technology (considering it from the perspectives of data technology and sensor technology) while other papers are directed more to the development of ICT applications related to this technology (considering human-actions-driven application specification and service-oriented application models) as well as to "externalization" of IT and cloud computing.

Taking this opportunity, we would like to express our gratitude to all who have contributed to I-WEST 2009, including the authors (who have provided the main content for these proceedings) as well as the program committee members (who have provided constructive comments contributing to the content quality). We would also like to thank Vitor Pedrosa for the brilliant work and support in preparing the proceedings. Last but not least, we thank the invited speaker, Marten van Sinderen, for his invaluable contribution. Finally, we tremendously appreciate the willingness of INSTICC to publish the proceedings, expressing respect and gratitude especially to Joaquim Filipe.

We wish all presenters and attendees an inspiring workshop and a nice stay in the beautiful city of Sofia.

July 2009

José Cordeiro
Ivan Ivanov
Boris Shishkov

Workshop Chairs

José Cordeiro
Polytechnic Institute of Setúbal / INSTICC / IICREST, Portugal

Ivan Ivanov
SUNY Empire State College, United States

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(The Netherlands)

INSTICC - Institute for Systems and Technologies of Information,
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INVITED SPEAKER

From Service-Oriented Architecture to Service-Oriented Enterprise

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Abstract. Service-Oriented Architecture (SOA) was originally motivated by enterprise demands for better business-technology alignment and higher flexibility and reuse. SOA evolved from an initial set of ideas and principles to Web services (WS) standards now widely accepted by industry. The next phase of SOA development is concerned with a scalable, reliable and secure infrastructure based on these standards, and guidelines, methods and techniques for developing and maintaining service delivery in dynamic enterprise settings. In this talk we discuss the principles and main elements of SOA. We then present an overview of WS standards. And finally we come back to the original motivation for SOA, and how these can be realized.

Keywords: Service-Oriented Architecture, SOA Principles, SOA Patterns, Service-Oriented Computing, Web Services, Service-Oriented Enterprise.

1 Introduction

Service Oriented Architecture (SOA) was originally motivated by the need of enterprises to better match information systems with their business goals, combined with the market trend of more and more flexible cross-organizational collaboration between enterprises [6]. Vertical integration (business-IT alignment) and horizontal integration (IT supported cross-organizational collaboration) are considered crucial for modern enterprises, but traditional IT architectures have serious integration deficiencies. Architectures often comprise monolithic (silo) applications that are effective for the specific purpose they were created, but which do not allow integration without custom coded connections. Architectures with component-based applications provide units of business logic, which ease the definition of connections, but still require that the flow of control and the transformation of data formats are bound into the business logic.

SOA is an IT architectural style that tries to achieve integration by way of defining composite applications as an orchestration of services, with services potentially offered by different organizations. A service externalizes public functions of an application that implements a repeatable business task. Since a composite application can also be offered as a service, integration may involve multiple levels of composition, and a service can be internal to an organization or cross-organizational.

This short paper aims at surveying the concepts and architectural elements of SOA, and investigating to what extent existing standards supporting SOA enable and have created service-oriented enterprises. In this context, we mean with service-oriented enterprise a business organization whose business and IT are well-aligned to flexibly engage, operate and disengage in cross-organizational collaborations and be (more) effective in the given market by using and providing services according to SOA.

The remaining of this paper is structured as follows: Section 2 provides an overview of SOA concepts, architectural elements and principles; Section 3 briefly discusses the standardization of Web Services, constituting one of the now widely adopted technologies to implement SOA; Section 4 looks into the impact that the adoption of Web Services has on organizations and whether this turned them into genuine service-oriented enterprises; and Section 5 summarizes our main findings.

2 SOA Foundation

The central concept of SOA is, of course, 'service'. There are several possible interpretations of 'service', partly due to the fact that SOA addresses two distinct disciplines, which already have existing and different uses of the term for some time. In a business context, a service involves the exchange of some action, performance or promise for value between a client and provider [13]. Examples are transportation services, health services, education services, outsourcing services, and helpdesk services. In an IT context, a service refers to the external behavior of an IT system, as can be observed and experienced by the users of that system [12]. Examples are data communication services [15] and application services [1]. For convenience, we will use the terms 'business service' and 'IT service' to distinguish between the business view and the IT view on services.

SOA holds the promise to bring business and IT together, by repeated aggregation of IT services into composite applications supporting business services that in turn are aggregated into business processes [14]. Figure 1 shows the basic architectural pattern that underlies SOA. In this pattern, three roles are distinguished: service provider, service broker and service requestor [10]. A service *provider* offers one or more services, which may be implemented using arbitrary technologies and involving backend systems protected by a firewall. Each service has well-defined interfaces referred to in a service description. Service descriptions may be published with a service *broker*, thus opening the possibility for service requestors to find services by providing required service properties to the service broker. The service broker searches for service descriptions that satisfy the required service properties, and the service requestor can select from the result of this search. Based on the location/access details in the service description, the service *requestor* can then bind to a service provider that offers the selected service. After a successful binding, the service requestor can invoke the service, according to the interface details in the service description.

Using this pattern, vertical integration is tackled by presenting a service as a virtual component that can be implemented by alternative concrete components using different technologies. The service requestor is therefore decoupled from

implementation concerns of the service provider. Using SOA for application design and proving a service wrapping for legacy applications thus presents a viable approach to Enterprise Application Integration (EAI).

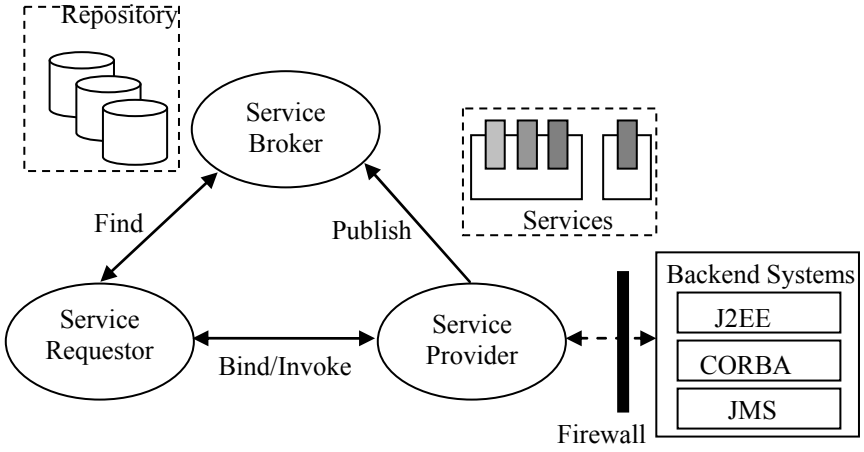

Fig.1. Basic SOA pattern.

Vertical integration, or business-to-business (B2B) integration, requires that each potential business partner defines a public view on its private process, with corresponding services and associated incoming and outgoing message exchanges that allow linking to external partners. The previously presented basic SOA pattern only shows a single service provider and a single service requestor role. In a B2B collaboration scenario, business partners may play either role for any number of supported services. An individual partner coordinates the services used and provided through its private process. Since this in general does not determine the overall coordination involving all partners, a coordination protocol can be defined that concerns the public view on how the partners should work together. Figure 2 shows an example of a SOA-based business collaboration with three partners whose processes are connected through services coordinated in compliance with some coordination protocol.

A coordination protocol, such as the one depicted in Figure 2, does not provide a concrete and executable process for the coordination of service. It only defines the order in which messages should be exchanged, where messages are used to invoke a service or return a service result in accordance to a service provided by one of the partners. A definition at this level of abstraction is also referred to as service *choreography*. If, on the other hand, this definition would be refined into a concrete process, which can be assigned to and executed by some computing node, we use the term service *orchestration* instead [11]. When assigned to a node, this node can in turn offer the external functionality of its process as a service. This service thus allows service requestors to invoke and use the coordinated behavior of several services, while hiding how the composition of services is achieved and which service providers are offering these services.

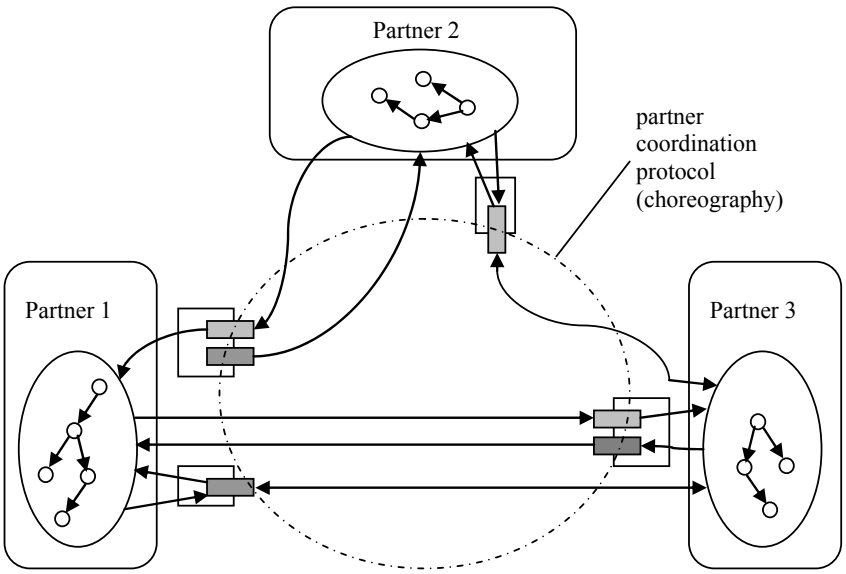

Fig.2. SOA-based business collaboration using a coordination protocol.

Since the principle of encapsulating processes that compose services can be repeatedly applied, we can build a hierarchy of service aggregations, ranging from simple generic IT services to complex dedicated business-oriented services. Figure 3 shows such a hierarchy, illustrating how SOA supports a way of integrating business as linked services. Although SOA itself does not imply or propose any methodology for designing IT support for business activities, it does make clear that business processes can be seen as a driver of collaboration with services playing a central role at all levels.

Design methodologies centered on SOA [9] should then include an analysis phase that reviews identified business processes with respect to the extent to which SOA can contribute to improvement and adding value. If SOA is deemed to play a role, business services should be identified that represent this SOA potential. In a subsequent design phase, service interfaces should be defined as well as processes that can orchestrate services based on their interfaces, and basic IT services should be identified. Both functional and non-functional (performance, reliability, availability, etc.) requirements on services should be considered during this phase, and legacy applications may be leveraged as service if they match such requirements.

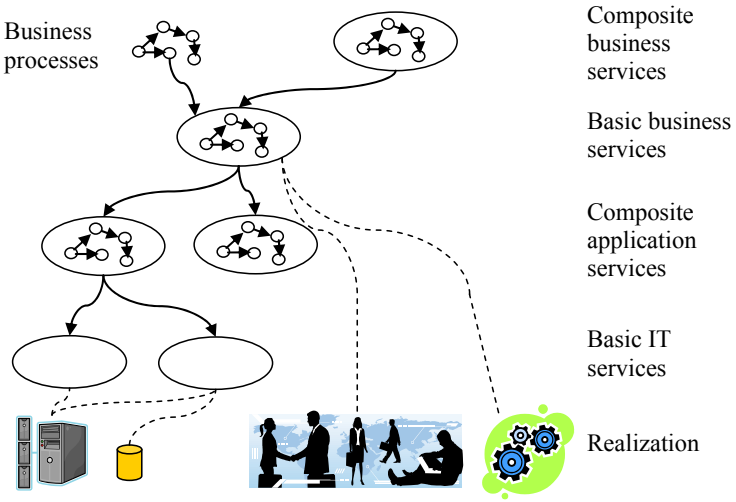

Fig.3. SOA-based business integration by way of linked services.

The above sketch of a design methodology is also useful to illustrate the importance of the guiding principles of SOA [3]:

- *Loose coupling:* a service is defined independent of its implementation and usage context. This means that a service requestor does not have to be aware of the technology used to implement the service, and the service provider has no a priori knowledge of the service requestor. As a consequence, requestors and providers can evolve independently, without affecting interoperability, provided that service (interface) definitions are adhered to.
- *Re-use:* a service is a unit of functionality which is potentially useful in many different contexts and applications. Having service descriptions stored in repositories, which a service broker can search in order to find a service that matches properties specified by a service requestor, further helps to promote reuse.
- *Composable:* the invocation of services can be coordinated and the results can be composed to form composite applications. The functionality of composite applications can in turn be exposed as services, which permits hierarchical composition with different degrees of software reuse and business specificity at each level.
- *Standards-based:* the above mentioned architectural principles can only be realized if technology standards are available that allow services to be described, published, invoked, composed etc. This is the topic of the next section.

3 Web Services

Web services (WS) are a collection of emerging standards, which are widely accepted as the technology of choice for implementing SOA [10]. Web services to a large extent supports the concepts, patterns and principles mentioned in section 2. An application designed and implemented according to WS standards is self-contained and modular, has a description which can be published, can be found on basis of its description, and can be located and invoked over networks.

The core WS standards are the following:

- *Simple Object Access Protocol (SOAP):* this is the Internet protocol for Web (service requestor and service provider) applications to communicate. It suns on top of other standard Internet protocols, including HTTP. SOAP defines how messages are structured and processed in a platform-independent way. It comprises two message exchange patterns, viz. one-way and request-response.
- *Web Service Description Language (WSDL):* this is the language for specifying he interface of Web services. It is used to provide a description of the service for the (potential) service requestors. Such a description includes information on which messages are related to each operation that is supported by the service, how these messages are related (e.g., operation input and output), and how SOAP messages are exchanged.
- *Universal Description, Discovery and Integration (UDDI):* this standard is defined to enable the storage of information for organizing and discovering Web services. UDDI consists of data structures and APIs for publishing and querying Web services. The UDDI APIs are themselves Web services, and thus are described and can be invoked as any other Web services.

In addition, all WS standards rely on the Extensible Markup Language (XML) to represent structured data. XML documents and schemas are defined to standardize the format and typing of data communicated by Web services.

The basic SOA pattern explained in the previous section can be supported with SOAP, WSDL and UDDI. These standards are, however, not sufficient to correlate messages exchanged between a service requestor and a service provider, to distinguish between multiple instances of the same service, or to coordinate the use of different services. Also they do not address policies that govern the use of Web services, non-functional aspects of Web services such as reliability, security and atomicity. For this purpose, several other WS standards have been developed.

This paper has not the intention to discuss these standards even at a high level of abstraction. Instead, we argue that WS standards are becoming widespread and have reached a certain level of technical maturity. In addition, we can observe that WS standards pretty much cover all the important technical areas that were identified for SOA. Figure 4 shows an overview of standards supporting different aspects of SOA.

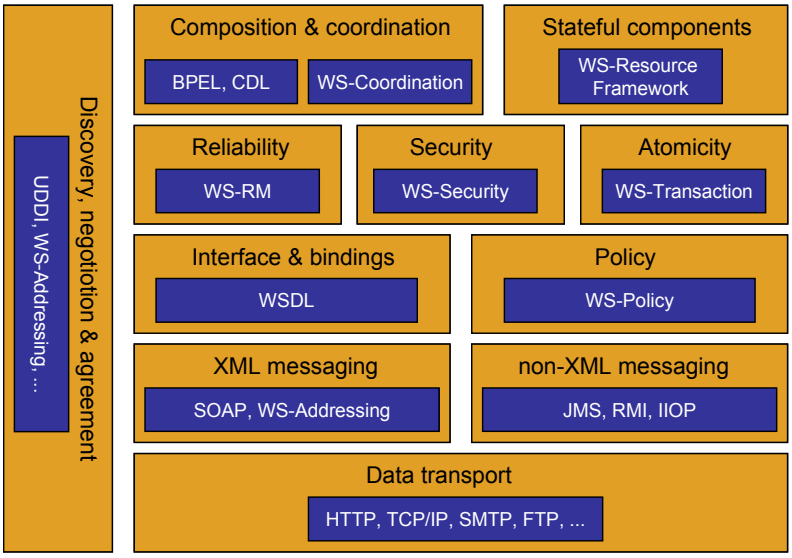

Fig.4. WS (and some other) standards supporting SOA.

The acceptance and the technical maturity and coverage of Web services provide no guarantee that the business objective of SOA is also realized [8]. Web services may be used to extend the existing technology infrastructure with a new layer on top, facilitating technology-level interoperability, integration and maintenance, but overall benefits may still be small if business processes remain unaffected due to a lack of 'service thinking' at business and application level. We will address this further in the next section.

4 Service-oriented Enterprise

Several major technology vendors have invested significant effort in supporting and promoting SOA and corresponding technology standards[1]. As a result, SOA is now generally accepted as a useful architectural style, and adoption of Web services is widespread. Also business-level awareness for SOA has been created, thanks to technology trend and market analysis reports that claimed, among others, the necessary adoption of SOA for most companies in order to stay competitive[2].

Nonetheless, SOA adoption in practice often boils down to the use of Web services as an enabling technology, whereas service-oriented business that applies SOA principles and exploits the potential benefits of SOA technology is less commonplace. Some researchers report that impact of SOA on business organizations and business processes is so far rare and limited [5]. This contrasts with the often heard claim that SOA will change the way business is done and organized. It is argued that not the introduction of new technology, but the application and

[1] See, for example, www.w3c.org and www.oasis-open.org.
[2] See Gartner's press releases over the years: www.gartner.com/it/products/newsroom.

management of that technology delivers real business benefits. Therefore, business itself should be transformed by 'service thinking', leading to added value and innovation. One reason for the still existing mismatch between enabling technology and business exploitation with respect to SOA may be the weak link between business executives and their company's IT organization [2].

The term 'service oriented enterprise' has been coined to refer to business organizations that pursue an optimal business-IT integration using SOA principles and technology [8]. Accordingly, we characterize a service-oriented enterprise as an enterprise that uses service-oriented technology (such as Web services) and that organizes its business model and processes to profit most from the potential benefits of this technology.

There have been recent reports on failed SOA projects and statements that for this reason and because of the current recession SOA popularity is on its return. However, SOA projects often focus too much on the technology to be used, and disregard project management. Gartner forecasts that lack of working SOA governance arrangements will be the most common reason for SOA failures[3].

Also, companies may loose initial enthusiasm if they learn that the introduction of SOA may be expensive, and that building their first SOA application may take longer than building the same application using traditional approaches and existing technology. However, subsequent SOA applications and changes to existing SOA applications can be expected to be less costly. This is inherent to any evolutionary approach. SOA offers no one-time gain, no immediate return on investment, but promises benefit over time [4].

Independent on their success or failure, a handful of SOA applications within a company cannot prove much about SOA. Companies should be aware of SOA principles, have strategies and practices in place, and persistently apply them throughout their business. In other words, they should become service-oriented enterprises. This led to the development of SOA maturity models [2, 8, 4], to position enterprises with respect to their service orientation and to provide a roadmap towards higher maturity levels. For example, in [8] the following levels of maturity are identified:

- *Usable:* an organization has standards and protocols that are usable across the organization's platforms and technologies.
- *Repeatable:* an organization has the capabilities to develop, deploy and maintain services, and scale the use of services.
- *Supportable:* an organization has the capabilities to provide and maintain services for its mission-critical applications.
- *Extensible:* an organization has the capabilities to apply service aggregation and realize business agility, and can provide this directly to customers and/or partners through services that generate new revenue channels.

Although it is difficult if not impossible to precisely assess and score the maturity of an organization, there is general agreement that maturity models are useful as a roadmap to improve upon a current situation. Achieving a higher maturity requires organizational actions, such as establishing proper IT directives, governance policies

[3] Gartner press release April 2, 2009.

etc. In general, also several technical obstacles and issues need to be addressed in order to transform into a service oriented enterprise, including performance and Quality of Service (QoS) [4, 7]. Mission-critical applications have to meet certain minimal QoS requirements. Determining what exactly are the QoS requirements for SOA applications, and how to specify, negotiate and monitor Service Level Agreements (SLAs), is a major and complex task [7]. Especially QoS management in composite applications is a critical issue for SOA systems, since service aggregation is the cornerstone for reuse and agility. So far there are only some academic studies in this area [14], and little empirical data.

Despite experienced setbacks and still existing obstacles, Gartner recently claimed that SOA is emerging from the Trough of Disillusionment within Gartner's hype cycle, and is climbing the Slope of Enlightenment[4]. This phase of the hype cycle is entered if mainstream organizations start to establish best practices to effectively use a technology and begin to experience benefits.

5 Summary

SOA is an IT architectural style that tries to achieve integration by way of defining composite applications as an aggregation of services, with services potentially offered by different organizations. Integration has a vertical (business-IT alignment), horizontal (cross-organizational interoperability) as well as a time (agility with respect to changes) dimension. The guiding principles of SOA are loose coupling, re-use, composability and reliance on standards. Web services constitute an emerging set of standards which are widely adopted as technologies to implement SOA. The acceptance and the technical maturity and coverage of Web services provide no guarantee that the business objective of SOA is also realized. In order to realize this business objective, i.e. to achieve integration paired with productivity benefits, companies should become service oriented enterprises. Companies should be aware of SOA principles, have strategies and practices in place, and persistently apply them throughout their business. SOA should be understood as an architecture, not as a technology. Technology, such as provided by Web services, is enabling, but not realizing the potential benefits of SOA. Consequently, only introducing a Web service technology infrastructure and blindly converting existing applications to become service-enabled is not enough. Business should determine which applications should be service-oriented, and have good governance in place to help decision-making. SOA maturity models can help to provide a roadmap to transform into a service oriented enterprise.

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Brief Biography

Marten J. van Sinderen is associate professor at the Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS) of the University of Twente, Enschede, The Netherlands. He is a member of the Information Systems (IS) group since 2008, and before that led the Architecture and Services of Network Applications (ASNA) group between 2004 and 2008. He is currently also coordinator of research in the area of Service Architectures and Health Applications, on behalf of the Centre for Telematics and Information Technology (CTIT), the ICT research institute of the University of Twente.

During his professional career, he has been active in the areas of network interconnection, communication protocols, middleware, application protocols, and enterprise interoperability. His current main research interests are design methods and architectures for networked systems, particularly mobile middleware, service platforms, and context-aware mobile applications. Among the design paradigms being considered are Service Oriented Architecture, Model Driven Architecture and the Semantic Services. He was co-chairman of the Program

Committee of EDOC 2004, and general (co-) chair of IDMS 2000, PROMS 2001, EDOC 2005 and EUNICE 2007. He has been a member of the steering committees of IDMS, PROMS, MIPS and EDOC, and involved in numerous program committees of major international conferences, including INFOCOM 2006 and ECMDA 2005, 2006 and 2007. He participated in European initiatives/projects including MODA-TEL (Model Driven Architecture for Telecommunications Systems Development and Operations, IST 37785), E-NEXT (Emerging Networking Experiments and Technologies, IST 506869), AMIGO (Ambient Intelligence for the Networked Home Environment, IST 004182), and SPICE (Service Platform for Innovative Communication Environment, IST 027617). He currently leads the Dutch Freeband A-MUSE project (BSIK 03025) on model-driven service design for context-aware mobile applications, and the Dutch GenCom U-Care project (IGC0816) on user-tailorable healthcare services for the home environment.

