Towards provision of knowledge-intensive products and services over the Web

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Abstract

The overall objective of the INKASS ("Intelligent Knowledge Asset Sharing and Trading") project is to develop an intelligent Internet-based marketplace of knowledge assets. At the core of our technological approach stands a case-based reasoning approach for ascertaining knowledge assets for relevant user contexts and a comprehensive metadata description of information objects which represent tradeable knowledge products. The research approach and the e-marketplace developed for a management consultancy is discussed in its first version in this paper.

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2Introduction

Internet-based marketplaces have recently emerged that support buying and selling of knowledge assets or sharing of knowledge across internal organisational boundaries (Mueller et al., 2002). Existing approaches vary on the focus they have on the type of knowledge exchanged (tacit or explicit), the business model employed, the pricing mechanisms supported and the technical infrastructure used to manage content and support matchmaking between demand and supply. An in-depth review of existing implementations presented in (Kafentzis et al., 2003) identified the following points of consideration for the development of knowledge marketplaces:

- Account should be taken for the fact that knowledge is not just a book which can be described and retrieved with a simple keyword retrieval, but has manifold complex context and content features which determine its applicability and usefulness in a given situation;
- Account should be taken for the fact that for electronic knowledge trading one can not simply copy ways of working known from traditional business (like book selling with a catalogue and a simple, sequential seller-intermediary-buyer relationship), but in exploiting the strength of manifold synchronous and asynchronous communication means, as done in conventional knowledge provision services (e.g. professional service provision);
- Account should be taken for developing the necessary technical, business and organisational mechanisms for managing and maintaining an electronic knowledge marketplace. These include customer relationship mechanisms, revenue models, appropriate pricing mechanisms for different kinds of knowledge, etc.

INKASS is a European RTD project that, by developing an electronic knowledge marketplace that tackles both information technology and business engineering issues (Apostolou et al., 2002; Inkass, 2002), addresses the aforementioned research challenges. This paper presents the interim project results and how these have been used to support a real-life application scenario. It starts out by describing the business need addressed. Next, the Internet-based platform developed is presented. Next, lessons learned and implications for the development of similar initiatives are discussed. Finally, further research directions as well as our own future work plans are outlined.

3Application Scenario and Problem Addressed

Planet Ernst & Young (PLEY) is a multinational consulting firm providing management and engineering consulting services in southeast Europe[1]. PLEY's consulting practice has focused on developing and expanding their relationship with key large organizations in the region. PLEY's expectation of the INKASS platform has been both to provide a kind of knowledge supply for its established clients and to extend its market reach to SMEs and other organisations that do not typically hire consulting services. To support the later, and following the methodology of Schmid (1998) for designing media platforms, we first identified the concrete, real-life user situation that captures the business need: The "Option Planning" situation occurs when a prospective client has a general problem, but has neither a clear idea of a solution nor a way to approach his/her problem. S/he typically wants to get different options on how to solve this problem. S/he can then either recognise a possible solution on his/her own, or s/he would like to receive some expert advice on how to approach his/her problem.

In a first step of the methodology followed (*Organisational Design*) the different roles and their intentions, need, rights and duties have to be identified. For the Option Planning we have identified 3 different roles with their specific intentions, needs, rights and duties (which won't be presented here). These Roles are: the Knowledge User, the Knowledge Broker and