He was invited reviewer for the European Union of C-ARCTIC (Concurrent Environment and Architecture for Telecollaboration Integrated in the Company, IST 1999-20087). He is a member of the Editorial Board of the Enterprise Information Systems journal, published by Taylor & Francis. He is also member of the Managerial Board of IFIP WG5.8 on Enterprise Interoperability.

PAPERS

Towards a Human Oriented Approach to Information Systems Development

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Abstract. Current approaches to information systems (IS) are roughly based on technical, scientific or formal aspects which miss the human nature of IS or, otherwise in organisational and social aspects highlighting the human but missing concrete implementations. This result too often in IS failures. We think the problem relies in an inadequate paradigm to deal with the human element and we propose a new philosophical stance – human relativism – to overcome the problems felt. This new approach will lead to a new way of developing IS that will be human centred. In this sense we propose also as a possible way to apply this new paradigm a human action oriented perspective that could be used for information systems development. Therefore, human-action is analysed as well and a comprehensive multi-dimensional holistic view of it is given, followed by a particular choice of a selected group of dimensions suggested for use in information system development according to human relativism.

Keywords. Information systems, Information systems development, Information systems approaches and paradigms, Human-centred information systems, Human relativism.

1 Introduction

Nowadays computerised information systems are increasingly integrating all kinds of business and organisations and becoming an essential element of modern societies. In order to develop these systems the information system development (ISD) field proposes different methodologies, methods and techniques with the goal of providing processes and information to organisations and their members by using information and communication technologies. Most of the methodologies in ISD are originated from computer science and software engineering and are technically oriented emphasizing computer and formal aspects of IS. In this sense they are commonly grouped and known as "hard approaches" to ISD [1]. On the other hand there is another group of methodologies known as "soft approaches" that intend to highlight the social and organisational aspects of ISD by giving the primary role to humans. These methodologies can also be called socio-technical approaches to ISD although these last terms are usually connoted to the ETHICS methodology [2] in particular. A

problem that has been around ISD for a long time is that of information systems (IS) failure (see [3] for an overview). Many developed IS and computer systems in particular fail to meet their goals by taking too much time to develop, to be over budget, to be unreliable, to provoke user dissatisfaction, to not meet the requirements, to be difficult to maintain, etc. In spite the many existent methodologies none of them has proof effectiveness to avoid failures. In fact soft approaches were mainly attempts to overcome the problems felt with the dominant technical approaches that forget the human nature of IS understood as the main reason for failure. The inability of handling the human factor, many times ignored by traditional technical methodologies is in our opinion the relevant reason for most failures. Scientific and objective methods are effective in many domains where predictability, repetitiveness, and stability are present but fail in IS where unpredictable, unique and variable human behaviour is mixed with technical computer systems. The picture today is that "hard approaches" to ISD are still dominant and "soft approaches" that promised to develop better systems didn't achieve the desired acceptance and adoption. We think that the problems felt are originated at higher levels, namely the guiding paradigms of both approaches and we propose a new way of looking to information systems and perhaps to technology in general whenever human behaviour is present that is supported by a new philosophical stance – Human Relativism - that takes the human as the central element. This stance originates a new approach to ISD that is human-oriented and seeks to acknowledge properly the role of humans in IS and ISD.

This paper is organised as follows: section 2 presents most common philosophical stances in IS, section 3 criticises the use of these philosophical stances in ISD and proposes a new philosophical stance for IS: Human Relativism. In section 4 it is shown how we may apply in practice this new paradigm and move towards real human-oriented IS. Section 5 presents related work and, finally, section 6 presents the conclusions and the work being done and planned.

2 Philosophical Basis of Information Systems

2.1 The Nature of Information

The concept of information is at the core of information systems. It is symptomatic to find that this concept has many different meanings within the IS community. For example:

"*Is data that has been processed or interpreted within a particular context to inform or reduce uncertainty*" [4].

"*A collection of symbols which has the potential to alter the cognitive state of a decision maker*" [5].

"*What remains after one abstracts from the material aspects of physical reality*" [6].

"*A numerical measure of the uncertainty of an outcome*" [7].

"*Is the meaning someone assigns to data*" [8].

Besides information there are many other terms that are not clearly defined and generally understood. Key terms like knowledge, communication, meaning, truth,

etc., may have different interpretations for different groups of people. The relative importance of this subject matter is recognized by the International Federation for Information Processing (IFIP) and particularly the FRISCO task group within work group 8.1 on Design and Evaluation of Information Systems that declared in their manifesto (cited in [9]):

"*There is a growing concern within IFIP WG 8.1 about the present situation, where too many fuzzy or ill-defined concepts are used in the information system area. Scientific as well as practice-related communication is severely distorted and hampered, due to this fuzziness and due to the frequent situation that different communication partners associate different meanings with one and the same term. There is no commonly accepted conceptual reference and terminology, to be applied for defining or explaining existing or new concepts for information systems*".

This difficulty to clearly define some important terms should be emphasized as it is fundamental for the understanding, application and evolution of a successful methodology in IS development. We need to understand the problems and difficulties that prevent us to define a precise and consensual vocabulary needed to support and ground any methodology. There is a close relationship between information and reality or, in other words, ontology. Ontology, epistemology and other underlying paradigms usually followed by the different IS approaches will be analysed next

2.2 Typical Information Systems Philosophical Stances

Hard approaches to ISD are many times connoted with an objectivist view of the world where reality exists independent of the human being, his perception or his consciousness. This real world is populated with objects, facts, allowing everyone to discover them and check their validity or truth. Creating a model of this world is straight forward implying the creation of a simple mapping connecting concepts to real things. This is the world of natural sciences where the laws of nature rules the world and all the happenings can be scientifically explained, predicted and governed by a general theory. Related philosophical stances include realism from ontology, and positivism from epistemology.

Within Information Systems, many researchers, especially those connected with the soft approaches don't feel comfortable with this objectivistic view. Whenever people are involved objectivity seems to be lost. Human concerns such as goals, intentions, commitments, responsibilities, values, attitudes and many others cannot be clearly identified, defined or represented. Existence is not just a true/false question and involves human interpretation, judgement and negotiation. Human behaviour cannot be accurately predicted. For these researchers, a better perspective should be intrinsically social and, according to them, the best philosophical stance is the constructivist view. For constructivists reality and knowledge are socially constructed. Individuals take the leading role in actively constructing reality rather than passively acquiring it from the environment. In this process previous experience and knowledge are essential means for creating new knowledge. Constructivists don't deny completely an objective reality but assume the existence of different personal realities from which it won't be possible to be sure about the existence of an independent reality. This view seems appropriate because important elements of human

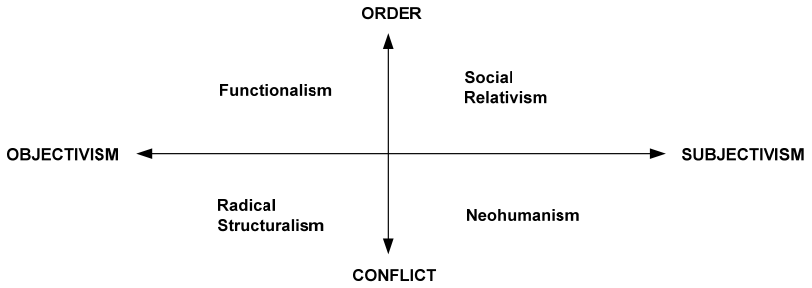

Fig. 1. Information System Development Paradigms (**[10]**).

information systems such as meanings, commitments, goals, and many others are understood as social achievements submitted to negotiation and acceptance. Constructivism can also be related to subjectivism which delegate the primacy to the subjective experiences and reality is seem as created by perception.

Other philosophical stances appear in the IS literature, an example is [10], [11] that proposed four paradigms for IS development. These paradigms were obtained by splitting a plane in two dimensions: an objectivist-subjectivist dimension and an order-conflict dimension (Figure 1). The first dimension deals with an objectivist view of the world from which models and methods of natural science were applied to the study of human affairs and an opposite subjectivist view which is concerned to understand the basis of human life from the subjective experience of individuals. In the second dimension the opposite views are, first an order or integrationist view emphasizing a social world characterized by order, stability, integration, consensus and functional coordination and second, a conflict or coercion view stressing change, conflict, disintegration, and coercion [11]. The resulting four divisions are related to four different paradigms namely: Functionalism, Social Relativism, Radical Structuralism and Neohumanism. Each of these paradigms has an embedded philosophical stance about knowledge (Epistemic) and existence (Ontological). The philosophical stances for each paradigm are shown in Table 1.

Table 1. Philosophical stances of the 4-paradigm for ISD from Hirschheim and Klein.

Paradigm	Epistemic stance	Ontological stance
Functionalism	Positivism	Realism
Social Relativism	Anti-positivism	Social Constructivism
Radical Structuralism	Positivism/materialism	Realism
Neohumanism	Positivism (in technical control) and anti-positivism (in mutual understanding and emancipation)	Realism (technical interests) and Social Constructivism (mutual understanding and emancipation)

3 A New Paradigm for Information Systems – Human Relativism

3.1 Issues in Common Information Systems Philosophical Stances

All philosophical stances presented in the previous section have their own 'truth' and all of them are defendable and useful in different situations.

The objectivist view proofed to be useful to science and technology in which theories and knowledge obtained from the analysis of an objective reality permit to explain and predict that reality in many useful ways. It should be noted that the elements analysed by science usually exhibit a repetitive, reproducible and/or predictable behaviour that can be observed and stated with accuracy without ambiguity or differences in interpretation. This is not usually the case in organizations where there are many elements that cannot be easily predicted (such as human behaviour) or stated clearly (such as information). In fact elements like human behaviour are highly dependent on individuals, on their knowledge, experience, mood, values. Also information expressed by language and all the terms used to represent and communicate the organizational reality are not possible to state accurately and are dependent on individual perceptions, interpretations, knowledge, judgement, experience, etc. This information and interpretation dependence on individuals can be seen as another form of dependency on human behaviour. Humans are responsible for the perception, interpretation and communication processes. Any misunderstandings occurring between humans are relative to them and are part of their behaviour. Constructivism acknowledges these evidences and is supposed to deal with this social and human dependence by adopting a view of an organizational shared reality in constant construction by its members where meanings came from negotiation and agreement. Although a better approach, constructivism is again difficult to apply, the dependence on each situation and the myriad of possible interpretations and behaviours makes it too hard to generalize, to define or to create reproducible and applicable theories. Moreover, constructivism misses the rigor of science to deal with the predictable and precise aspects of the organizational reality. To overcome these problems a new philosophical stance is needed.

3.2 Human Relativism

In this paper we propose a new philosophical stance – human relativism – with the goal of giving a different perspective of the world by acknowledging the power of the different views described before and by permitting to use formal methods and theories without the errors and assumptions of most objectivist stances.

One fundamental problem with all previous approaches is the unpredictable behaviour usually originated or related to the human element. This behaviour includes most inter subjective experiences such as interpretation, knowledge, beliefs, intentions, values, etc, which stand hidden from our senses. Scientific methods and objectivism are unable to deal with human behaviour in general; it is not possible to reproduce or predict things like interpretation or understanding or to regulate mechanically human actions. These are heavily human dependent. On the other hand IS reality, according to the adopted perspective is essentially human centred.

Everything an organization is or does is for people through people. Therefore using scientific methods in organizational activities seems to be wrong. But, a nearer look will show us that all human kind and their achievements also live in organizational structures and may be seen from an IS perspective. Even in science itself we acknowledge the presence of individuals and organizations behind all scientific discovers and theories. This increases the importance of a successful IS modelling and development. But, a question remains, how can we take advantage of the power and success of scientific and technical approaches in the IS field? The solution, seems to be first to acknowledge the human centeredness and its unpredictable behaviour. Human relativism recognizes this human centrality in all human activities by acknowledging an objective reality as human relative. There are many evidences of this human relative view even in objectivitism. As an example everything we see using our eyes, according to science and to our experience and beliefs, is particular to human kind. Our vision is limited to a range of frequencies from the electromagnetic spectrum denominated the visible spectrum. Science gave us the possibility to see images translated from different ranges of frequencies such as infrareds. The visible images transformed from infrareds into the visible spectrum allow us to experience a different reality where human bodies cannot be easily separated from the environment, because there are no clear boundaries. However, this reality is in fact seen and experienced by some animal species as science proofs. In this sense we may question ourselves, which is the real reality, the reality we observe with our vision or the reality observed using, for instance, the infrared spectrum? Or, are they different views of the same reality? There is no claim in human relativism that the reality we see is the real reality, neither an explanation nor sense of what a real reality is. The solution is more a practical solution – this is the reality we have, we experience and we share. By assuming the human at the centre we also assume and accept his view as bounded, focused and particular.

Besides persons, IS and organisations also includes information and this is once again human related. Information is extracted by humans from the reality using perception and interpretation processes. The distinction between perceptions, the process of acknowledging the external reality through our senses, and interpretation, the meaning making process, is a useful way to help understanding the nature of information and its acquisition process. Only information goes through an interpretation process, the other elements of the (human) reality are just perceived. In fact, perception filters part of the human reality accessible to a particular individual.

To perceive does not mean to interpret and this separation allow us to understand what is observable. Usually, **observability** concerns what we think a human being is able to percept or to acquire through his senses. This excludes the interpretation process and information as well. Usually information is not observable but it can be extracted from observable things. Observable things can be viewed as material or physical things from the objectivist view. As an example happiness is not an observable thing although it may be expressed by a smile, an observable thing itself. On the other hand we cannot derive happiness from a simple smile in a general way. This will be subjected to interpretation and may have different results depending on people. This leads to the problem of divergent interpretations, one of the most fundamental problems of IS, that is in the basis of the difficulties of applying scientific approaches to IS. To solve this ambiguity or meaning problem the

observability concept described is a first step to reach consensus. So, human relativism makes the following assumption:

Assumption: ***Anything that is observable will be more appropriate to be used by scientific methods.***

Nevertheless we need a second step to recognize the elements that can be used without problems by scientific methods. The notion of **precision** in Human Relativism will deal with this issue.

To achieve a high degree of precision we need to remove ambiguities and different meanings from any term or information making it generally accepted, recognized and shared. This doesn't mean to make everyone agree on it based on negotiation as in the case of constructivism. The solution goes by adopting a kind of operational meaning or human observable independence that makes it clear and precise. Human observable independence is achieved if everyone is able to interpret in the (apparently) same way. It may be necessary to have previous knowledge to reach this shared and accepted interpretation. One way of achieving precision is by using physical measurement. It is simple to say (to be precise) if a specific string has or hasn't one meter of length. Some people could argue about this but without relevance for scientific purposes where it would be used without ambiguities in some technical system.

If it would be possible to measure the precision degree of each term we would be able to assign each term a different value. Surely the elements analysed and used by science, the physical things less correlated with human interpretation would achieve a higher precision value. Concepts are generally difficult to be precise; they are the result of human creation and therefore much human dependent. Therefore they have to be treated with special attention in order to make them or to select them as precise as possible.

The Human Relativistic Hypothesis is:

By adopting high precision observable elements under a human relativistic view it may be possible to derive a scientific and theoretical well founded approach to IS.

A second hypothesis to be drawn is that:

The human behaviour problem in IS (or in other fields) can be overtaken in technical approaches if it is recognized clearly.

Finally, a last hypothesis is:

We may freely apply technical approaches if there is no unpredictable behaviour present, specifically human behaviour.

4 Using Human Relativism in Information Systems as a Guiding Paradigm

4.1 The Human Action Perspective

Human relativism (HR) point us a way to overcome the difficulty of dealing with unpredictable behaviour, in particular human behaviour that is central to IS. When we think of human behaviour we realize that we just have access to its observable part – the (observable) human actions. In effect human behaviour is expressed or externalised through human actions. Therefore, according to HR we should acknowledge the power and the unpredictability of human action (and human behaviour) to be able to design more powerful and robust IS. One way to achieve this is to reduce the dependability of the IS in human behaviour but in this case we would be limiting and reducing the power of the IS as well. A complementary or alternative approach is to use efficiently its power by creating the necessary tools and provide support to human action. This approach will permit to extend human capabilities by using information technologies as specialised tools facilitating, improving, expanding and complementing human action thus allowing the human to express its creative power without expecting a mechanical behaviour from him. In order to achieve this goal a deeper understanding of human behaviour in general and human actions in particular is required.

4.2 Human Action Holistic View

Because HR is a new guiding paradigm, an analysis concerning observable human actions as part of the human behaviour in IS cannot be found in current IS literature. Therefore, to have an initial understanding of the multiple aspects related to human action and IS a detailed empirical analysis was undertaken. Our goal was to have a multi-dimensional holistic view trying to cover all important aspects connected to human action that would help us to define the key dimensions following HR. A first identification and categorization of the dimensions related to human actions was obtained by applying the common questions framework (CQF) proposed in [12]. The CQF was originally used to compare different modelling techniques according to typical comparison dimensions such as organisational, functional, behavioural, temporal, contextual, and motivational dimensions. These dimensions can be related to some common sense questions used to enquire about some fact or subject, these are the who, what, which, how, when, where, with and why questions, thus the name used.

Applying the CQF to human actions (HA) we identified the following 8 dimensions as shown in Figure 2:

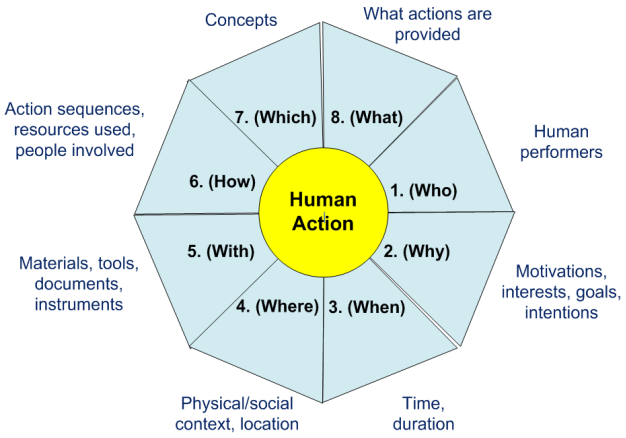

Fig. 2. Human action dimensions identified by the Common Questions Framework.

1. Organisational (who) – The "who" applied to HA refer to its performer, not to the organisational hierarchy or power structures as originally used to.
2. Motivational (why) – Regarding motivation, important aspects related to HA and human behaviour such as interests, goals, intentions, purposes, objectives, and aims are addressed in this dimension.
3. Temporal (when) – The temporal dimension deals with time aspects of action such as duration, start and finish times.
4. Contextual (where) – Context is about the location and the surrounding environment where the action take place. Given our holistic purposes we should extend this dimension to include cultural, political, organisational and other social contexts.
5. Resources (with) – Resources are physical things that are consumed, used or transformed by the HA, they may include, tools, instruments, materials or documents.
6. Behavioural (how) – In the behavioural dimension we will be concerned in the detail of the HA execution, involving the use of tools and other resources, the relations to other actions and so on.
7. Conceptual (which) – This dimension concerns the identification of concepts related to HA. Usually this is a very subjective dimension using mostly non-observable elements and perhaps not useful for objective purposes.
8. Functional (what) – The functional dimension covers the group of actions available without entering in the detail of each one.

In spite of most important dimensions covered by the application of the CQF there is still space to add more dimensions. So, in Figure 3 we provide an augmented view of HA that includes new dimensions in order to form a comprehensive view. From this view other aspects related to HA are added and considered, namely: constraints and rules, pre and post conditions for actions, physical and social measurements or valuations, monitoring, including verification and validation, relationships with other action and triggers for actions. Of course not all of them are to be used for ISD but this list is useful for a complete analysis of human action and for deriving a better support for it in IS.

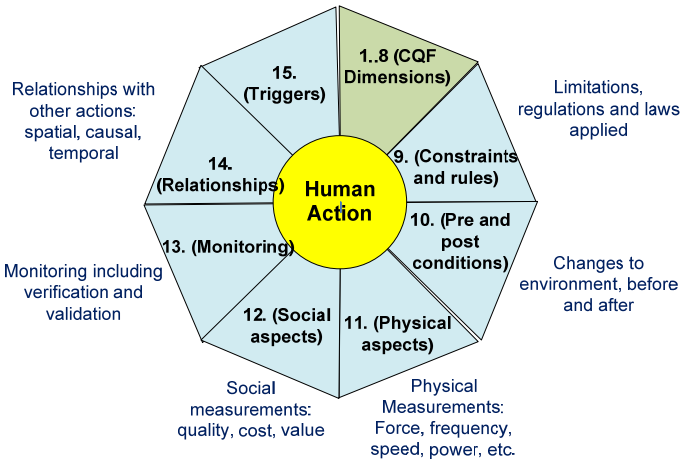

Fig. 3. Human action - a holistic multi-dimensional view.

4.3 Human Action Dimensions for Information Systems Development

In the previous holistic view of human action some of the dimensions may overlap and may not be suited for practical ISD. On the other hand regarding HR, observability establishes what can be used without much ambiguity. From this perspective, as observers we are just able to easily identify physical things such as HA performers, all kind of involved physical artefacts and the surrounding physical context. The informational aspects remain hidden because they are particular to each individual after perception and interpretation. In fact, we should understand information as non-observable and provide a separate dimension exclusive for it. Thus, from a practical (and observable) point of view we selected and purpose a group of five essential dimensions as follows:

1. *Information dimension* – joins most non-material aspects of human action such as the why, how, when and where dimensions plus other aspects such as cost, quality, verification, validation, etc. It is a key dimension for IS analysis and design
2. *Communicational dimension* – captures the links and exchange of information between humans. A communication can be seen as exchanges of speech-acts, also a speech act is effectively a kind of non-material human act that corresponds to an observable human action.
3. *Material dimension* – joins all the material aspects involved in human action except for the human performers. It is the with dimension
4. *Human dimension* – this must be a separate dimension because of the relevance of the human actor within the human relativist view. The human dimension is concerned about the humans involved in human actions.
5. *Context dimension* – In order to enable any kind of human action it is necessary that the environment afford us that action. The state of the environment that enables that human action provides the necessary context.

Although other choices may be done, these group of dimensions seems to us fundamental for IS analysis and goes with our goals to integrate some soft approaches to ISD in a new approach that intends to be more effective and succsseful than current ones.

5 Related Work

Within IS there are different attempts to escape from traditional ISD towards human-centred or human-oriented ISD. Nurminen, considered the father of the humanistic approach for ISD proposed in [13] this alternative perspective contrasted to the current systems-theoretical and socio-technical approaches, roughly related to the hard and soft approaches mentioned at the introduction. His perspective shares our understanding of information technology as an auxiliary tool and the emphasis in human beings, human needs and human activities. Much of his considerations are quite valuable but he doesn't really give us an effective solution for ISD and doesn't root his ideas in strong philosophical foundations. A good analysis of human-centeredness in ISD can be found in [14], where the trend towards a human-centred solution is clearly found in ISD. Starting with early hard approaches that ignored many human aspects, and going through participative solutions where the user is included in the design process, through end-user computing leaving to the user the tailoring of the system according to his needs, through prototyping expecting the user to collaborate actively in the interactive aspects of the final application and ending in actual combinations of methods originated in human-computer interaction (HCI) and computer supported collaborative work (CSCW) fields in ISD. Still, as the authors argued, there is "...a lack of a holistic picture of how the users should be studied or considered in ISD, or what should be their role there". In another article - [15] - user-centeredness in ISD is studied as a multidimensional concept along the following four dimensions: 1) as user focus, 2) as work centeredness, 3) as user participation and 4) as system personalization. Again in the conclusions the authors posed the question whether any of the user centred design approaches analysed forms a systems development approach by itself. The answer was not clear with many aspects being considered revealing the absence of a real human-oriented approach to ISD.

6 Conclusions, Present and Future Work

In this paper a new paradigm for information systems – Human relativism - was introduced. Human Relativism shows a new way to look into information systems that acknowledges the human nature of it and provides the essential basis for a well founded technical approach. In this sense a possible direction in how to apply this new paradigm by focusing the analysis of IS within a human action perspective is provided. Besides a holistic view of human action according to a comprehensive set of dimensions, also a selected group of important dimensions is proposed for use in ISD. In fact, this perspective is part of our current work where a new modelling language – NOMIS - was developed allowing analysing and model any IS according

to a coherent set of views along each of the dimension proposed. These views are aligned with three theories that are integrated in NOMIS namely the Theory of Organized Activity ([16]), Organisational Semiotics (see [17]) and the Language Action Perspective (in [18] and [19]). NOMIS by following Human Relativism and using the views mentioned before defines a new form of business process modelling closer to the organisational reality. As future work we plan to test this approach in an e-learning application prototype already developed and we intend to apply, use it, test it and evaluate it in some other different experimental projects before it is released.

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Service-Oriented Coordination Platform for Technology-Enhanced Learning

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Abstract. It is currently difficult to coordinate learning processes, not only because multiple stakeholders are involved (such as students, teachers, administrative staff, technical staff), but also because these processes are driven by sophisticated rules (such as rules on how to provide learning material, rules on how to assess students' progress, rules on how to share educational responsibilities). This is one of the reasons for the slow progress in technology-enhanced learning. Consequently, there is a clear demand for technological facilitation of the coordination of learning processes. In this work, we suggest some solution directions that are based on SOA (Service-Oriented Architecture). In particular, we propose a coordination service pattern consistent with SOA and based on requirements that follow from an analysis of both learning processes and potentially useful support technologies. We present the service pattern considering both functional and non-functional issues, and we address policy enforcement as well. Finally, we complement our proposed architecture-level solution directions with an example. The example illustrates our ideas and is also used to identify: (i) a short list of educational IT services; (ii) related non-functional concerns; they will be considered in future work.

Keywords. e-Learning, Service-oriented architecture, ICT architecture, Coordination.

1 Introduction

The Web is currently a preferred medium for distance learning and the learning practice in this context is referred to as technology-enhanced learning or *e-learning*, for short [8]. We claim that actual e-learning challenges are: (i) Reinforcing the links between individual and organizational learning, and between learning and creativity - it is challenging to embed learning, embracing knowledge, competency, and talent as well as collaborative innovation and process workflows; (ii) Establishing and sustaining interdisciplinary networks on emerging trends; (iii) Allowing context-awareness and real-time adaptability in learning activities.

These challenges seem hard to resolve when taking into account the current state of the art in e-learning that rarely reaches much farther than the distribution of *.ppt* and

.pdf files (even sophisticated environments that support learning, such as Blackboard [2,3] are argued to be mainly content-driven and thus insufficiently powerful in terms of collaborativeness, knowledge co-creation, and context-awareness). We claim that this is partially due to the lack of instrumentation to adequately address the coordination-related needs associated with a learning process.

Coordinating learning processes is currently difficult, not only because multiple stakeholders are involved (such as students, teachers, administrative staff, technical staff), but also because these processes are driven by sophisticated rules (such as rules on how to provide learning material, rules on how to assess students' progress, rules on how to share educational responsibilities). This is one of the reasons for the slow progress in e-learning. Consequently, there is a clear demand for technological facilitation of the coordination of learning processes.

In this work, we suggest some solution directions that are based on *SOA - Service-Oriented Architecture* [1,13,20,21]. In particular, we propose a coordination service pattern consistent with SOA and based on requirements that follow from an analysis of both learning processes and potentially useful support technologies. We present the service pattern considering both functional and non-functional issues, and we address policy enforcement as well. Finally, we complement our proposed architecture-level solution directions with an example. The example illustrates our ideas and is also used to identify: (i) a short list of educational IT services; (ii) related non-functional concerns; they will be considered in future work.

The outline of the remaining of this paper is as follows: In Section 2, we introduce the Service-Oriented Architecture – SOA and we outline some of its strengths that are relevant to e-learning. In Section 3, we analyze the complex learning process and identify SOA-relevant requirements for an advanced ICT coordination system. Then, in Section 4 we propose architecture-level solution directions that relate to some of the identified requirements and are partially illustrated in Section 5 by the means of an example. Finally, in Section 6, we analyze related work and present our conclusions.

2 SOA for e-Learning

In this section, we briefly recall the principles that underlie service-oriented approaches and subsequently discuss the potential beneficial implications of these principles for the e-learning domain.

SOA Principles. The main objective of SOA is to be able to create new applications from existing services, independently of who provides these services, where they are provided, and how they are implemented. Although this ideal is hard to realize to a full extent given practical business requirements, SOA provides a sound architectural foundation [6] and supportive technologies are currently available to test service-oriented approaches in practice [11].

A 'service' is a self-standing piece of functionality offered to the outside world. To access this functionality, a service user interacts with the service interface, using messages and a basic message exchange pattern defined by the interface. The service interface is independent from the service implementation. For example, a legacy

application may expose its functionality through a service, thus allowing external use without disruptive measures for internal users. The technologies supporting these principles are WSDL, for the definition of web service interfaces, and SOAP, for the exchange of messages based on standard Internet protocols.

Service providers can store information on their services, called service descriptions, in public (or closed community) repositories, enabling users to discover services that fulfill their requirements. These repositories can be organized in much the same way as telephone directories, with white pages, yellow pages and green pages, to facilitate different search strategies. For example, a repository's 'green pages' provide information on how to interact with a service by giving a pointer to the corresponding interface (WSDL) definition. The functionality of a repository for storing and organizing service information and enabling discovery of services can be provided as yet another service. The technology supporting this is UDDI.

Often real-life collaborations require coordination between partners which cannot be enforced by the simple message exchange patterns defined by a service interface. Therefore, service behaviors have to be defined that capture required orderings and dependencies. There are two perspectives on service behavior. The first perspective, called choreography, is concerned with the exchange of messages between two or more partner processes. The second perspective, or orchestration, considers a message exchange from the point of view of one partner process. A technology for defining choreographies is WS-CDL. Frameworks for specific types of coordination are also available, such as WS-Transaction. Orchestrations can be defined with WS-BPEL.

Choreography is essentially a public process or protocol that tells a partner how to behave in order to take part in a collaboration. On the other hand, an orchestration is a private process which specifies interactions with external services. An orchestration can therefore be used to define a composition of services. The result of this composition can again be exposed as a service. This composite service has a richer functionality or targets a more specialized community of users compared to the composed, or atomic, services. Since composite services may again be used in compositions, a hierarchical organization and composition is possible. Advanced discovery and composition algorithms allow rapid service creation and even dynamic service composition at run time. In the latter case, a service request is resolved by a suitable service composition (in case no match exists between the request and an individual service) based on the services found in the services registry. OWL-WS is a technology that allows the composition of services in a workflow using semantic information.

For an overview structure of SOA-related standards, we like to refer the reader to Figure 4 in [20].

Benefits for e-Learning. Being able to abstract from technological details and create reusable components (i.e., services) brings several potential benefits to enterprises, including those involved in education. Here, we will focus on the benefits from the e-learning perspective.

First of all, SOA allows institutions to continue to use legacy applications in new systems. This is the case since services are described independently from any implementation technology, and are accessed through standard WSDL interfaces. It is important to realize the relevance of this principle for the e-learning domain. Educational institutions must integrate processes and provide services for many

different people: those involved in the primary process, such as teachers, students, and assistants; those involved in providing educational resources, such as librarians; those involved in administrative support; those involved in planning, designing and maintaining educational material, systems, facilities and so on. Because of the varying needs of these people, educational institutions typically use various IT systems, legacy as well as new, which have to share data in order to support the enterprise processes.

SOA allows to mix and match legacy applications exposed as services with new application components to form composite applications. Moreover, 3rd party applications may be used as well, provided they are exposed as services. In this way, an e-learning system may be assembled by choosing required functionalities from the Web, if not available in-house, instead of building them from scratch or buying packages that have to be installed and integrated in the existing environment. Again, this can be of great benefit to educational institutions, since each of them has developed components (course material, course delivery systems, searchable repositories of learning objects and so on) which are potentially useful to other institutions.

Hence, SOA brings greater flexibility to (re-)use applications and to develop new applications and systems. Development may be much faster, and more cost-effective, also because services of 3rd party applications can be incorporated in new systems. Maintenance may also be easier, as implementations of services can be replaced without affecting functionality, and functionality may be changed or extended according to new requirements by changing or extending the composition of services. In addition, focus can be on domain aspects such as learning, processes and experience, instead of on technology.

The modular approach supported by SOA also allows educational institutions to offer diversity and apply different pedagogical methods according to purpose, audience and circumstances. Furthermore, e-learning may become more learner-centric and personalized, with high learner-empowerment and personalized learning pathways, thanks to the greater flexibility offered by SOA. Two parallel technological developments related to SOA are relevant here: dynamic service composition and context-aware services.

Dynamic service composition refers to the possibility to have runtime discovery, selection and composition of services based on a user request, followed by the delivery of the resulting composite service to the user who submitted the request. This technology is still in an early stage, based on syntactic matching of input and output messages of atomic (request-response) services. However, it is expected that advances in this area will allow semantic discovery and matching of services with more complex behaviors. A future scenario could be that a learner formulates requirements in terms of learning objectives, topics and timing, and that a service discovery and composition engine subsequently proposes possible services bundles which can be scheduled for delivery.

Context-aware services concern applications that take the context of the user into account when delivering their services to that user. User context comprises a range of dynamic properties that reveal something about the person who is also the potential user of a service [15]. Examples are the geographical location, local weather or environmental conditions (temperature, humidity, pollution, toxic gases), physical activity (sleeping, exercising), and bodily position (standing, sitting, lying). User

context data is unobtrusively gathered by sensors, and converted into useful context information for the application through a process of aggregation and inference. The application then adapts its service based on the context information, which is correlated to perceived personal needs of the user. Context-aware technologies have been developed in several research projects, but design methods that can systematically derive useful context-aware services and scalable supportive mechanisms are still lacking. Nonetheless, the relevance of context-awareness for e-learning is not hard to imagine. A future scenario could be that the e-learning system uses context (as well as stored preferences and historical data) of individual learners to adapts its services in order increase effectiveness and efficiency of learning.

3 Implications from the Perspective of Learning

A typical learning process is driven by the necessity of educating the student [10]. It requires also considering the one helping students in acquiring knowledge, namely the teacher. Student and Teacher are hence two *essential roles* in any learning process. Besides teaching and learning, some other activities to be taken into account, especially in modern society, are: (i) student selection (examiners usually conduct an entrance selection); (ii) controlling the learning process (administrators usually execute control over teachers on the learning content; it is necessary clarifying that by administrators we do not mean the administrative staff responsible for gathering and processing some administrative information but those who control the courses with respect to fitness in the overall educational program). We claim that a student-teacher-examiner-administrator model can be considered as a valid although simplified model of any learning process (the model is in fact simplified because we ignore, for the sake of brevity, some issues including: *a)* another responsibility of examiners, namely to evaluate students (through exams); *b)* another responsibility of teachers, namely to specify the prerequisites for their courses and also the entrance criteria for the exam (e.g. some practical assignment may have to be completed and approved before entrance to an examination is allowed) while checking such prerequisites and criteria is usually responsibility of administrators). We thus consider Examiner and Administrator as two other essential roles in a typical learning process. In order to identify requirements, we hence need to structure this as an initial step in describing and analyzing the learning process in general.

Figure 1 shows the student-teacher-examiner-administrator model using a diagrammatic technique derived from DEMO [5,18,19]. The identified entities (reflecting corresponding roles) are presented in named boxes – these are Student (S), Teacher (T), Examiner (E), and Administrator (A), while the small grey boxes, one at an end of each connection, indicate the *executor* role of the connected entities. The connections indicate the need for interactions between entities, in order to fulfill the goal of educating; with each connection, we associate a single interaction, i1 – i3, as follows: S-E (i1), S-T (i2), T-A (i3). As for the delimitation, S is positioned in the environment of the education system – ES, and E, T, and A together form the ES system. Through i1 and i2, ES is related to its environment (represented by S).

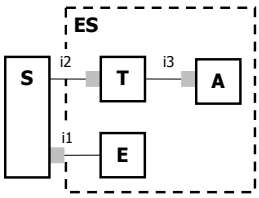

Fig. 1. A simplified business entity model for an education system.

In order to be part of the learning process, a student would have had fulfilled the entrance criteria, by passing some kind of entrance exam (i1 represents this with the student in an executor role since the student has to deliver). Once the student is in a position to participate in a learning process, a teacher is to deliver some kind of learning service (i2) however only under the condition that this has been approved by the controlling administration (i3).

This essential business model needs to be fulfilled by a realization no matter if it is technology-driven or not. Since we are mainly interested in service-oriented IT solutions, we analyze further the possible reflection of the model in that direction (it is to be stated nevertheless that much of the following concerns at the same time the business/institutional level). Further, we take an idealistic view, assuming that the possibility to transfer credits among some institutions is acceptable in general – said otherwise, a Student from University A can follow a course from University B and use the result for credits at University A. We make this assumption because we believe that the current globalization of education would lead to this. It might be even possible (in the near future) for students from universities which are not very prestigious, to attend courses in more prestigious universities. If this is the case nevertheless, such 'external' students would have to follow special 'versions' of these courses, adequate to their level and giving them less credit than to the 'local' students. As for the gap between what we want and what is available, we have mostly an 'institutional' gap and a coordination gap. This is because currently, sufficient technology exists, in our opinion, whose use is restricted however by university regulations, national regulations, and other regulations, and also by the lack of all-encompassing coordination mechanisms. Our proposed solution directions (that concern an open service platform) are not supposed to overcome the 'institutional' gap, being only directed to the coordination issue – this is considered to be the added value of what we propose in the current paper. It is to be mentioned as well that we do not consider a university as an isolated entity – we consider universities as global collaborative players, such that everybody can produce and consume global educational services, driven nevertheless by some underlying rules. We can therefore 'draw' on the basis of this initial information (presented above), a high-level view on what such a platform is to be:

- S-T *SEARCH* (ES should facilitate students in finding the most appropriate teachers for their needs and vice versa; we would however consider students to be in general foremost interested in the content (topic, learning material, course set-up) and only then look for the best or most suitable teacher);
- S-T *MATCH-MAKING* (ES should adequately connect a student(teacher) only to those teachers(students) who match properly for collaboration, which

includes for example matching students' demands and teachers' qualifications);
- S-E *EXAMINE* (ES should facilitate students in their finding the appropriate entrance exams and go for on-line selection with regard to the course(s) they would like to enroll in);
- A-T *REGULATE* (ES should support administrators to regulate teachers' work, by enforcing some compulsory rules through the platform);
- S-T *RANKING* (ES should help monitoring teachers' qualification, contribution and reputation, and storing such information for the purpose of ranking teachers);
- T-T *CO-CREATION* (ES should facilitate teachers in their co-creating courses, supported by course templates, collaboration tools as well as by wizards).

Based on the above analysis and motivated proposal, we firstly define some GENERAL REQUIREMENTS (demands) that are relevant to our suggested platform: (i) possibility of easy and flexible use minimum burdened by the underlying technology; (ii) process alignment (it is crucial that all ES-related processes are appropriately aligned and synchronized so that adequate coordination can take place); (iii) hierarchy of complex rules underlying the platform as a way to enforce the desired functionality guaranteeing that all users will be properly served.

Taking these high-level demands that relate to the technological perspective, we combine them with the domain details, considered in this section, concluding that the platform must be capable of enabling and facilitating an innovative methodology on how to conduct education. From this objective, some REQUIREMENTS ELABORATION can be derived upfront:

- it should be possible to mix and match learning modules offered by different organizations on geographically distributed nodes using diverse technologies;
- the mixing and matching is typically prepared and constrained by a program, by defining learning profiles, learning paths and learning policies that are generally useful with regard to a goal;
- the mixing and matching should be completed by the student, such that (s)he can tailor the learning content, method and plan according to personal needs and preferences given the constraints imposed by a learning program;
- it should be easy to add, remove and update learning modules so as to keep pace with changes in knowledge/skill demands and to profit from the availability of new or improved learning modules;
- it should be possible for students to transfer their experience and expertise to other students by contributing to or co-creating the content of certain learning modules;
- the delivery of learning content should be automatically adaptable to personal conditions, such as availability, place and device characteristics, using context sensors and context reasoning;
- teachers should have the possibility to be informed about the learning modules that are successfully completed by their students so as to compare realized and required knowledge/skill levels relevant for the considered education goals;
- students should have the possibility of knowing their knowledge/skill level (based on learning modules successfully completed) and as well how to improve it.

We discuss in the following section solution directions that relate to some of the requirements already defined.

4 Solution Directions

Elaborating further on how IT services can usefully support education goals, we will consider in this section: (i) the composition of IT services for education; (ii) related cross-cutting concerns; (iii) resolution of conflicting business processes.

Composition of IT Services for Education. The demands mentioned in the previous section provide a starting point to create education services. We need to take into account also the following:

- the *education services* may be supported in terms of *IT services* which in turn are provided by *generic education service components*;
- *business processes* need to be analyzed in order to adequately determine orchestration (coordination) with regard to the use of IT services.

We illustrate this view in Figure 2:

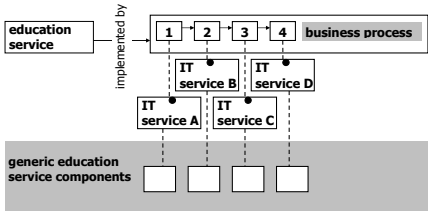

Fig. 2. Composition of IT services for education.

As shown in the figure, a business process implements an education service, as a way to underlie the desired functionality that corresponds to a customer (end-user) need. The business process needs to be analyzed in order to define adequately a data and control flow in which the supporting IT services are called in the right order and with the right parameters. Thus the IT services point to service components that are in general not especially developed for the application under consideration (for example, education resource manager, examiner, regulator), although they are specific for the education domain. They need to be configured (instantiated with the proper parameter values) in order to lead to the realization of IT services that relate to business process actions.

It is as well seen that (i) the upper part of the figure is about business activities unrestricted by technology (the education service is implemented by a business process that in turn consists of actions performed by humans (or at least controlled by humans)); (ii) the lower part of the figure concerns IT services which are realized by ICT components. We hence should address the 'IT level' with more attention because much at the 'business level' is driven by organizational and/or societal rules, human relations, intuitive human decisions, and so on, which need to be analyzed, simplified and reflected in the 'intelligence' of the IT system. The coordination (orchestration) of business actions is pushed by human intelligence; with regard to the coordination

of IT services nevertheless, we need to actually make decisions about it at design time. In considering technology-enhanced learning, we propose a single point of coordination because of the following reasons: (i) unlike in solving supply-chain-related mediation, for example, in supporting learning, we would not often have the case of hundreds of users being served simultaneously and therefore sophisticated coordination would add little value; (ii) mixing and matching learning modules (as required – consider Section 3) adequately would usually demand one point of coordination (otherwise, too complex facilities for prioritization would have to be considered); (iii) the domain of education is dynamic in a sense that often new rules/regulations appear, which means that the system design would have to be easily updateable, and with a single point of coordination updates would obviously be easier than in cases of complex coordination.

In the remaining of this paper, by *service* we mean only *IT service*.

Hence we introduce a service coordinator which in SOA terms should be a *service that can be invoked to coordinate other services* (we label such a service *coordination service*). In taking care of this nevertheless, the coordination service would deal inevitably with exchange of information concerning many issues, and this information would need hence to be stored and managed. We introduce thus a *service that can store information and allow other services to find information* (we label such a service *information service*). Such services (coordination-related and information-related) are claimed to be central for approaching problems that concern technology-enhanced learning in a service-oriented way. Figure 3 gives a general view on this.

The figure depicts 5 layers that are widely considered in discussing service-oriented reference architectures – ICT components can operate on top of an operational system, in their delivering services which in turn are developed for the purpose of supporting particular goals concerning some business processes, which goals appear with regard to needs of customers [7]. The layer that is explicitly considered in this work is the 'Services' layer and we thus elaborate there our proposed solution directions. As it can be seen from the figure, the coordination service and the information service are of crucial importance since they support the deliveries of all other services – the coordination service orchestrates the overall work of the system, invoking other services at the right moment and offering them also the right input; as for the relation between the coordination service and the information service, it is not trivial since the coordination service would need support from the information service on most of the service invokations, hence this complex relation is indicated by the dashed line between the coordination service and the information service. What is also shown in Figure 3 is that all other services operate through the mediation of the coordination service.

In the following section, we will identify through an illustrative example, a short list of IT services that have relevance to technology-enhanced learning. It should be noted that all that has been discussed so far with regard to IT services concerns the functional perspective and in order to be more exhaustive in presenting our proposal, we consider briefly in the below paragraphs crosscutting non-functional concerns.

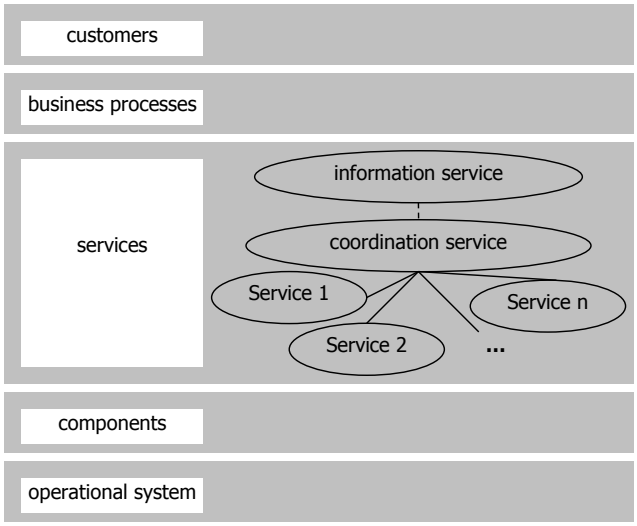

Fig. 3. A service-oriented solution direction for technology-enhanced learning.

Crosscutting Concerns. The architectural view already presented in the current section focuses on the desired primary functionality. Nevertheless, it appears that some concerns can not be easily localized and specified in individual architectural components, as researched by [22]. Similar to practice in aspect-oriented software development, we call such concerns *crosscutting concerns* [23,4]. Since crosscutting concerns are inherent, it is claimed that these cannot be undone simply by redefining the software architecture using conventional architectural abstractions. Explicit mechanisms are thus needed to identify, specify and evaluate such concerns at the architecture level. For the sake of brevity, we are not going to discuss this in further detail and will limit ourselves to only mentioning several such crosscutting concerns, especially ones that we claim to have relevance to the service-oriented IT support to technology-enhanced learning, as considered in the current paper: *synchronization*, *distribution*, *security*, *privacy*, and *logging* (illustrated in Figure 4):

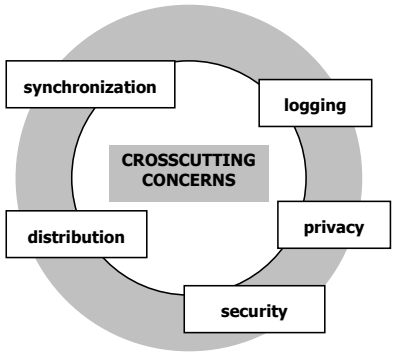

Fig. 4. Identified crosscutting concerns.

Although they are not specific to any particular process/component (with respect to the delivery of IT services for supporting technology-enhanced learning), these crosscutting concerns are still claimed to have huge importance for the adequacy of the platform, because:

- all processes that concern students and teachers are to be synchronized among each other and with respect to the overall program so that it is avoided for example that an exam is appointed for a date on which the examiner has also other obligations [**synchronization**];
- it is essential to offer support for distribution with regard to the need for courseware co-creation by teachers who are in different locations [**distribution**];
- high levels of security are necessary for adequately controlling numerous copyright-protected resources and personal data [**security**];
- privacy-sensitivity is essential in guaranteeing that for example, only the education-related data concerning students will be accessible to their teachers [**privacy**];
- it is also necessary keeping track of events that may later play a role in presenting proof of what actually happened [**logging**].

We have presented in both functional perspective and non-functional perspective our proposed views with respect to SOA-related supporting of activities that concern technology enhanced learning, and we will discuss in the remaining paragraphs of this section some complementary policy-related issues.

Policies. As already mentioned in this section, some corresponding business processes need to be analyzed in order to define adequately a data and control flow in which the supporting IT services are called in the right order and with the right parameters; this is needed in order to properly specify the coordination service which is responsible for invoking other services.

Hence, we need to consider *policies* in specifying the coordination service. This would often point a (standard) procedure that may be defined by rules (e.g., a service at a library often points to the following business process: Student makes selection of books, Librarian announces the maximum possible period of holding (each of) the books, Student takes the books). There could nevertheless be conflicting actions (in a business process) or even conflicting business processes [14]: let's assume, for example, that the education service 'Assessment' is implemented by a sequence of activities as follows: Examination, Evaluation, Announcement (the teacher should conduct the exam first, then make a review and put mark, and finally – announce the mark to the student); it may be that in cases of external teachers examining, there is a requirement for an approval (by a local teacher) of the evaluation output. We are thus facing a conflict that concerns both semantics and pragmatics [16].

Figure 5 illustrates this:

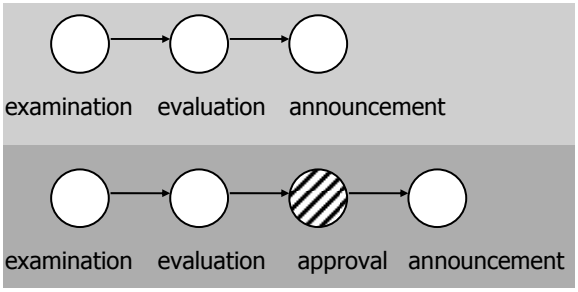

Fig. 5. A semantic conflict concerning an education service.

Based on previous work [17], we claim that Organizational Semiotics (OS) in general and the Norm Analysis Method – NAM [9], in particular can be of use in resolving such semantic conflicts and enforcing policies, taking into account not only the rules-related strengths of NAM but also its sound semantics-related OS theoretical roots.

Norms, which include formal and informal rules and regulations, define the dynamic conditions of the pattern of behavior existing in a community and govern how its members (agents) behave, think, make judgments and perceive the world.

Norms are developed through practical experiences of agents in a community, and in turn have functions of directing, coordinating and controlling their actions within the community. When modeling agents and their actions, which may reveal the repertoire of available behaviors of agents, norms will supply rationale for actions. Norms will also provide guidance for members to determine whether certain patterns of behavior are legal or acceptable within a given context. An individual member in the community, having learned the norms, will be able to use the knowledge to guide his or her actions, though he or she may decide to take either a norm-conforming or a norm-breaking action. When the norms of an organization are learned, it will be possible for one to expect and predict behavior and to collaborate with others in performing coordinated actions. Once the norms are understood, captured and represented in, for example, the form of deontic logic, it will serve as a basis for programming intelligent agents to perform many regular activities [9].

The long established classification of norms distinguishes between perceptual, evaluative, cognitive and behavioral norms; each governing human behavior from different aspects. However, in business process modeling, most rules and regulations fall into the category of behavioral norms. These norms prescribe what people must, may, and must not do, which are equivalent to three deontic operators “of obligation”, “of permission”, and “of prohibition”. Hence, the following format is considered suitable for specification of behavioral norms:

whenever <*condition*>
if <*state*>
then <*agent*>
is <*deontic operator*>
to <*action*>

The condition describes a matching situation where the norm is to be applied, and sometimes further specified with a state-clause (this clause is optional). The actor-

clause specifies the responsible actor for the action. The actor can be a staff member, or a customer, or a computer system if the right of decision-making is delegated to it. As for the next clause, it quantifies a deontic state and usually expresses in one of the three operators - permitted, forbidden and obliged. For the next clause, it defines the consequence of the norm. The consequence possibly leads to an action or to the generation of information for others to act [9].

Norms can be specified in both a natural language and a formal language. For example, adopting the format given above for specification of behavioral norms, a credit card company may state norms governing interest charges as:

whenever an amount of outstanding credit
if more than 25 days after posting
then the card holder
is obliged
to pay the interest.

We hence claim that underlying (hierarchies of) norms can play a useful role in enforcing policies with regard to the coordination service, as depicted in Figure 6, where the importance of enforcing policies in each service invokation is explicitly shown as well as our proposed use of a hierarchy of semiotic norms for that goal (a possible norm hierarchy is illustrated abstractly in the figure); the dashed line between the coordination service and the norms indicates the need for the service to be aware of the norms which it should enforce in invoking services.

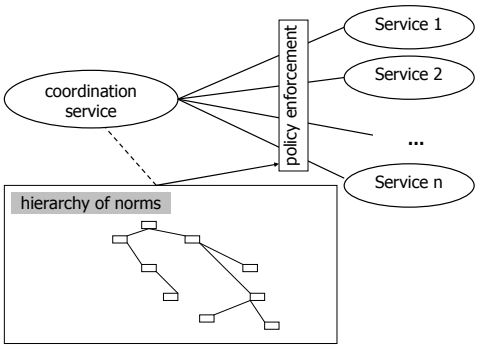

Fig. 6. Norm-driven policy enforcement.

After having introduced our proposed solution directions with regard to a service-oriented coordination platform for education, we will present in the following section partial illustration concerning nevertheless only some business-processes-related issues, and in particular the reflection of business processes in application functionalities as a bridge between the education services and the IT services supporting them.

5 Illustrating Example

We start from the simplified business model that is depicted in Figure 1 in order to illustrate partially how IT services can be methodologically reflected in a model, which reflection is driven by analyses concerning not only the corresponding business processes but also the demanded ICT support. We in particular derive the Education Mediator (EM) on the basis of the details that have been presented in Section 3. We would expect hence that an EM would support customers in a number of ways, in an e-learning context. By 'customers', we mean the users of EM's services; those could be students and teachers (in the simplest case). Furthermore, we address (for the sake of brevity) only EM's advice provisioning service: *a customer can receive from EM advice which of the Student/Teacher entities (registered in the system) best satisfy a need* (for example, which is the best teacher with respect to a particular student demand). To receive advice from EM, the customer approaches EM's *ADVISOR* (an entity inside EM, which is responsible for handling the advice provisioning). It should be nevertheless noted that the Advisor may be shielded from the customer by the EM and in such a case the customer would be 'talking' to the EM and the EM would in turn route requests to (and results from) the Advisor. Approaching the Advisor, the customer should specify a request: course type (e.g. lecturing course or experimental course), preferences (e.g. closest to a particular subject), and so on. Based on this (and acting 'through' the Match-maker, to be introduced further on in this paragraph), EM's *REQUEST HANDLER* (an entity inside the EM which processes requests) generates a standardized request specification, appropriately synthesizing some of the information provided by the customer. This is delivered then to EM' *MATCH-MAKER* (an entity inside EM, which is responsible for finding a match using the standardized request and considering what is currently available); the Match-maker realizes matches driven by particular criteria, chosen by the customer (and represented in the standardized request), for instance: a preference for a teacher from a particular country or institution or the earliest available teacher. In order to realize a criterion-driven match, the Match-maker applies relevant rules and procedures, nevertheless needing input from EM's *DATA SEARCHER* (an entity inside EM that is responsible for searching). The Data searcher searches through the information concerning the available (Student/Teacher) entities and also applies procedures to it. This hence supports the identification of candidate matches relevant to the particular customer's request. The Match-maker applies its rules and procedures to realize a final match, passing this information to the EM's Advisor.

Considering the above-presented briefing, a business entity model is built (Figure 7), with the same notations as we have already used in building the model that is presented in Figure 1.

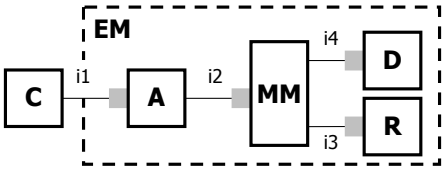

Fig. 7. Business entity model for the EM case.

The identified entities are presented in named boxes as in the previous model – these are Customer (C), Advisor (A), Match-maker (MM), Request handler (R), and Data searcher (D). Interactions i1 – i4 are identified as follows: between C and A (i1), between A and MM (i2), between MM and R (i3) and between MM and D (i4). As for the delimitation, C is positioned in the environment of the education mediation system EM, and A, MM, R and D together form the EM system.

We model then interactions using the notations of UML Activity Diagram [16]: i3 and i4 are to be progressing in parallel and only after they have been exhausted (the standardized requests and candidate matches have been delivered) the match-making can be done (i2) followed by the advice (i1) – this is illustrated in Figure 8 (upper part). This is the *business process level*, as labeled in the figure, and it is assumed that human-driven roles (and responsibilities) stay behind each of the interactions and as it is about human activities, much is driven by complex organizational (and societal) norms, much is actually done using best practices, and much is done in an intuitive way. IT services nevertheless require defining everything explicitly. That's why the IT services that correspond to the business-process-level interactions, are considered together with other related issues, as it is shown in Figure 8 (lower part), depicting the *IT service level*, as labeled in the figure.

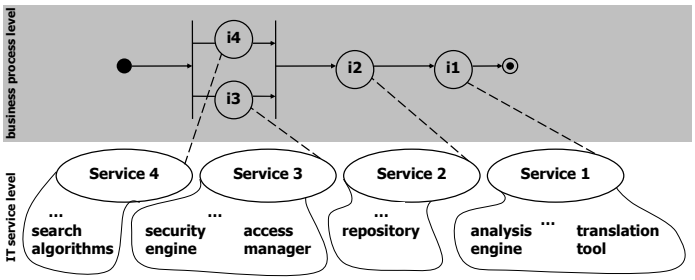

Fig. 8. Service derivation for the EM case.

As it is seen from the figure, searching requires search algorithms, request processing requires an adequate supportive security engine and access control facilities, match-making needs repositories with candidate matches and match criteria, the delivery of an advice requires an analysis engine and sometimes, a translate facility, just to name a few.

We need to extend further this model, particularly with respect to 'IT Services level', by considering our adopted service pattern that is depicted in Figure 3, which pattern is driven, as it has been discussed already, by a coordination service, responsible for orchestration. The EM service model is presented in Figure 9:

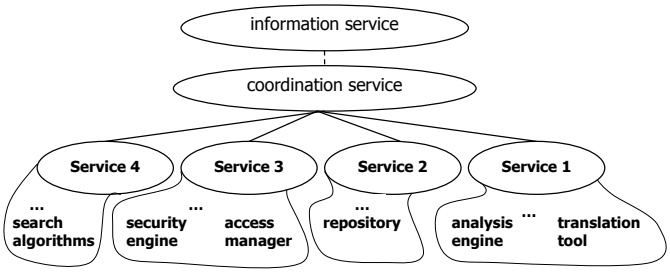

Fig. 9. Service model for the EM case.

As it is suggested by the figure, a coordination service (supported by an information service) orchestrates the work of the other services, namely Service 1, Service 2, Service 3, and Service 4, in a way that has been discussed in Section 4. Taking into account the case information and the considered domain, we label these 4 services in the following way:

- Service 1: **Educational Mediation Service**;
- Service 2: **Educational Broker Service**;
- Service 3: **Educational User Agent Service**;
- Service 4: **Educational Resource Discovery Service**.

We claim hence that the service pattern presented in Figure 9 as well as this short list of services (which can be extended) are useful for further related research in the area of technology-enhanced learning.

With respect to crosscutting concerns, the already identified ones are valid for this case, taking into account the discussion that has been already presented in Section 4:

- Crosscutting concern 1: **Synchronization**;
- Crosscutting concern 2: **Distribution**;
- Crosscutting concern 3: **Security**;
- Crosscutting concern 4: **Privacy**;
- Crosscutting concern 5: **Logging**.

This is as well a useful short list of crosscutting concerns (which can be extended), useful for further research in the area of technology-enhanced learning.

We will not consider in this example policy enforcement, for the sake of brevity.

6 Related Work and Conclusions

In this paper, we have presented solution directions that concern technology-enhanced learning and in particular the adoption of a service-oriented architecture for accomplishing better coordination and ease of application and use.

The current developments that concern technology-enhanced-learning-related systems point in several directions, namely: (i) Virtualization of learning; (ii) Adoption of Service-Oriented Architecture for enterprise systems in Education; (iii) Tooling.

With regard to virtualization, the project LiLa [10] addresses the challenge of making lab experiments more widely accessible, through automation and control from distance via Internet, driven by advanced access control mechanisms. With regard to service-orientation and related solutions, IMS Global Learning Consortium [8] has proposed an architecture for education-related enterprise systems, inspired by some of the latest SOA-related achievements. With regard to tooling, tools such as Moodle [12] are currently undergoing development that nevertheless strongly depends on the envisioned upcoming advances in the direction of service-orientation.

Distinctive features of the proposed solution directions are: (i) Methodological derivation of IT services, based on business analysis and modeling; (ii) Consideration of (service-oriented) coordination as a way for orchestrating and facilitating the work of an e-learning system; (iii) Envisioning underlying infrastructures for the next generation of e-learning systems.

To further this research, we plan to achieve a holistic perspective on technology-enhanced learning, in which we will consider the aspects mentioned above.

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Emerging Utility and Cloud Computing Models

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Abstract. This paper explores emerging opportunities and challenges for end-users and corporations with the shift in the geography of computing services and applications. Recent trends in consolidated Enterprise Information Technology solutions have proven to enhance business efficiency when significant fractions of local computing activities are migrating away from end-user computers and enterprise servers. Data, Information Systems and Enterprise Applications are being removed from desktop PCs and departmental servers and are being integrated and packaged on the Web into "the computing cloud." The shift from locally installed and maintained programs and systems to hosted services in "the compute cloud" affects the entire computational ecosystem, from the CIO to the end-user, software developer, systems analyst, and IT/IS vendor. We may need to take a fresh look at Thomas Watson's pivotal statement from 1943 "I think there's a world market for maybe five computers." There are several distinct innovations towards emerging centralized computational mega-structures such as:

- Grid computing infrastructure, middleware and application services
- Virtualization for more transparent scaling of complex systems
- Utility Computing services and models
- Dynamic Resources and Computing in the Cloud.

Growingly companies seem to achieve business advantage from the recent IT transformations and different forms of Cloud or Utility Computing services. Conversely, many issues remain: how well do the new models protect our investments, business specific challenges, innovations, privacy, and information security?

Keywords. Utility Computing, Cloud Computing, Internal-, External-, Private-, Community-, Public Cloud, Cloud Software as a Service, Cloud Platform as a Service, Cloud Infrastructure as a Service.

1 Introduction

The past decade has witnessed important Information Technology (IT) advances and shifts in geography of computing services, applications and capabilities. The IT transformations and changes stimulate business adaptations and social adjustments to a great extend.

The economic difficulties in 2000s, the cost-effective strength of the Internet, and some new technological advances have made businesses more vigilant and more demanding about the return of their IT investments [6]. The economic and social

motivation for efficient consolidated IT solutions such as utility or cloud computing is steadily increasing. Insightful businesses and IT organizations are grasping the ideas, discerning what the emerging technology and models are and how they can use them to create a competitive advantage. Any delays in understanding and adapting novelties might lead to dramatic changes or collapses. One of the many examples from the first decade of the century is with the retail book industry - it was slow in adapting to the Internet and E-commerce opportunities and got "Amazoned."

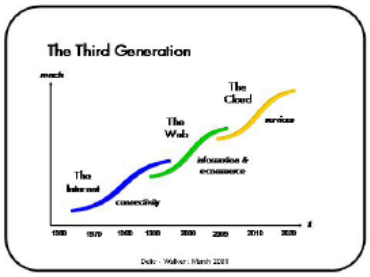

Fig. 1. Internet evolving into Cloud [1].

The magnitude of the Internet revolution broadens with the advancement of the infrastructure, operations and available services though the global network. According to Delic and Walker [1], the evolution of the Internet infrastructure and associated activities (Fig. 1) is heading in the Third Generation – The Cloud Services.

There is a new wave of interest in "Externalization of IT" --anything as a service (including Software as a Service - SaaS, Infrastructure as a Service - IaaS, Platform as a Service - PaaS), On-Demand, Utility and Cloud Computing, Outsourcing-- and many businesses are exploring any alternatives that would allow them to reduce IT operating costs while improving and intensifying information resources. Growing companies appear to achieve business advantage from the recent IT transformations, different forms and delivery models of Utility or Cloud Computing services.

New Utility and Cloud computing services are changing the ways we think of IT, from economics of delivery mode to process and usage models. Many organizations look to the cloud as a potential cost-savings boon by moving internally hosted IT services to external providers. Other IT organizations view the Cloud as a potential disaster recovery plan or as on-demand elastic capacity to boost business continuity and operating service levels. The shift from locally installed and maintained programs and systems to hosted services in "the compute cloud" affects the entire computational ecosystem, from the CIO to the end-user, software developer, systems analyst, and IT/IS vendor. We may need to take a fresh look at Thomas Watson's pivotal statement from 1943 "I think there's a world market for maybe five computers."

Just as it was with that new-fangled "Internet" mania few decades ago, the Cloud and the technologies of Cloud Computing suffer from confusion and hype [2]. Multiple proprietary related definitions, competing vendors and alliances, undefined risks, new business models' obscure utility and cloud computing services are slowing down adoption. Although there is tremendous interest in the "Externalization of IT" services, most organizations are approaching it cautiously until they have a more complete picture of the risks involved.

Beyond important economic aspects of the emerging utility and cloud computing models, I assume the business sector and society at large will see benefits and opportunities in a global scale of utilizing those services. In this paper, I will describe some of these new business oriented systems and models in more detail.

2 The Evolution of Computing Mega-Structures

As the demand of faster and more powerful computing structures increases, and as the number and variety of applications and services progressively elevates, the need for more capable and dynamic computing environments increases, too. According to the IBM Corporation White Paper "Seeding the Cloud," the evolution toward Cloud Computing started in the late 1980s with the concepts of grid computing [4].

Grid computing specifically refers to leveraging massive number of computers in parallel to solve particular problems, or to run specific applications. The key element of Grid computing is that computers, or nodes, in a grid are able to act independently without centralized control, handling requests as they are made and scheduling others. Grid computing is the underlying technology for utility computing. In a long term, grid computing is heading towards a convergence of utility computing from the pricing and delivery prospective, and Web services-based integration and virtualized technologies to enable multiple, networked computers to be managed as one [13]. Amongst vendors developing and exploiting grid concepts are HP with HP Adaptive Enterprise Initiative, Sun Microsystems Network One, IBM's On-Demand Computing, and Oracle Grid Computing.

In the late 1990s, with virtualization of systems, servers and applications, the model has expanded to higher level of abstraction – a virtual platform, including storage and network resources, and subsequently virtual applications, which have no specific underlying infrastructure. Utility computing has offered clusters as virtual platforms for computing with a metered business model [4]. The utility computing uniquely integrates storage, applications, computing power and network infrastructure as a foundation for business adjustable IT services. It offers companies and private users an access to hosted computing services, scalable and portable business applications through a utility-like, pay-on-demand service over the Internet network. In the ultimate utility computing models, organizations will be able to acquire as much IT services as they need, whenever and wherever they need them [7].

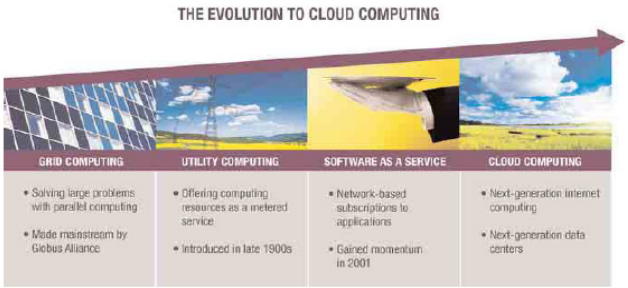

Fig. 2. Evolution toward Cloud Computing [4].

Lately, software as a service (SaaS) has elevated the level of virtualization to applications. The SaaS model has been developed to overcome common enterprise challenges to meet fluctuating demands on IT resources efficiently. Whether referred to a SaaS, utility computing, or hosted services, the idea is basically the same: instead of buying, installing and supporting expensive packaged enterprise applications or systems, users can access and utilize "externalized" applications over the network and pay a fixed subscription fee, or an actual usage fee [14].

The concept of cloud computing has evolved from the concepts of grid, utility and SaaS. In reference to IEEE Computer Society definition cloud computing "is a paradigm in which information is permanently stored in servers on the Internet and cached temporarily on clients that include desktops, entertainment centers, table computers, notebooks, wall computers, handhelds, etc." Cloud computing is an emerging model through which users can gain access to their applications and systems from anywhere, at any time, through their connected devices. These applications and services reside in massively scalable data centers, structured in public or private clouds, where compute resources can be dynamically provisioned and shared to achieve significant economics of scale. The strength of the cloud computing model is its infrastructure management, enabled by the maturity and progress of virtualization technology to manage and better utilize the underlying resources through automatic provisioning, re-imaging, workload balancing, monitoring, change request handling, and dynamic and automated security and resiliency platform [4].

3 Cloud Computing Characteristics and Models

Cloud computing is still an evolving model and definitions, underlying technologies, issues, risks, and benefits have been developed in vigorous debates by the providers, public and private sector users. There are neither standards nor agreed definitions related to the Cloud computing. The most illustrative description of what the cloud is comes from Kevin Marks, of Google "The idea of cloud computing comes from the early days of the Internet, where we drew the network as a cloud. We didn't care where the messages went --they came in one side and out the other-- and we didn't have to worry about the network … the cloud hid it from us."

According to Wyatt Kash, editor in chief for Government Computer News, "A group of leading standards development organizations are working jointly to foster common standards for cloud computing and storage, beginning with the launch a new site called cloud-standards.org." The organizations joining in the collaborative effort include the Cloud Security Alliance, the Distributed Management Task Force, the Open Grid Forum, the Storage Networking Industry Association and the Open Cloud Consortium, with other groups expected to participate. The Clouds Standards Coordination working group plans to focus its efforts on identifying current and emerging practices and products supporting cloud computing. In addition, it expects to help rationalize cloud computing security, deployment and data-exchange formats, taxonomies and reference models, storage standards and service-level agreements [8].

3.1 Cloud Computing Definitions and Characteristics

The National Institute of Standards and Technology, U.S.A. has drafted a definition of Cloud computing to serve as a starting point for government agencies and to maintain the implementers and providers on the same track.

According Peter Mell and Tim Grance from NIST "Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. As the cloud computing industry represents a large ecosystem of many models, vendors, and market niches, this definition attempts to encompass all of the various cloud approaches. This cloud model promotes availability and is composed of five essential *characteristics*, three *delivery models*, and four *deployment models*" [5].

In relation to NIST definition the five key cloud ***Characteristics*** are [9]:

- *On-demand self-service* - a consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with service's provider.
- *Ubiquitous network access* - capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms.
- *Location independent resource pooling* - the provider's computing resources are pooled to serve all consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand. The customer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter). Examples of resources include storage, processing, memory, network bandwidth, and virtual machines.
- *Rapid elasticity* - capabilities can be rapidly and elastically provisioned to quickly scale up and rapidly released to quickly scale down. To the consumer, the capabilities available for provisioning often appear to be infinite and can be purchased in any quantity at any time.
- *Measured Service* - cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service.

3.2 Cloud Computing Delivery and Deployment Models

NIST team has defined three ***Delivery Models*** based on the variety of services requested by the consumer and supported by the provider. Delivery Model Architecture – see Figure 3, must be deployed on top of cloud infrastructure that incorporates the listed above key characteristics [9]:

- *Cloud Software as a Service (SaaS)* - the capability provided to the consumer is to use the provider's applications running on a cloud infrastructure and accessible from various client devices through a thin client interface such as a Web browser. The consumer does not manage or control the underlying cloud infrastructure, network, servers, operating systems, storage, or even individual application capabilities.
- *Cloud Platform as a Service (PaaS)* - the capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created applications using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure, but the consumer has control over the deployed applications and possibly application hosting environment configurations.
- *Cloud Infrastructure as a Service (IaaS)* - the capability provided to the consumer is to rent processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly select networking components.

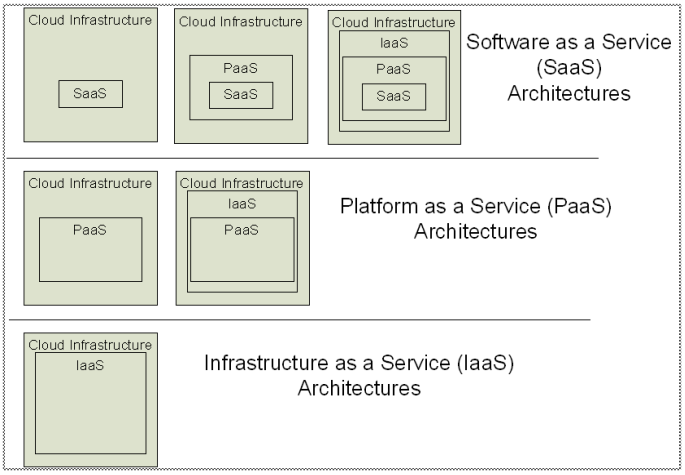

Fig. 3. Delivery Model Architectures [9].

In the same NIST document, Peter Mell and Tim Grance have described four ***Deployment Models*** specified in two types of clouds: *internal* or *external*, depending on where the clouds reside – within or outside of organization's network security parameters:

- *Private cloud* - the cloud infrastructure is owned or leased by a single organization and is operated solely for that organization.
- *Community cloud* - the cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns.
- *Public cloud* - the cloud infrastructure is owned by an organization selling cloud services to the general public or to a large industry group.

- *Hybrid cloud* - the cloud infrastructure is a composition of two or more clouds (internal, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability.

The NIST drafted definition, characteristics and models are in compliance with currently well positioned platforms such as VMware's vSphere and the open source Eucalyptus software. Similarity and matching descriptions related to types of clouds and delivery models appear with VMware Cloud Business Types, see Figure 4, and NIST defined above models [9].

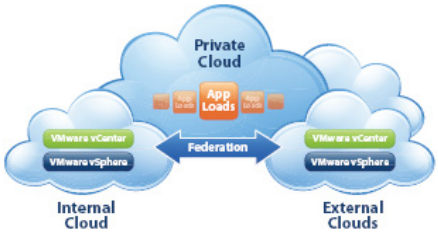

Fig. 4. VMware vSphere and vCenter ***on*** and ***off*** premise clouds [15].

4 Utilizing the Cloud to Tackle Limitations

A growing number of investors and consumers are exploring cloud options and opportunities while Amazon, Google, Oracle, SUN Microsystems, VMware already have appealing offerings and leading companies in the sector such as Microsoft, HP and IBM are investing billions in this initiative. According to leading vendors' and implementers' the new mega-trend - Cloud computing, has become a bona fide enterprise solution when users want to avoid dealing with infrastructure and configuration management. It works well as a consumer service such as SaaS, Web and DB hosting, email, and offsite PCs backup. On the developer side, it lends itself to Web applications design, content delivery, and building online systems and applications where scale, performance, and selection of infrastructure and software environment aren't critical. The provider or the service partners' ecosystem are in complete control of the infrastructure, the platform and the services.

Grid and Utility computing users, conversely, are more inclined to install, arrange, scale and manage online services using the provider's resources being in most cases in full control of the infrastructure and applications. There is immense variety in possible and actual configurations of technologies and infrastructure to support utility and grid computing models. According to Alfredo Mendoza [10], well established and proven technologies like virtualization, advanced application accounting, and dynamic partitioning, that have long existed in mainframes and now are available on newer server architectures in combination with grid computing, web services and hyper-threading technologies are contributing to create grid infrastructures and promote the utility model. The two models fit well where the implementers need to control geographic distribution, scalable compute resources, bandwidth, and performance in order to manage the user experience as the

applications are in their own data center. Analyzing the three concepts – grid, utility and cloud computing, their evolution and differences listed above, the final argument actually is: outsourcing IT operations to providers or purchasing your own IT assets.

All three models have proved, in many cases, better and more efficient ways of delivering enterprise IT services, but the final decision may well come down to how confident the user feels about the utility or cloud computing provider. When planning the shift to the clouds there are different options depending on what you want to put there and for how long. Although vendor offers similar services, while moving your computing applications away from your own premises, they might apply quite different pricing models and SLAs. Users have to take into account the current needs, potential growth and ability to change the SLA with forms and cloud services that suit the company best. In her review of recent cloud services, Jarina D'Auria from CIO magazine describes Amazon's Elastic Compute Cloud (EC2) as an environment to run computing resources while keeping the control over the data in the user's hands and emphasizing pay-per use model. The new Google App Engine allows you to build your own virtual application to run Web applications on Google's servers and features include dynamic Web serving, automatic scaling and load balancing, storage sorting, APIs for authenticating users and different pricing scales. The VMware vSphere 4 and vCloud initiative are providing the capability to move physical infrastructures and broader application capability on and off premise via hundreds of cloud services providers. By moving all physical data centers, companies not only save computing and operation costs but also have one silo for storage and resource management , based on vMotion management tools, VMsafe security APIs and data recovery systems [11].

Applying any of the available cloud services, the users will have, in most cases, unlimited computing resources, elastic infrastructure and more opportunities for new applications at a price they are able to pay and with no upfront costs. Strategizing the company final solution it might be most appropriate to build a specific hybrid model incorporating internal private cloud for the most sensitive data and critical applications and to outsource into public or community clouds some less decisive systems and routine applications. Evolving the internal IT infrastructure toward a cloud-like model for supporting the most sensitive and critical business operation at lower risk and higher security will enhance and facilitate the integration with outside applications running into external clouds [12]. In many industries such approach would decrease the risk of total outsourcing and the company will better control its information assets. Amongst higher educational institutions most of them keep and control in their own data centers students' records and financial systems while widely utilized educational services from external providers such as on-line course delivering environment (ANGEL, Blackboard), student consulting and supporting services as Smarthinking, email and e-collaborative tools from Google (Google Apps), or back up and archive services from Amazon (S3) or other vendors.

5 Conclusions

The shift to cloud computing will shake the $3.4 trillion global tech industry, and as the marker researchers Gartner expects the 3.8% shrinking this year will not affect

portables, wireless networks and cloud computing over the next few years. Gartner predicts the market for cloud computing services will triple from $46.6 billion last year to 150.1 billion in 2013 [3].

Ultimately, cloud computing is hovering to make a real impact on businesses of all sizes and society at large. It gives to smaller businesses a chance to utilize resources and services previously only IT leading companies could afford. According Vivek Kundra, Federal CIO "The cloud will do for government what the Internet did in the '90s … I believe it's the future … It's a fundamental change to the way our government operates by moving to the cloud. Rather than owning the infrastructure, we can save millions … It's moving technology leaders away from just owning assets, deploying assets and maintaining assets to fundamentally changing the way services are delivered."

As any change this new mega-trend in IT industry and services may take a while for building users' confidence, but like any major concept, it always starts off slowly, but once businesses and society realize the advantages of cloud computing, it will pick up pace rapidly.

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The Architecture of a Learner Adviser Service

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Abstract. One of the most important challenges faced by institutions that deploy e-Learning activities is to prove beneficiaries that the learning process is effective. This paper proposes a structure for a Service Oriented Architecture (SOA) in which a Learner Adviser Service (LAS) will run. The proposed architecture enables different e-Learning platforms to access the service through published and discoverable interfaces. The LAS will provide feedback for each learner according with the setup that has been done between the e-Learning platform and LAS. The feedback refers to actions that are recommended to be performed by the learner. LAS uses machine learning algorithms for classifying learners according with their performed activities. The ultimate goal of LAS is to provide an overall activity measurement for the student's activity in such a way to increase the trust into the effectiveness of the e-Learning platform.

Keywords. Service Oriented Architecture, e-Learning, Recommender system.

1 Introduction

Using service type architecture has the advantage of providing the ability to register, discover, and use services, where the architecture is dynamic in nature.

A typical Service-Oriented Architecture is presented in Figure 1. One can see three fundamental aspects of such architecture:

a) Advertising. The Service Provider makes the service available to the Service Broker.

b) Discovery. The Service Consumer finds a specific Service using the Service Broker.

c) Interaction. The Service Consumer and the Service Provider interact.

In an e-Learning context, the service consumer is represented by the e-Learning platform itself, while the service provider is represented by LAS. Once a service is advertised and discovered, any interaction with it is controlled by the service level agreement (SLA) that is going to define the entities that are allowed or denied access to the service, as well as the interval time the access is allowed or denied.

The lifetime of LAS can be described by the three following steps: creation, advertising and discovery. Each of these steps is represented in LAS by a set of interfaces. There will be explained these different steps and demonstrate them through a prototype LAS.

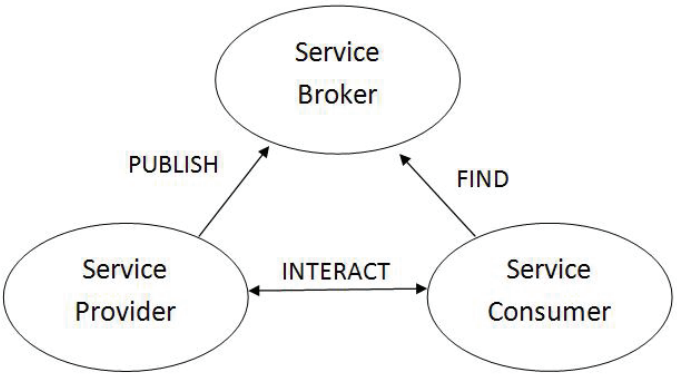

Fig. 1. The Service-Oriented Architecture.

As seen before, the different application areas have different requirements to the data management. Workflows need a reliable place for the storage of temporal or permanent processing results. The usage of content sharing applications needs sophisticated querying functions and short access times. Applications based on resource sharing require standardized reliable database access. Finally, collaborative applications require concurrency control.

In the service oriented applications, the same classical requirements that apply to databases are still valid:

Durability: Data need to be stored for longer time. In web application, data have to be available even if storage peers disappear.

Consistency: Data have to be always consistent. This is challenging in web application as data can be changed in every storage peer and changes have to be propagated to other peers.

Reliability: The reliability of web application data stores is accomplished by the distributed storage of data. Hence the reliability of web application storage is related to the durability property.

Concurrency: From the architecture of web application system a high level of concurrent operations on data is given. Changes can be done on several peers in parallel. Hence updates have to be done in a more controlled way.

Scalability: The scalability is base property of web applications.

The LAS employs machine learning algorithms in order to create a knowledge management infrastructure that has as main goal building trust for the obtained advice. The input for the business logic of LAS is represented by learner's activities and by goals. Learner's activities represent the data used for creating learner's model. The goals represent the criteria that need to be optimized in order to obtain quality advice.

Advice obtained by LAS regard the level of fulfilling proposed goals. This is an objective measure of the quality of the evaluation environment. On the other hand, the recommendations represent advice for course managers and learners. The aim of advice is to increase the quality of the e-Learning process. The procedure consists of several steps. Firstly, the platform has to produce enough data regarding the learner's performed activities such that a learner's model of good quality is obtained. At this

step there are also set up goals. Course managers set goals regarding their course and learners set up their own goals. This step is called SETUP and is considered to be the most important one since next steps heavily rely on it.

After the model has been obtained the next step is to obtain advice. The advice is supposed to be strictly followed by course managers. The period in which course managers carry out the recommendations is called EEI (Evaluation Environment Improvement). The activities performed by learners in this period will not be taken into consideration regarding in the learner's model or recommendations by the LAS. After the EEI period ends a new dataset of learner's performed actions is recorded. This dataset is used for rebuilding the learner's model and reevaluation of initially set goals. This step is called EER (Evaluation Environment Reevaluation).

Regarding the advice for learners, the e-Learning platform has implemented means of keeping track of advice that has been given to learners and the way the advice were followed. This is accomplished also in EER step. The LAS provides at this step conclusions regarding the quality of recommendations by evaluating whether or not the learners were helped to reach their goals or not.

This three step process may have as many iterations as needed. Each reevaluation step compares a challenger learner's model with initial model in terms of classification accuracy. The model with best accuracy will be further used for offering advice to learners. The challenger model is based also on newly recorded data from the time old model has been obtained. It is a primary concern to continuously improve the learner's model in terms of classification accuracy. This is the basis for obtaining valuable advice for learners and course managers.

2 Related Work

Several service definitions exist in the literature, e.g., [3][4]. In general, services provide one or more functionalities to consumers. Consumers can be anybody that needs a specific functionality. They could be client applications requesting some external support, or other services as well. The client can be of any system, in or case an e-Learning application.

One important class of example for services are Web services. Web services use the available infrastructure of the Internet as the communication medium. They are built on a wide range of standards or proposed standards for service description and high-level communication protocols. All data formats use the XML [5] encoding. Services are described by WSDL [7] and published with the help of UDDI [6].

The individual service calls use SOAP [8]. For the implementation of distributed workflows BPEL [9] has been proposed as a new standard. With the introduction of a transaction protocol [10] also some work on the reliability of Web service architectures has been done. The strict focus on open Internet standards is an important difference to other approaches of distributed computing like Corba [11], or DCE [12]. Since only the strict interface details are published, Web services are neutral to the programming language, programming model and the underlying operating system.

The business logic of LAS makes intensive use of machine learning talgorithms implemented in a knowledge management infrastructure. From this perspective LAS benefits from knowledge management concepts and technologies.

Knowledge is considered to be “the information needed to make business decisions” [13], and so knowledge management is the “essential ingredient of success” for 95 per cent of CEOs [13].

3 Design and Implementation of LAS

3.1 Creation, Advertising and Discovery

A service is defined by its interface, i.e. the list of methods it provides. For example, the interface and the implementation of an adviser service providing basic functionalities to find and classify a learner. It is important at this level to notice there is no information on how the service is going to be implemented. We will see in the following sections how this abstract LAS is going to be implemented by using for example the Jini library.

The instantiation of the service is done through a call to a meta factory, which first instantiates a service factory for the used implementation, and asks this factory to return a new instance of the service.

Once created, a service can be advertised on a specific domain through the advertizing manager service. The service is advertised with a SLA that defines the access policy that will be used to enforce interaction with the service. The same service can be advertised in different organizations (e.g. other e-Learning platforms) with different SLA’s. This gives a flexible mechanism to control how different organizations may access the service, by allowing advertising the service capabilities as required.

The advertising of a service is done through a XML document that defines the SLA’s of the service for all the virtual organizations where the service is to be made available.

By connecting to a virtual organization, a service consumer can query a service and interact with it once discovered. LAS provides different types of query such as interface matching that allow to listen to all services of a specific interface, or service data matching that allow to query services based on the value of their service data elements. Discovering a service is accomplished in three steps: (1) Instantiate a discovery manager, (2) Instantiate a discovery query - the instantiation mechanism is based on the interface of the service will listen, (3) Register a listener - for every new service matching the query, the *service-Published()* method will be called with the service as a parameter. Similarly, the *service-Unpublished()* method will be called for each service disappearing from the virtual organization.

Any interaction with the service is controlled by an external entity; it first authenticates the service consumer through its certificate and authorizes it against the policy of the service it wishes to access.

Jini network technology [1] is an open architecture that enables developers to build adaptive networks that are scalable, evolvable and flexible as typically required in

dynamic computing environments. The first version of the LAS was directly implemented on top of the Jini API [2].

When using Jini, the following classes are automatically generated for a service named LAS.

– LAS_ServiceJiniNoAbstract.java extends the implementation of the service LAS to provide an implementation for all the basic LAS/Jini mechanisms.

– LAS_ServiceJiniStub.java is the main Jini interface extending the interface java.rmi.Remote. It acts as a proxy for LAS service, and defines exactly the same methods.

– LAS_ServiceJiniStubImpl.java is the implementation of the interface LAS_ServiceJiniStub. It uses a reference to LAS_ServiceJiniNoAbstract to redirect all the method calls on the service.

– LAS_ServiceJini.java implements the interface LAS by using a reference to LAS_ServiceJiniStub to redirect an LAS service's method call as a Jini service's method call.

Step 1: Creation. This step creates an object of the class LAS_ServiceJini and initializes it with the corresponding stub, i.e. an instance of the class LAS_ServiceJiniStub-Impl.

Step 2: Advertising. The object LAS_ServiceJiniStubImpl – hold by the LAS service created in the previous step – extends indirectly the interface java.rmi.Remote, it can therefore be made available in a Jini lookup service.

Step 3: Discovery. The object returned from the Jini lookup service is a LAS_ServiceJiniStubImpl. It is going to be wrapped in an instance of the class LAS_ServiceJini before being returned to the listener. We obtain here a similar object to the one obtained when creating the service.

Step 4: Invocation. Any method call is done on an instance of the class LAS_ServiceJini and is finally redirected on an instance of the class LAS_ServiceImpl.

Figure 2 shows an interaction diagram of these different classes and interfaces.

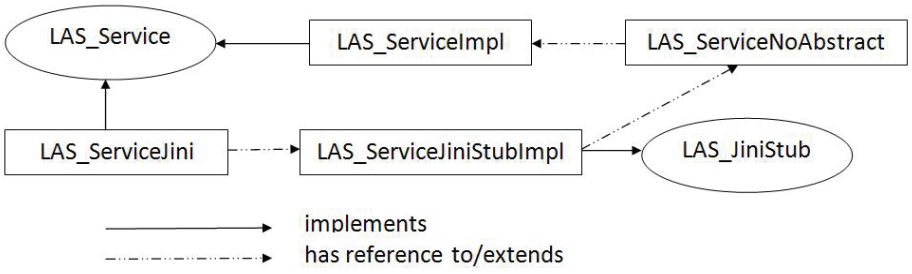

Fig. 2. Jini Implementation of an LAS Service.

3.2 Advantages/Disadvantages

The functionalities provided by the SOA of LAS and the Jini library are basically the same. It was therefore very easy to implement the SOA on top of Jini without tying up LAS to Jini and get an implementation-independent SOA. The Jini implementation is very scalable; experiments of testing the performance of Jini when increasing the number of Jini services, demonstrate a good result in the performance when discovering and accessing the Jini services. The potential problems when using Jini lie in security and in the connection of services across firewalls.

3.3 System Prototype Design

Based on key requirements of e-learning systems, we can prototype the LAS. This service may respond to queries from three types of users: learners, instructors and administrators. Figure 3 presents a LAS, and two e-Learning systems, Uni-1 and Uni-2, which benefit from the same services, implemented in LAS.

Users (learners, professors, administrators) from different universities (e-Learning platforms) can benefit from using the LAS. Each university is required to be registered with LAS and a setup procedure needs to be accomplished. This procedure regards the way in which the universities will provide activity data to LAS. Once this setup in accomplished, the universities will be able to query LAS using the specified interface.

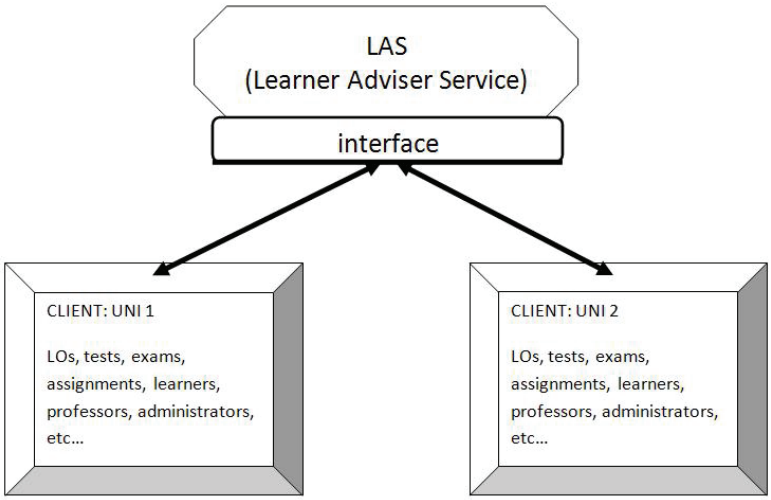

Fig. 3. General architecture design.

From logical point of view, the architecture will have the following layers:

- LAS – Learner Adviser Service itself. This layer is represented by the business logic implementation of the provided services;

- Client Representation level – at this level, within LAS, there are stored the data regarding a registered client (e.g. an e-Learning system). These data regard the locality of client, the format in which data is sent, the credentials of the client.
- LAS interface – this level regards the way in which LAS may be queried by clients;
- Access control layer – Authenticates and authoresses users such that there are determined what resources a user is allowed access. Administration refers to the ability to specify the way LAS and client interact.

The Client level – this level is represented by the e-Learning platform itself.

3.4 Framework Implementation

Figure 4 presents the implementation framework of LAS and an e-Learning system. It focuses on the implementing flows between different layers.

From the container (e.g. an Internet browser), in which the client contents are presented by the forms of HTML, JSP (Java Server Pages) or XML, the user (learner, professor, administrator) can submit their query through HTTP requests to the Servlet Container and receives HTTP responses. The query goes through the Database Connection Layer (e.g. JDBC (Java Data Base Connection) API) to get information from the database.

Regarding LAS, the request goes from Servlet container to the Service agent which parses the request streams and transmits the data to LAS. Once request is fulfilled the same Servlet container will get back the response.

The procedure may be enhanced by doing a look up in a UDDI registry, the Web Service Agent Layer can search and locate the LAS. The location of WSDL binding information will be sent back as a SOAP message. The binding information of our own sharable learning services is also published here. After the service Agent Layer gets the binding information, it can directly invoke the learning service by passing the essential data indicated by the WSDL file in a SOAP message over the Internet or Intranet. And the learning service could be J2EEbased or other platform-based residing on any platform.

Access control is the process to identify client applications (e.g. e-Learning platforms) that need to access LAS. Once a client has been authenticated, authorization determines what resources a client is allowed to access. Administration refers to the ability to modify the way in which the client interact with LAS.

Service Requestor is a component that needs to be integrated within the e-Learning application that wants to receive a service from LAS. It does not know where this other application is or how to locate it, so it turns to the Service Registry and requests a find operation. The Service Provider publishes this service as a Service Proxy in the Service Registry. Service Proxy is a java proxy that helps the system to communicate with web service.

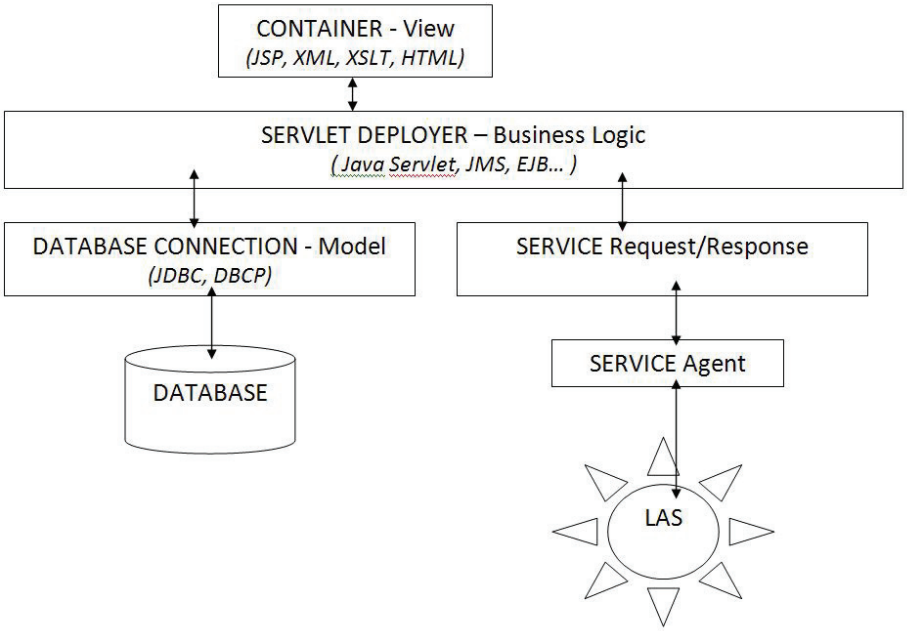

Fig. 4. Implementation framework of LAS and e-Learning system.

3.5 Business Logic of LAS

The whole process is conducted following the steps of target modeling presented in figure 5 [14].

Defining the goal represents the first step. Our goal is to create a model of analysis for Tesys e-Learning platform that is to be used for optimizing the criteria specified by learners and course manager goals. Setting up the goals is accomplished by formally defining the criteria that is to be evaluated and optimized. Selection and preparation of data are the next steps. Here, we have to determine the necessary data that will enter the modeling process. The preparation gets that data and puts it into a form ready for processing of the model. Since the processing is done using machine-learning algorithms implemented in Weka workbench [15], the output of preparation step is in the form of an *arff* file. Under these circumstances, we have developed an offline Java application that queries the platform's database and crates the input data file called *activity.arff*. This process is automated and is driven by a property file in which there is specified what data will lay in *activity.arff* file.

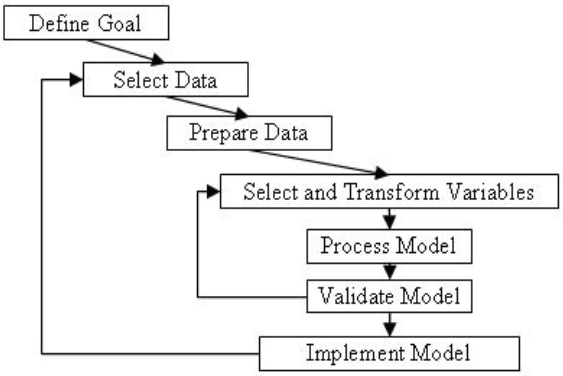

Fig. 5. Steps for target modeling.

For a learner in our platform we may have a very large number of attributes. Still, in our procedure we used only attributes related to testing procedures: the number of taken tests, average time spent on tests and average results obtained. Here is how the *arff* file looks like:

```
@relation activity
@attribute noOfTests {1, 2, 3, 4, 5}
@attribute avgTimeForTesing {1, 2, 3, 4, 5}
@attribute avgResultsOnTests {1, 2, 3, 4, 5}
@attribute avgFinalResults {1, 2, 3, 4, 5}

@data
3,3,4,5
4,4,5,4
……
```

As it can be seen from the definition of the attributes each of them has a set of nominal values from which only one may be assigned. The values of the attributes are computed for each of the 650 learners and are set in the *@data* section of the file. For example, the first line says that the learner took an average number of tests, spent an average amount of time for testing, and obtained good results at testing and very good results at final examinations.

Now, since we have prepared the data we start analyzing it. Choosing between two learning algorithms given a single dataset is not a trivial task [16]. Firstly, we make sure the data is relevant. We test the "goodness" of data trying to build a decision tree like C4.5 [17] from data. A decision tree is a flow-like-chart tree structure where each internal node denotes a test on an attribute, each branch represents an outcome of the test and leaf nodes represent classes [18].

The basic algorithm for decision tree induction is a greedy algorithm that constructs the decision tree in a top-down recursive divide-and-conquer manner [18].

The computational cost of building the tree is O(mn log n) [15]. It is assumed that for n instances the depth of the tree is in order of log n, which means the tree is not degenerated into few long branches.

The information gain measure is used to select the test attribute at each node in the tree. We refer to such a measure an attribute selection measure or a measure of goodness of split. The algorithm computes the information gain of each attribute. The attribute with the highest information gain is chosen as the test attribute for the given set [18].

Consequently the data must be preprocessed to select a subset of attributes to use in learning. Learning schemes themselves try to select attributes appropriately and ignore irrelevant and redundant ones, but in practice their performance can frequently be improved by preselection. For example, experiments show that adding useless attributes causes the performance of learning schemes such as decision trees and rules, linear regression, instance-based learners, and clustering methods to deteriorate [18].

In the tree building stage, the most important step is the selection of the test attribute. Information gain measure is used to select the test attribute at each node in the tree. Such a measure is referred to as an attribute selection measure or a measure of the goodness of split. The attribute with the highest information gain (or greatest entropy reduction) is chosen as test attribute for the current node. This attribute minimizes the information need to classify the samples in the resulting partitions and reflects the least randomness or "impurity" in these partitions.

Finally, the cross-validation evaluation technique measures the correctly and incorrectly classified instances. We consider that if there are more than 80% of instances correctly classified than we have enough good data. The obtained model is further used for analyzing learner's goals and obtain recommendations. The aim of the LAS is to "guide" the learner on the correct path in the decision tree such that he reaches the desired class.

The main characteristic of the LAS is that it uses a machine learning algorithm for obtaining knowledge regarding learners. The e-Learning environment produces data regarding the activity of learners and passes this data to LAS. The LAS creates and maintains a learner's model based on data received from the e-Assessment tool. This architecture allows the usage of LAS along with any e-Learning platform as long as the data is in the accepted format.

The raw data is dumped by e-Learning platform in a log file *activity.log*. The log file, together with database relations represent the raw data available for the analysis process. Because we use Weka [19] the data is extracted and translated into a standard format called ARFF, for Attribute Relation File Format [20, 21]. This involves taking the physical log file and database relations and processing them through a series of steps to generate an ARFF dataset.

At this phase the most important decision regards the features selection for instances. There may be derived a large number of features that describe the activity of a student. Choosing the attributes is highly dependent on data that we have domain knowledge and experience. For our classification we choose three attributes: noOfTests– the number of taken tests, avgTimeForTesing – the average time spent for testing, vgResultsOnTests – average results obtained at testing and avgFinalResults-average of final results. For each registered student the values of these attributes are determined based on the raw data from the log files and database relations. Each student is referred to as an instance within classification process.

The values of attributes are computed for each instance through a custom developed off-line Java application. The outcome of running the application is in the

form of a file called activity.arff that will later be used as source file for Weka workbench [19].

The activity.arff file has a standard format which is composed of two sections. In the first one there is defined the name of the relation and the attributes. For each attribute there is defined the set of nominal values it may have.

At this point we may say we have obtained useful data that may be used for experimentation with machine learning schemes. The original dataset was divided into a training of 90% of instances and a test set of 10 % of instances. The model was constructed using four attributes: nLogings, nTests, avgTest and nSentMessages. The obtained decision tree represents the learner's model. This model is used as reference when analyzing learner's activity.

More detailed results regarding the obtained model are presented below.

```
=== Run information ===
Scheme:       weka.classifiers.trees.J48 -C 0.25 -M 2
Relation:     activity
Instances:    375
Attributes:           3:  noOfTests,  avgResultsOnTests,  avgTimeForTesing,
avgFinalResults
Test mode:    10-fold cross-validation
=== Classifier model (full training set) ===
J48 pruned tree
------------------
noOfTests = 1: (25/2)
noOfTests= 2
|  avgResultsOnTests = 1 (20/1)
|  avgResultsOnTests = 2
|  |  avgTimeForTesing= 1
|  |  | avgFinalResults = 1 (10/3)
|  |  | avgFinalResults = 2 (27/10)
|  |  | avgFinalResults = 3 (7/2)
|  |  | avgFinalResults = 4 (5/1)
|  |  avgTimeForTesing= 2
|  |  |  avgFinalResults = 1 (20/6)
|  |  |  avgFinalResults = 2 (13/4)
|  |  avgTimeForTesing= 3 (7/1)
|  |  avgTimeForTesing= 4 (5/0)
|  avgResultsOnTests = 3 (113/6)
noOfTests = 3
|  avgResultsOnTests = 4 (11/3)
|  avgResultsOnTests = 5
|  |  avgTimeForTesing= 3 (17/4)
|  |  avgTimeForTesing= 4 (29/3)
|  |  avgTimeForTesing= 5 (35/4)
noOfTests = 4 (21/2)
noOfTests = 5 (12/2)
Number of Leaves  :     17
Size of the tree :          25
```

Time taken to build model: 0.13 seconds
=== Stratified cross-validation ===
=== Summary ===
Correctly Classified Instances 302 80.6 %
Incorrectly Classified Instances 73 19.4 %

The most important part is the results validation, which ensures that the model is valid and provides solid knowledge. The stratified cross-validation evaluation technique revealed that 302 (80.6 %) instances were correctly classified and 73 (19.4%) were incorrectly classified.

Whenever a learner performs specific actions he is classified by the decision tree and conclusions are obtained. These conclusions may be regarded by recommendations for learners having as final goal helping them in reaching educational objectives. This continuous monitoring and classification may have a big contribution to building a quality e-Learning environment.

Within the e-Learning environment there is specified a set of goals for learners and course managers. For learners the set of goals from which they may choose is:

- Minimization of the time in which a certain level of knowledge is reached. This is accomplished by specifying a desired grade.
- Obtaining for sure a certain grade. The learner has to specify the grade he aims for.

Course managers may choose from two goals:

- Having a normal distribution of grades at chapter level.
- Having a testing environment that ensures a minimum time in which learner reaches a knowledge level for passing the exam.

For these goals there were created two sets of recommendations. Learners may obtain one of the following recommendations:

- More study is necessary for chapter X.
- You may go to the next chapter.
- You need to take more tests at chapter X.

For course managers the set of recommendations is:

- At chapter X there are needed harder/easier questions.
- At chapter X there are to few/many questions.

For obtaining recommendations for course managers we have used the obtained model. Running the Decision Tree algorithm created 17 classes. For these classes, we compute the likelihood of a set of test data given the model. Weka measures goodness-of-fit by the logarithm of the likelihood, or log-likelihood: and the larger this quantity, the better the model fits the data. Instead of using a single test set, it is also possible to compute a cross validation estimate of the log-likelihood. For our instances, the value of the log-likelihood is -2.61092, which represents a promising result in the sense that instances (in our case learners) may be classified in four disjoint clusters based on their activity.

After the model has been created the recommendations towards course managers were made and the evaluation environment was altered accordingly. The recommendations and the behavior of learners (whether or not they followed recommendations) were logged for further analysis.

The behavior of learners has a very important role in obtaining challenger learner's models that at some point may replace the current one.

On the other hand, checking whether or not the learners followed the recommendations may lead to conclusions regarding the quality of recommendations and of currently employed learner's model.

4 Conclusions

The paper presents the design of a Service-Oriented Architecture for a LAS service that may be integrated with an e-Learning platform.

LAS have been designed as a complex Web service that may be used by e-learning systems. LAS web service, as a service provider, provides the response to the client' request.

The main purpose of LAS is to create a learner's model corresponding to a registered e-Learning platform. Once the model has been created, LAS may receive queries from the e-Learning platform regarding the actions that need to be performed by learners in order increase the trust into the effectiveness.

The software architecture of LAS uses only Java related technologies. That is why the system has an open architecture and uses open application interfaces to enable interaction and integration seamlessly between educational institutions and LAS. The architecture is able to take advantage of the open, dynamic nature of the web by supporting just -in-time application integration.

Our LAS produces advice for learners and course managers using different machine learning techniques on the activity data obtained from the platform. We use Weka workbench [19] as environment for running state-of-the-art machine learning algorithms and data preprocessing tools. We have developed a custom application that gets the activity data from the platform and transforms it into the specific file format used by Weka, called arff.

A decision tree learner is used for estimating whether or not the data may be used to obtain significant results. The outcome of decision tree validation is the percentage of correctly classified instances. We say that a value of over 80% in correct classified instances is a promise that we might finally obtain useful knowledge.

Clustering may also be used for estimating the classification capability evaluation environment. This is mainly be performed to obtain better recommendations for course managers.

We have tested this procedure on data obtained from the e-Learning platform on which 375 learners were enrolled and had activity for six month. The results are satisfactory and prove that the evaluation environment can be successfully used in an e-Learning process.

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Determining the Railway Track Condition using the INS / GPS System

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Abstract. The paper discusses the development of the "test vehicle" system for preliminary test of the railroad. The test is accomplished on the basis of the own developed systems for data storage based on the GPS receiver and inertial sensors. All data are stored in the external energy independent memory (FLASH) while the navigation data are sent to the navigation server via GPRS network. The quality of the railway is determined according to the three axis acceleration analysis while the GPS receiver defines the event position. The experimental data are recorded on the selected part of the railroad and furthermore are analyzed.

Keywords: Railway faults, GPS receiver, Accelerometer.

1 Introduction

Nowadays the railway geometry is measured by the high speed wagon measurement tools like EM120 or EM250 [1]. These tools control the railway condition and parameters, which are compared with the regulation technical data. The control is performed according to the preliminary elaborated schedule while the time period between two consecutive tests is defined as one year or higher. During this period it is possible to emerge a digression at the railway geometry, which is a potential source of an accident. This is the reason to develop a system, which may register the railway places with increased risk to avoid the accidents during the exploitation time. This system does not require any additional high – qualified personal or railway equipment.

The "test vehicle" system is developed at [2]. The dangerous railway places are recognized according to the effective values of the vehicle accelerations. Another method is discussed at [3], where the proposed method for defect recognition is based on wavelet transformations of the acceleration signals. This method requires a perfect suspension state to guarantee the correct results. Another method for determination of the railway deflection in the longitudinal direction is proposed at [4], which is based on the acceleration of the vehicle terminal junction. Such type of test systems are also proposed at [5] and [6] but their high cost limited their application in the railway systems.

2 "Test Vehicle" System Description

The "test vehicle" system is realized with the measuring system, described at our previous work [7] (Fig.1), which is installed on a locomotive traveled regularly on the selected route. The measuring system is mounted on the locomotive reduction gear to ensure the system will measure only accelerations originated from the rails.

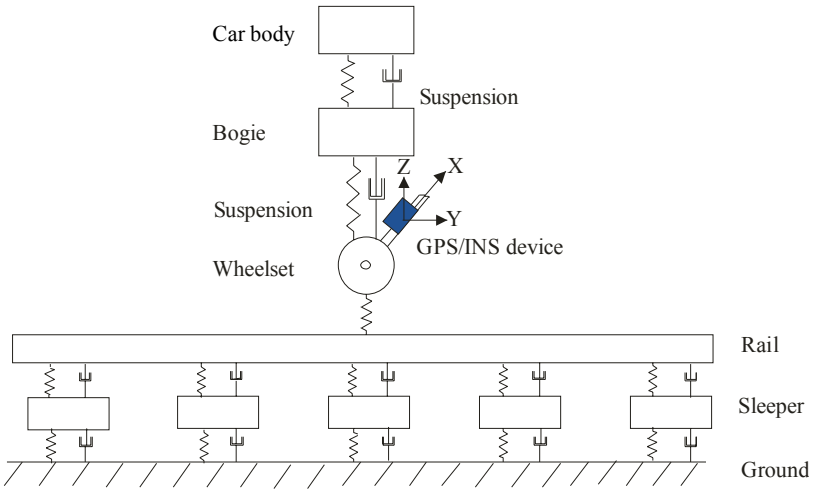

Fig. 1. Measuring system details.

The dynamics of the railway – locomotive interaction in the vertical direction may be explained with the mathematical model shown at Fig.1. The frequency distribution of the acceleration data vary from one axis to another. The maximum frequency of the vertical and lateral fluctuations is limited from 0.5 to 1Hz. In the same time the railway faults generate vibrations with a maximum frequency up to 2000Hz.

The force/translation (F/y) relation is described according to the equation:

$$F = c_h . y^{\frac{3}{2}} \qquad (1)$$

The connection between the wheel and the railroad is very tight, so the wheel translation repeats the railway faults. If the railway quality is very good, the system vibrations are provoked by the non – parallel rail position or rail defects.

The proposed system measures the accelerations of all three axes. The acceleration data are recorded with the GPS navigation data as a data block per 1 second. One data block contains 40 inertial data and 1 GPS message, so the time distance between the inertial samples are defined as 0.025s. The traveled distance for each data block is defined as follows:

$$\Delta\lambda_{мин} \geq 2.\Delta t.v \qquad (2)$$

where $\Delta\lambda_{мин}$ - traveled distance, Δt – time interval and v - vehicle speed. If the maximum speed is limited to 60km/h, the traveled distance is equal to $\Delta\lambda_{мин}$ = 0.833m.

The normative standards define the lateral acceleration maximum value. For Bulgarian railway this value is set to 0.85m/s^2. The maximum longitudinal acceleration varies according to the vehicle speed, but its maximum value is set to 0.6m/s^2. Esveld [8] defines the safety maximum accelerations of the French railway company SNCF. These values are summarized at Table 1.

Table 1.

Transverse cart acceleration	6 m/s^2	Vehicle speed V<350 km/h
Transverse crate acceleration	2.5 m/s^2	
Vertical crate acceleration	3 m/s^2	

These values may be used as recommended maximum values for inertial data analysis.

3 Experimentation Results

The experiment is implemented for ten days while the test vehicle is driven on the same route. The navigation and inertial data are recorded on MMC/SD memory card and are simultaneously transmitted to the map server via GPRS network. Furthermore the data are analyzed using MATLAB software tools.

The developed software tool allows to select the desired maximum acceleration limit and to find the places where the previously defined limit is overcome. This choice is made through GUI (Graphic User Interface) menu (Fig.2).

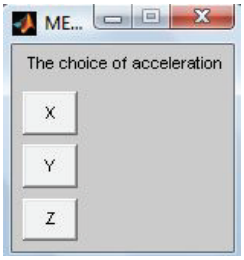

Fig. 2. Graphic User Interface menu.

The MATLAB tool also allows to select one or more days using alternative menu (Fig.3).

Fig. 3. Alternative menu.

The basic criterion of the railway faults is based on the number of acceleration values which overcome the selected maximum value. The analyzed railway length is set to 80m. The distribution of the number of points where the acceleration exceeds the limit is shown at Fig.4 (analyzed acceleration – X axis, maximum acceleration - 0.4m/s^2).

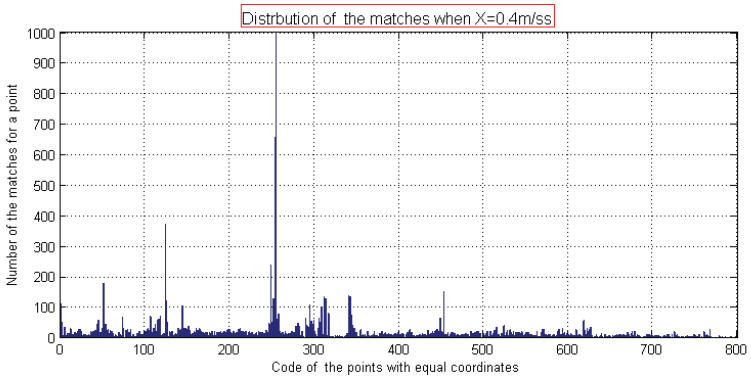

Fig. 4.

Figure 5 also represents the number of points with exceeded acceleration on 3D map. At this figure the latitude and longitude regions are divided to 100 bars to create 3D map.

When the points of interest are determined the tool may print that points which acceleration exceeds a given number. Figure 6 represents such distribution when the number of points of interest for some region exceeds the limit of 110 coincidences.

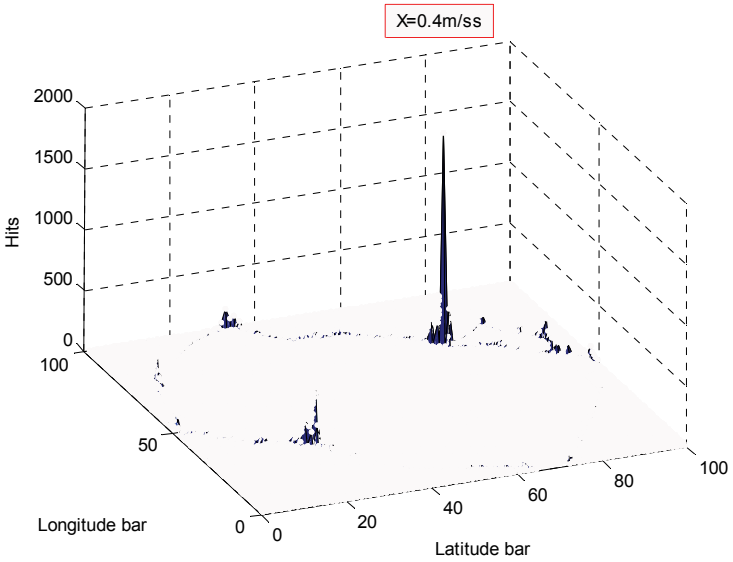

Fig. 5.

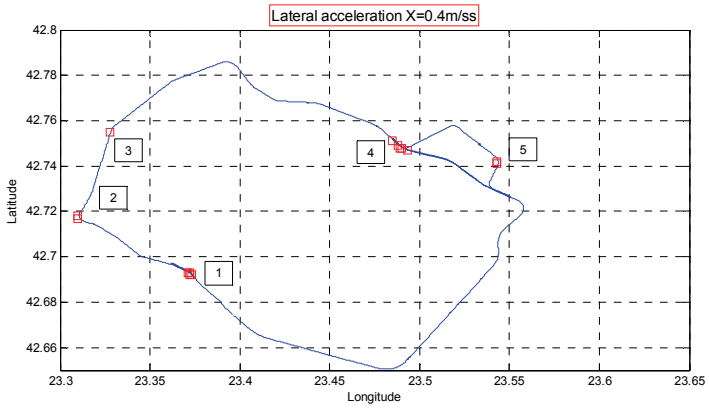

Fig. 6.

The Z axis is also analyzed to specify the railroad condition. The limitation value is set to 4m/s^2 and the obtained distribution of Z accelerations which exceed the selected limit is shown at Figure 7.

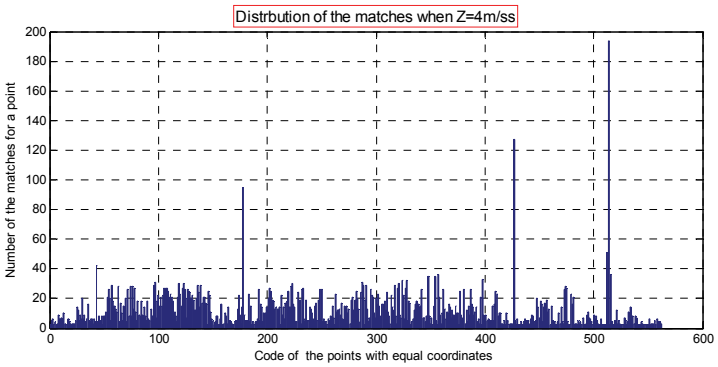

Fig. 7.

The same distribution with shown latitude and longitude bars in 3D graphic is shown at Figure 8. At this figure the longitude and latitude regions are also divided to 100 bars.

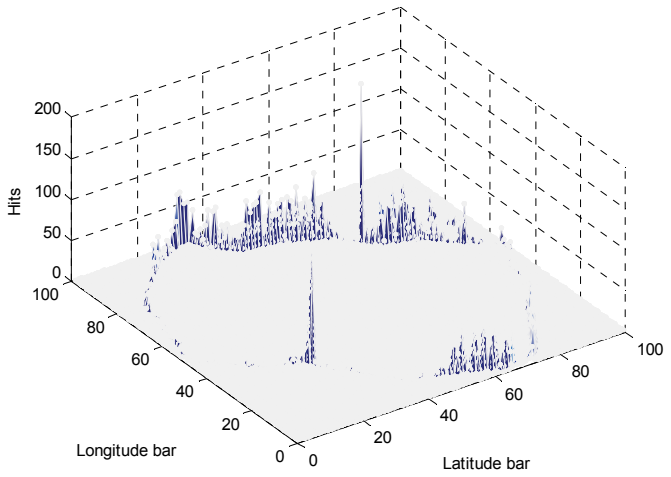

Fig. 8.

The limit number of matched points is set to 45 and the number of points of interest are estimated from Figure 7 and their position are shown at Figure 9.

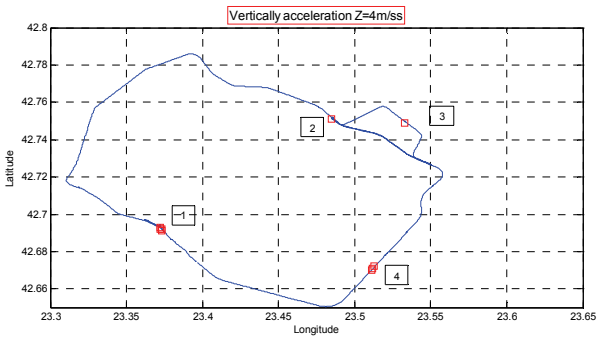

Fig. 9.

4 Conclusions

The proposed "test vehicle" system may be used for preliminary test of the railroad state to increase the safety level of the railways. As the system is permanently installed on the locomotive, it constantly gives the actual information and may warning for railway problems in a real time via GPRS network. When such condition is found, the railway company may use standard measurement tools to establish the real railroad state to increase the safety level.

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Multimedia Database Server Implementing Content based Retrieval

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Abstract. The article presents a software tool implemented in C++ that implements a multimedia database server. An element of originality is that along with the classical functions of a server it has a specialized module for content based retrieval. The users can execute both simple text based queries and complex visual queries, based on a query image. The server processes the images and extracts the color and texture characteristics and stores them in a new data type called IMAGE. The image color information is represented by means of color histograms resulting from the transformation of the RGB color space to HSV color space and the quantization to 166 colors. In order to represent the texture it is considered the co-occurrence matrices .To compute the dissimilitude between the images, the histogram intersection has been used for the color and the Euclidian distance for the texture. It is also presented the client-server communication based on SQL language.

Keywords: Multimedia database server, Content based retrieval, Image data type.

1 Introduction

The success of the digital revolution and the growth of the Internet have ensured that huge volumes of high-dimensional multimedia data are available all around us. The medical system represents an important area were large amount of digital information are produced every day due to medical devices (echograph, endoscope, MRI). As the quantity of medical images is increasing, the problem of storing medical image collections in digital format along with the associated information (patient name, diagnosis, consulting date and treatment), managing the database and executing efficient queries, are aspects that are intensely studied for finding new and more efficient solutions. This information is often mixed, involving different data types such as text, image, audio, graphics, and video components interspersed with each other.

In order to manage content based retrieval for medical image collections a series of applications that use traditional DBMS, have been implemented. Most of them use servers like MS SQL Server, My SQL or PostgreSQL. The complete solution is provided by Oracle - the Oracle 10g database server and Intermedia tool that can

manage all kind of multimedia data. This kind of solution involves high costs for buying the database server and for designing and implementing complex applications for content based query [6].

This paper presents an application implemented in C++ that includes a Multimedia Database Management Server (MMDBMS) based on the SQL3 standard that is less expensive than a commercial database server. This server is designed to manage medium sized image collections.

This MMDBMS has the following elements of originality and advantages:

- images are stored directly in the database in a new data type called image
- a specialized module is used to process images and extract visual characteristics from images
- possibility to execute visual content based queries
- possibility to add on the client side a visual interface for content-based image query using color and texture characteristics, in order to visually select the query image.

The paper has the following structure: section 2 presents the server description, section 3 presents the content based retrieval functionality, section 4 presents the client server Image data type, and section 5 presents the conclusions and future work.

2 Server Description

The MMDBMS allows database creation, table and constraints adding (primary key, foreign keys), inserting images and alphanumerical information, simple text based query and content-based query using color and texture characteristics. The software tool is easy to be used because it respects the SQL standard. It does not need advanced informatics knowledge and has the advantage of low cost. It is a good alternative for a classical database management system (MS Access, MS SQL Server, Oracle10g Server and Intermedia), which would need higher costs for database server and for designing applications for content-based retrieval.

It is designed in a modular way, where each module executes a certain function. There is a module specialized to client communication, database management, executing text based queries, executing content based retrieval and collecting the responses to queries.

A simplified schema of the server is presented in the next figure.

In the first step, the client applications connect to the server using TCP sockets. This way it will be created a communication channel between them. All commands and responses will use this channel to send queries requests and receive answers.

The communication module manages all these messages. It waits to receive commands from users (queries, updates, system commands, etc.) and pass them to a main module which manages them all. After the command is executed, the response will be returned by the Query Response Module to the Communication Module in order to be sent to the client. The Query Response Module will compact the result using a standard format and then return it to the client. The client will receive it on the same communication channel used to send the request.

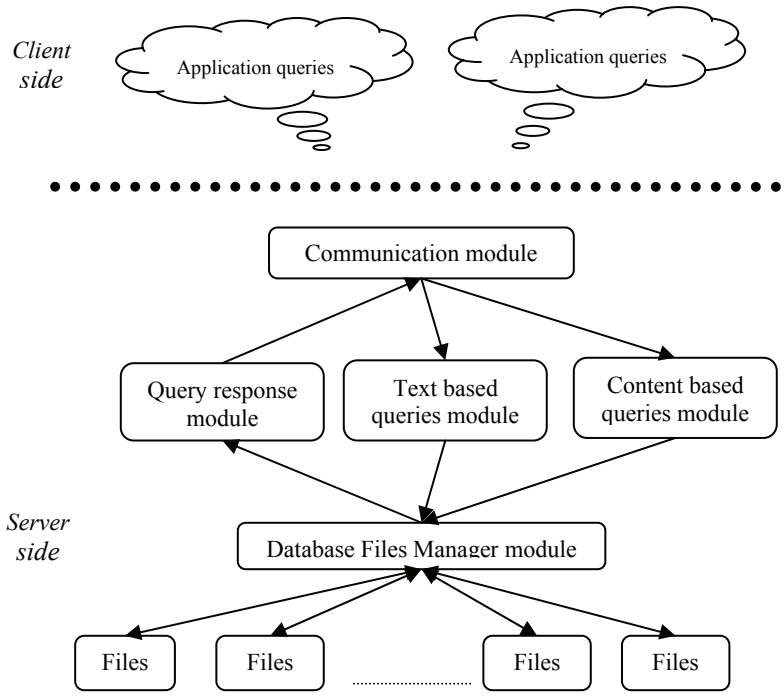

Fig. 1. Multimedia Database Server design.

There can be two kinds of queries:

- Classical text based queries
- Visual content based queries

When the command is received, it is checked what type of query is, it is extracted the parameters of the query and then calls the specific module to execute it. Each of them is computed by a different module: if the command refers to a text based query, it will be computed by the Text Based Queries Module. If it is a content based retrieval query it will be sent for computation to the specialized Content Based Retrieval Module.

This module extracts the parameters from the query and then search in the database files for specific information. If the query is a SELECT IMAGE query, it will use for comparison the similitude of characteristics instead equality of parameters. The parameters used by this module are color histogram and texture characteristics. When the image used as a query image is not already in the database it is needed first to be processed. Before executing the query there are called the functions specialized to extract the color and texture characteristics of the image. The obtained data will be used to initialize an attribute of a special data type called IMAGE.

This type can be used to store all the information regarding the image: color characteristics, texture characteristics, width, height, etc.

Other specialized functions included in this module are:

- Delete Function. It is called when the user executes a DELETE command. The kernel executes only logic deletes. It never executes physical deletes. The physical deletes are executed only when a "Compact Database" command is sent by the user.
- Update functions. If the query received from the user is an UPDATE command, it will be called the Update functions to execute it.

Another important module is the Database Files Manager Module. It is the only module that has access for reads and writes to the files in the database. It is his job to search for information in the files, to read and write into files and to manage locks over databases. It receives read/write requests from the Text Based Query and Content Based Retrieval modules and sends responses to the Query Response module.

When a request to read form a file arrives, it is enabled a read lock to the specific file (that represents a table in the database). All other read requests will be permitted but no writes will be allowed. If the client module request a write to file, it will be enabled a write lock. No other requests will be allowed until the lock is canceled.

The files data read and write operations are not structured in any way. This module does not modify the structure of the result in any way. All the results will be raw data, as they are read from the files or received from client modules. The results will be structured in the Query Response module in a standard manner that can be understood by the client. Only after this operation is finished, the result is sent to the Communication Module to be returned to the client.

3 Content based Retrieval and Image Data Type

An element of originality of this server is the existence of an image processing module and a special data type called Image.

The image processing module will process the images before being used, extracting the color and texture characteristics. The results along with the image in binary will be stored in an attribute of Image data type.

The color is the visual feature immediately perceived on an image [1,2]. In content-based visual query on color feature is important the used color space and the level of quantization, meaning the maximum number of colors. This implementation uses the representation of images in the HSV color space that has the properties of being complete, compact, natural and uniform and its quantization to 166 colors [1].

The color histograms represent the traditional method of describing the color properties of the images. They have the advantages of easy computation and up to certain point are insensitive to camera rotating, zooming, and changes in image resolution. The quantization algorithm generates a characteristics vector of maximum 166 values and has the complexity O(width*height) where width and height represent the image dimensions. For computing the distance between the color histograms of the query image and the target image, the intersection of the histograms is used [1].

Together with color, texture is a powerful characteristic of an image, present in nature and medical images, where a disease can be indicated by changes in the color and texture of a tissue. A series of methods have been studied to extract texture

feature [3,2]. Among the most representatives methods of texture detection are the co-occurrence matrices, a method that have been also implemented in this server.

In this case, one matrix was computed for each of the three channels R, G, B. For an image f(x, y), the co-occurrence matrix $h_{d\phi}$ (i, j) is defined so that each entry (i, j) is equal to the number of times for that $f(x_1,y_1) = i$ and $f(x_2,y_2) = j$, where $(x_2,y_2) = (x_1,y_1) + (d\cos\phi, d\sin\phi)$. This leads to three quadratic matrices of dimension equal to the number of the color levels presented in an image for each distance d and orientation ϕ. The classification of texture is based on the characteristics extracted from the co-occurrence matrix: energy, entropy, maximum probability, contrast, inverse difference moment and correlation. The three vectors of texture characteristics extracted from the three occurrence matrices are created using the 6 characteristics computed for d=1 and ϕ=0. The texture representation in this case is done using a characteristics vector with 18 values stored in the database.

The results of these computations are stored in a variable of Image Data type. The color information is stored as a vector with 166 values and it is used furthermore in the content-based image query and content-based region query.

After the algorithm's execution, the resulted image texture feature will be an 18-dimension vector that is also added to the IMAGE variable.

The results of the content-based visual query process, using the color histograms with 166 values in HSV color space and Gabor Filters were presented in [4,5].

4 Client-Server Working Example

The first step is to create a connection with the server using TCP sockets communication. Once a channel has been open, all commands will be sent using this connection. Now, the server has accepted the client but cannot accept any command from it, yet. Before that, the client should be authenticated using a username and a password.

The command that should be sent first is an array with the text:

```
login username="username" password="password"
```

After receiving this message the server respond either with an acknowledge message, either with a reject message. In case of a reject message, the user has the possibility to try again two more times. If it doesn't get an acknowledge message after these tries, it will be banned for an hour. During this time, even if the client sends a connection message containing a valid username and password it will be rejected.

Once the client has been recognized by the server it will received a unique identification number that will be de-allocated only when the client closes the connection or send a logout message.

There are 2 kinds of commands that it can send: system commands and query commands.

The system commands refer to create new users, set/change users rights or get tables structure (attributes and the associated data types).

Among the most useful query commands used it can be enumerated:

- Create table. The available data types are: int, double, varchar and image. The command returns “ok” if it was successfully executed, or “fail” in case the table could not be created (eg: table already exists)
  `create table <table_name> (first_attribute type1, second_ attribute type2,…)`
- Adding constraints (primary keys, foreign keys). The command returns “ok” if it was successfully executed, or “fail” in case of an error.
  `alter table <table_name> add primary key (<column_ name>)`
  `alter table <table_name> add foreign key (<column_ name>)references <refered_table> ( <refered_column_name >)`
- Inset data into tables. The command returns “ok” if it was successfully executed or “fail” in case the table does not exist, one of the attributes has a wrong data type or a constraint didn’t allow the insertion.
  `insert into table <nume_tabel>values(val1,val2, val3,…)`

An element of originality is the possibility to add images directly in the database. If one of the columns has the image type, the insertion in the database it is a little more complicated because the client has to send the image and the server has to process it. After sending this command the server expects to receive from the client a “send image” command, followed by the image itself. Then the server calls the image processing functions to extract the image’s characteristics: color and texture.

The extracted values along with the image name, size and image in binary are stored in an attribute of a special type, called image. On the disk, the server stores all the information about image in the table data file. The image is stored in a separate file used only for images. In the table data file will be stored only a pointer with the position of the image in the images file.

- Delete records. It returns true if succeeded or “fail” if not. The server executes only logical deletes. That means if the server executes multiple insert/delete operations the size of the database will increase continuously. The server offers a solution for this problem by compacting the database. This operation needs a significant amount of time. That is why it should be executed offline, only when the server is less used.
  `Delete from <table_name> where <column_name>=<value>`
- Select records. It returns a recordset containing the records that are according to the condition specified in the where clause, or an empty pointer if there are no records that fulfill the condition.
  `Select * from <table_name> where <column_name>=<value>`
- Select images from database. In case that the where clause refer to an image attribute, the server will execute a content based retrieval. In this case we cannot discuss about equality between images, but similarities. The server will compare all the images in the table that has characteristics appropriate with the characteristics of the query image.
  `Select image from <table_name>.<column_name> where like <query_image>`

5 Conclusions

The paper presented a multimedia database management server used to manage medium sized multimedia databases. An element of originality is the possibility to store images directly in the database in a special data type called image. It stores information about image name, color characteristics, texture characteristics, image size and image name.

The software tool allows creating and deleting databases, creating and deleting tables in databases, updating data in tables and querying.

The client has the possibility to execute both simple text based queries and visual content based retrieval queries. In the second case the user selects one image from the database as a query image and the server returns all the images similar with it.

The color characteristics are represented by extracting color histogram from images. The texture characteristics are computed using co-occurrence matrices. Using these characteristics, the similitude between images is computed using the histogram intersection and the Euclidian distance. The complexity of both distances are equally O(m*n) where m is the number of values in the characteristics vector, and n is the number of images in the database.

This software can be extended in the following directions:

- Adding new types of traditional and multimedia data types
- Studying and implementing indexing algorithms for data inserted in the tables
- Also, a parallel computation of the two distances can be proposed in order to make the execution time for a query shorter.

Acknowledgements

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Virtual Learning Communities in the University Teaching of Physical Education

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Abstract. The appearance of the new technologies of the information has opened new expectations in the field of the higher education, which changes the student's relationship with the time, the space and the professor. A review of the recent literature reveals the different aspects that characterize a virtual community of learning but do not expose with clarity what factors are the determiners for the success in the top education. Tinto (1997) suggests that the relationship in the online classroom is significant for students and it is critical to learners' sense of scholarly belonging. Goodfellow (2003) says that, at least, five characteristics of online interaction have been identified in the literature as contributing to develop virtual communities. Through a review of recent literature it is proposed that teaching presence–viewed as the core roles of the online instructor is a promising mechanism for developing learning community in online environments. The purpose of the investigation has been to identify the key aspects to develop communities of learning based on the use of the technologies of the information and the communication (ICT) on physical education in higher education. After analyzing quantitatively and qualitatively the information, the results have allowed us to conclude that so that a community of learning based on the ICT can work of effective form, it is necessary to plan the educational process considering three aspects fundamental: its awaited organization, her interaction and results.

Keywords: Virtual learning communites, Physical education, Health.

1 Introduction

Nowadays the European and Spanish university are in a process of renewal that has a really sure future: by the year 2010 the European University will have to be adapted to the guidelines of the called European Space of Superior Teaching (ESST).

In the framework of the statement of Bologna and its development (http://dfes.gov.uk/bologna) the creation of an European system of transfers of credit (ECTS), the better quality of the teaching, the promotion of those aspects that promote the contribution among institutions and the integration of formation and research, are some of the important facts to get to the European Space.

We have the opinion that the uses of ICT are going to be, if it they are not already, one of the pillars in which to support this space of common formation. In fact, the

European Union was pointing out in 2000 that “every inhabitant has to have a <<digital culture>> and the basic aptitude to have bigger equality opportunities in a world that the digital communication is getting bigger and having more important”.

As a consequence of the <<digital culture>>, in the new model of the superior teaching that became as a consequence of this process we will have to develop strategies, mechanisms and resources so that the integration of said technologies in the college education been efficient and make a better teaching of quality.

So, the teachers will have to stimulate on the students a more active role, making new technologies oriented to get the participation of the students in the whole process of teaching learning.

This integration is going to carry us toward a conception of the university teaching in the following aiming years to the concepts “blended learning” and “virtual learning” because, progressively, in the university they live together the eyewitness model and the not eyewitness formation, and both are supported of growing form in the utilization of the technology. This combination has some demands and contributes some benefits to the educational process and to its protagonists.

The Physical Education (PE), as a scientific subject, it is being characterizes by a big capacity of evolution and innovation, even thought there was a diversity of the discipline that conform it. Nevertheless, since now the incorporation of the ICT to the university formation in PE is being resulting well scarcer. That is why we believe that it is necessary to analyze how we can work better to the ICT the processes of teaching learning of the university students in the subjects that we talk about above. This can carry us to devise extendible proposals to other areas of knowledge.

The shift to a new generation of learning involving collaborative group work as the main pedagogical method is emerging. There is a particular emphasis on community building in networked e-learning environments (Paloff & Pratt, 1999; McConnell, 2000; Rogers, 2000; Brown, 2001; Renninger, 2002).

Higher education are moving towards a pedagogical transition in which the collabortive work and the social learning are into the core. The term learning communities relate to the process of learning and the socialisation that serves to facilitate learning.

The associated pedagogical benefits emerging from the introduction of communities in higher education have been well documented. Learning communities have been linked with the achievement of learning outcomes (Gibbs, Angelides, & Michaelides, 2004) or with the promotion of critical thinking skills (Fink, 2003).

The five characteristics of online interaction that Goodfellow (2003) has identified in the literature as contributing to develop of virtual communities are: 'sense' of community, social networking, shared discourse, processes of social control, and trajectories of membership.

It is evident that the work in community or collaborative work contributes benefits in the learning process. Thus, to define a successful learning process based on a virtual community we will need to know the key factors.

Successful communities such as those described by Gongla and Rizzuto (2001) can be seen as embodying the three key characteristics: using good technology that can be accessed from a variety of locations, using a range of devices; the knowledge they produce, because it is subject to the scrutiny of so many experts and they are also decentralised because of the absence of managerial control.

2 The Work Context

We are in a context of eyewitness teaching there are degree students of two scientific areas: nursing and physical education.

With the students of nursing we worked about the environment of the following obligatory subjects: Medic Surgical Nursing II and IV. With the students of physical education we were working on the following obligatory subjects: Mobility and Theory and the History of the Physical Activity and also the Sport.

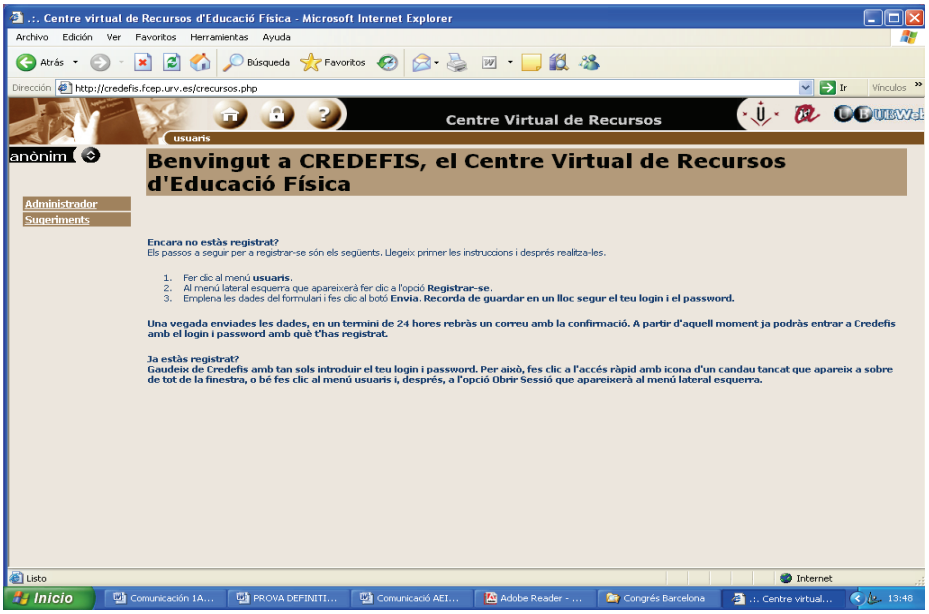


Fig. 1. Initial page of the CVR.

For the development of the experience we arranged a Centre of Virtual Resources (CVR) that is shared with all the subjects (http://credefis.fcep.urv.es), where the students can have the resources, the activities, and there are also forums for discussion. By this centre of resources is how the virtual communities of teaching that has been created for each of the projects have interacted, and also shared resources and results of the work of each community.

To each project there was associated a community of students and teachers and they were interacting in the centre of virtual resources. This centre has been working since 2004 as a result of another project of research that is why the structure and its operation were contrasted.

There were several reasons that motivated the type of work. On the one hand, it is a question of three different degrees but with common contents, which represent a topic centred community Polo (1998), besides being groups of students of similar characteristics. On the other hand the research team already was experienced at a previous. In addition, the geographical location was forcing to network.

3 Development of the Research

This experience has been carries out in the framework of a project of research in which two Spanish universities have participated: Lleida University (UDL) and Rovira Virgili University of Tarragona (URV). Of the first one have participated students and teachers of two diferents degrees: the first course of the degree of Physical Education and also from the third course of the degree of nursing. Of the second university they have participated students and professors of first course of the degree of specialists teachers in physical education for primary school. On the whole there have being working six professors and 142 students.

The purpose of the investigation has been to identify the key aspects to develop communities of learning based on the use of the technologies of the information and the communication on the university education of physical education.

Their have being organized three projects with a common nucleus of work: the role of physical activity in the actual society and the comprehension of culture of body and health.

From here it was organized each project with a thematic and a methodology concrete and differentiated of work:

- Project 1. Pathologies and physical activities. By the use of learning base on problems (PBL PROBLEM BASED LEARNING), to the students were presented situation with serious pathologies that had to try to alleviating by the intervention with programs of physical activities, with the aim to improve the conditions of perception of the sick one and his conditions oh his everyday life.
- Project 2. Body along history. Through the discussion of cases through forums about the role of the physical activity in the past and in the actual society.
- Project 3. Health and physical activity. Through 10 real cases with Light pathologies, the aim was the prescription of a program of physical activity that permits the increase of the quality of the life of the patient.

As an explanation of each project we present the following files:

Table 1. Description of the first project.

Project 1: Pathologies and physical activity
Participants: 2 professors and 14 students **Name of the centre:** Degree PE and School-nursing of UDL **Subjects/blocs/:** Mobility and Medico surgical Nursing 4. **Themes**: Amputation - Sclerosis Multiple - Traumatism encephalic cranium
Aims of the activity - Apply the centre virtual of resources in the process of teaching learning and in the subjects of physical education given in the university. - Promote the work collaborating, exchanging experiences and solving problems.
Competence developed trough the activity: - Generate and exchange educational resources in electronic files like elements of support for the university auto learning in both disciplines. - Promote the work collaborating between the areas of Physical Activities and Sport and of nursing with the active participation of the professors and the students.

Table 1. Description of the first project. (cont.)

Description of the activity: For each of the three themes it has been created a problem for its study. There were indicated questions that the students had to solve by interacting. And also students could visit patients with similar problems. They did a final project to explain how to treating this kind of illness from both areas.
Resources used to do the activity: electronic resources and communication tools of CRV, they make eyewitness meetings and also visiting patients with the same problems.
Criteria of evaluation: Work and final exposition. Monitoring in the different debates and looking for resources have served to have a better final mark based on the exposition of the final project as how to treat these kind of illnesses from both areas.
Time: First quartermaster of the academic course 2005-2006.

Table 2. Description of the second project.

Project 2: The body through history.
Participants: 2 professors and 85 students **Name of the centres:** Degree PE UDL and degree PE from de URV. **Subjects/Blocs/:** theory and history of the physical activity and sport (UDL) and theory and history of physic sportive activity (URV). **Themes**: Physical activity in: the first hominids, the prehistoric men, the first citizens (from Fluvial Citizens to the final of Roman Impair) the middle ages, the renaissance and the modern epoch (from the gymnastic schools to actuality)
Aims of the activity **1.** Being capable to make an argument opinion and documented to express it in a format of forum of discussion on internet. **2.** Be capable of discussing the opinions from others when we debate and formulating new ideas by forums where the students that participate from other universities.
Competences developed trough the activity: - Research and select sources of information to document the self opinion about concept and episodes historic. - Learning by autonomy to generate, justify and contrast with the self opinion.
Description of the activity: In parallel to the confession of the resources and the eyewitness classes each of the themes of history, it has been created some forums to expand and discuss, based on initial questions and minimum guidelines of participation.
Resources used to do the activities: Electronic resources of support and communication tools of CVR where the students learn to use by themselves in their times of study and their time to prepare the subject.
Criteria of evaluation: the persistence, the ponderation and to offer new ideas on the debates from the reading and the control of the whole thematic material and the interventions of the colleagues that also participate on it. The interventions have to be first of all argumented (comment that it have a reason in which there is a debate of an opinion or a synthetic collect of ideas with a sentence at the end of the message) and after they have to be documented (argument with reference complete of what was mentioned).
Time: First quartermaster of academic course 2005-2006.

Table 3. Description of the third project.

Project 3: Health and physic activity
Participants: 2 professors and 43 students **Name of the university:** Degree PE and School- nursing of UDL **Subjects/Blocs/:** Theory and history of physic activity and nursing medico surgical 2. **Themes:** Sedentary and active hypertension, sedentary and active heartaches, artery pathological, sclerosis multiple, diabetes, obesity, bariatrica surgery, asthma and Epoch.
Aims of the activity - Being able to apply programs of intervention of physical activities for concrete collectives.
Competences developed trough the activity: - Create ways of reflexing working and thinking of critic analysis. - Use and incorporate in the good way in the activities of learning-teaching the technologies of the information and communication (ICT). - Work with collaboration to make solutions adapted to real solutions.
Description of the activity: Resolving a case from the making of an intervention program of physical activity for fifteen days. It is offered to the groups a description of the case and a dash of the steps that one need to its resolution and digital resources in CVR.
Resources used to do the activity: Electronic Resources and communication tools of CVR, eyewitness meeting and also optional visits to the patients.
Criteria of evaluation: Consistence and specific of the proposal of intervention for the increase of the life quality of the subject and the possibility of application and monitoring.
Time: Second quartermaster of the academic course 2005-2006

From the methodology were generated this projects and to each one it was associated a community of work.

They were carried out a planning actions assembly of the work and monitoring of the same one and of their results. The tools used during the work of the three communities were the followings:

Table 4. Distribution of the tools of the monitoring and the evaluation.

BEGINNING	DURING	FINAL
INITIAL QUESTIONNER TO THE STUDENTS	FORUM OF DISSCUSSION OF THE STUDENTS	FINAL QUESTIONEER TO THE STUDENTS
COMMUNICATION BETWEEN THE PROFESSORS		
PARAMETERS FOR THE USE OF CVR (LOGS)		

The initial questioner was 15 questions and the final 18. The three questions more were about the feelings whit the experience, the community work and what the students had learnt. The initial questionnaire is shown on Figure 2.

For the descriptive analysis of the quantitative data of the questioners it has being using the program SSPS v.10.0. For the analysis of the forums, the communication between the professors and the open answers of the questioners it has being using the program NVIVO (version brought up to date of the software "Nudist", tool for qualitative analysis of information). To this information an analysis of the statistical parameters of use has been added that collected the own one CVR.

We only realize a descriptive analysis because we do not try to seek for any correlation between variables, only to establish the profile of the members of the community. With the questionnaires we identify 5 types of variables: availability of resources ICT and connectivity, the use of the ICT, degree of control of the computer, training level in ICT and attitude towards the ICT.

4 Results

The assembly of the results we have grouped them in three categories for its interpretation:

1- Those that permit us to establish a profile of the members of the community in relation to the ICT.

With the descriptive analysis of the variables we see that, in general, the level of use of the ICT is high, as their formation. The students use the ICT as tool of communication and work. We meet a few students' communities with a high level of use and experience with the ICT.

From the initial to the final questioners (the initial questionnaire had a total of 15 items and the final one 18) we could get information about, for example, the evolution of the control of the computers by the students as a consequence of their experience or the evolution of the level of formation in ICT in the students.

QÜESTIONARI INICIAL

Benvolgut/da,: Estem realitzant una investigació sobre les tecnologies de la comunicació i la informació (TIC) aplicades a la docència universitària. Per aquest motiu et demanem que tinguis l'amabilitat de respondre amb el màxim interès i sinceritat aquest qüestionari **anònim.**

Indicacions per a respondre el qüestionari:
1. La informació que ens aporteu és confidencial i només serà utilitzada en aquesta recerca.
2. NO ÉS UN EXAMEN. No hi ha respostes "correctes" o "incorrectes". Us agraïm la màxima sinceritat.
3. Si teniu qualsevol dubte o no disposeu d'informació suficient podeu dirigir-vos a l'enquestador/a
4. Al final de cada bloc de preguntes i del qüestionari, trobareu un apartat d'observacions.

A. Dades identificació

1. Edat:
2. Sexe: Home ☐ Dona ☐
3. Ensenyament: Alumnes Diplomatura MEF ☐ Alumnes Licenciatura CAFE☐ Altres.....
4. Universitat: URV ☐ UB ☐ UdL ☐

B. Disponibilitat de Recursos TIC i connectivitat
Resposta: senyala amb una X l'opció que correspongui.

5. Per estudiar has tingut que canviar entre setmana la teva residència familiar?
Sí ☐ No ☐

6. Tens ordinador en el teu lloc d'estudi habitual d´entre setmana?
Sí ☐ No ☐ En cas que la teva **resposta** hagi estat **afirmativa**, des de fa quant de temps?.....

En cas que la teva **resposta** hagi estat **negativa,** quin/s ordinador/s utilitzes per a realitzar els treballs universitaris?. **Si és el cas, pots marcar més d'una opció.**
Ordinador de la facultat ☐ Ordinador d'amics/gues
Ordinador d'un"Telecentre" ☐ Cibercafè ☐ Altres (Quins).....

7. Tens connexió a internet des del lloc d'estudi habitual?
Sí ☐ No ☐ En cas que la teva **resposta** hagi estat **afirmativa**, des de fa quant de temps?.....

En cas que la teva **resposta** hagi estat **negativa,** des d'on t'acostumes a connectar a internet?
Ordinador de la facultat ☐ Ordinador d'amics/gues
Ordinador d'un"Telecentre" ☐ Cibercafè ☐ Altres (Quins).....

Observacions:.....

C. Ús les TIC
Resposta: **1 totalment en desacord**, **6 totalment d'acord** i en blanc si no tens informació suficient.

8. Normalment utilitzes ordinador per a:	**1**	**2**	**3**	**4**	**5**	**6**
Realitzar activitats lúdiques i d'oci (jugar, xatejar,...)						
Realitzar activitats acadèmiques i formatives (fer treballs, buscar informació,...)						
Realitzar activitats laborals						
Realitzar activitats de gestió i administració (agenda,...)						
Com a eina de comunicació (internet)						
Autoformació/Autoaprenentatge						
Altres activitats: Quines?						

Observacions:.....

9 . Valora els següents sistemes / programes /aplicacions informàtiques, en funció de:
- La **freqüència** amb que els utilitzes
- La **utilitat** que tenen per a la teva activitat com a estudiant (encara que no els facis servir habitualment)
- El teu nivell de **domini/competència**
-

Exemple de resposta: Si et preguntem pels transport utilitzats per a anar a la facultat i el teu cas es que; no acostumes a anar-hi amb cotxe particular, però creus que és un mitjà de transport molt útil, i fa poc temps que tens el carnet, la teva valoració podria ser: **freqüència 2**, **utilitat 6 i domini 3.**

	Freqüència ús						**utilitat**						**Domini**					
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**	**5**	**6**
Autoformació / Autoaprenentatge																		
Bases de dades ("Access", "File-Maker")																		
Consultar i enviar correus electrònics																		
Edició de pàgines web																		
Editor de presentacions tipus "Power Point"																		
Fulls de càlcul ("Excel", "Lotus",...)																		
Fòrums de debat																		
Gestió i administració																		

Fig.2. Initial questionnaire.

Internet																		
Investigació i recerca d'informació (google)																		
Jugar "en línia" (jugar en xarxa)																		
Jugar individualment (jocs d´ordinador)																		
Llenguatge de programació (java, php,...)																		
Llistes de distribució																		
Processador de textos ("Word", "Amipro",...)																		
Tractament d'imatges o gràfics																		
Tractament estadístic de dades (SPSS,...)																		
Treball en grup																		
Xatejar (messenger)																		
Web-Cam (videoconferència d´escritori)																		
Altres (quins/es)																		

Observacions:.....

10. Com qualificaries el teu domini de l'ordinador?						
En general (en qualsevol dels seus usos)						
Com a eina de comunicació (internet)						
Com a eina de treball (processador de textes, bases de dades,...)						
Altres activitats: Quines?						

Observacions:.....

D. Formació en Tecnologies de la Informació i la Comunicació

11. Com qualificaries el teu nivell de formació en TIC?	**1**	**2**	**3**	**4**	**5**	**6**
En general(en qualsevol dels seus usos)						
Com a eina de comunicació (internet)						
Com a eina de treball (processador de textes, bases de dades,...)						
12. Com has adquirit aquesta formació?						
Formació reglada (cursos d´informàtica presencials)						
Autoformació (aprenentatge sol o amb llibres)						
Altres						
Altres activitats: Quines?						

13. Has participat en algún curs de formació no presencial i via internet?
Sí ☐ No ☐

En cas que la teva **resposta** sigui **afirmativa,** podries dir-nos quins?.....
.....
Com valores aquesta/es experiència/es?
.....
.....

E. Actitud en vers les TIC

14. Valora les següents afirmacions segons que hi estiguis menys o més d'acord.

	1	**2**	**3**	**4**	**5**	**6**
Als estudiants els resulta complicat utilitzar les TIC						
Als estudiants universitaris els interessen les TIC						
La formació tècnica rebuda per a utilitzar les TIC és suficient						
L'accés a aquests recursos és fàcil						
Els equips (hardware) existents a la universitat són suficients						
Els recursos TIC existents a la universitat són suficients						
Les TIC milloren significativament l'aprenentatge dels estudiants						
Les TIC potencien l'aprenentatge autònom de l'alumne						
Les TIC potencien l'aprenentatge col·laboratiu						
Les TIC suposen una ajuda imprescindible en l'activitat dels estudiants						
Els estudiants tenen l'hàbit d'utilitzar les TIC en la seva activitat formativa						

15. Sota el teu punt de vista, com valores la utilització de les Tecnologies de la Informació i la Comunicació (internet, Informàtica,...) en la teva activitat com a estudiant?
.....
.....

Observacions GENERALS
En aquest espai pots exposar qualsevol consideració respecte a aquest qüestionari
.....
.....

Moltes gràcies per la teva col·laboració.

Fig.2. Initial questionnaire. (cont.)

Table 5. Comparison of the control of computers by the students of the project 2.

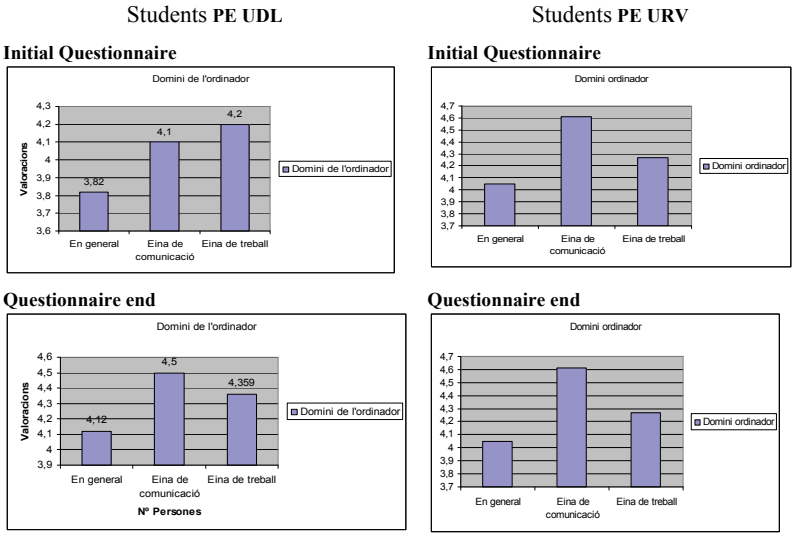
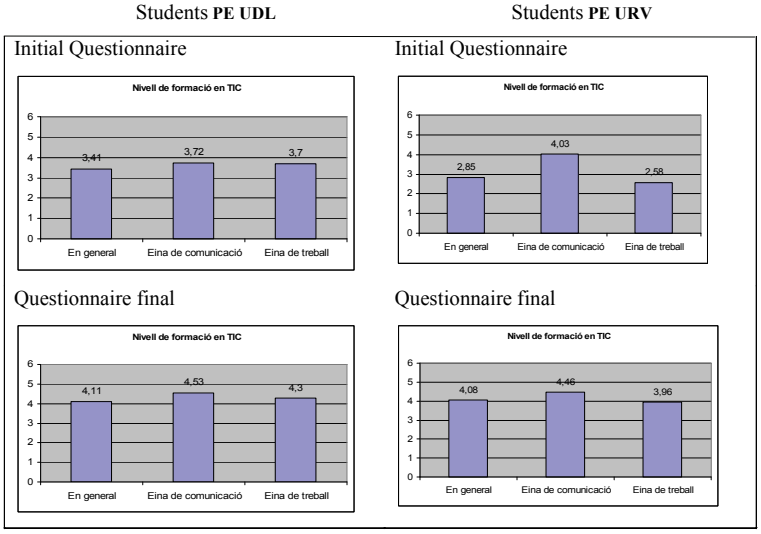


Table. 6. Comparison of the evolution of the level of formation in ICT in the students of project 3.



In addition to they have gathered data on the type of use of the ICT on the part of the students, their availability of computer and connection to Internet, its initial formation in ICT etc. As far as the professors we can say that it has evolved towards a new profile, since the integration of the health and the physical education have made possible the interchange of experiences. This interrelation has impelled one more a present conception of the physical education.

2- Those that permit us analyse the organization and the interaction between the members on the communities.

The qualitative analysis has permitted us to verify some improvements in the educational process in different levels:

- An environment of new auto learning. The volume of communicative exchanges and of resources that has facilitated the CVR has prompted a kind of evaluation continued and formative what has encourage the auto learning.
- Information exchange possibilities. The digital patrimony that we created have a big base of specific information about the physical activity and health that they will enjoy, in a future, excellent students, experts and any professional.
- Bigger autonomy in the learning. The students have participated in a work between different qualifications and in a communicative exchange from the reflection thematic and new methodological strategies.
- Significant formation. The study of cases and resolving problems have approached us to the professional world by the identification of problems, the search for resources and the application of solutions like intervention strategies.

Table 7. Participation and readings in forums of project 3.

Name of the forum	Answers	Readings
Cas 1: hypertense ex sportsman	100	699
Cas 2: sedentary hypertense woman	29	250
Cas 3: sedentary cardiologist woman	60	240
Cas 4: cardiologist ex sportsman	35	350
Cas 5: sedentary man with pathology in the arteries	52	430
Cas 6: sport woman with multiple sclerosis	120	750
Cas 7: diabetic adolescent who does sport	55	450
Cas 8: obese patient who has have an operation	150	700
Cas 9: asthmatic man who does sport	75	540
Cas 10: asthmatic man who does not sport	7	100
Cas 11: sedentary woman with EPOC	35	230

As interaction example we can say that like average, each user registered in the CRV has made more than 150 accesses to he himself during the period of work. As example we can see the interventions in the forums in project 3.

3- Those that permit us analyze the productivity of each community.

As a result of the work of the three communities they have been added to the CRV more than 1400 electronics resources and they have started up more than 15 forums of discussion on diverse subjects.

Students said that this experience of collaborative work was very useful because they could work without space and temporal limits, besides with the confidence of an authentic collaborative learning.

Thus, we can say that the experience has permitted us:

- A high active participation of the students involved in the experience.
- A high motivation towards the search and selection of information.
- Permanent discussion to develop practical works.

- Concreteness in the presentation of projects.
- Personalization and bigger implication in the process learning.
- Significant formation for the professionals.
- Evaluation continued and formative into university.
- Interdisciplinary curriculum.

5 Conclusions

As for the creation of communities of learning based on the use of ICT, to obtain it with efficients, some of the fundamental aspects that we can conclude are:

- Talking about the environment of interaction we think that it is really important the use of platforms that permit an easy communication, the immediate availability of all kinds of resources and the monitoring of the activity.
- Talking about the organization of the community, we consider that would be convenient to have educational guides that structure the work, besides trying to guarantee a level of control of the ICT on the part of the members of the community.
- Talking about productivity, we think that it is necessary to centre very well the thematic of the work promoting the specialization of each community and trying to get the maximum relation of the projects of work with its application in the professional activity of the members. For that it is necessary a very clear working plan.

Therefore, we agree with the idea that the teachers will have to stimulate on the students a more active role, making new technologies oriented to get the participation of the students in the whole process of teaching learning. The use of ICT is a way for that. However, we consider that it is necessary a control and the planning of the work of the community for effective results.

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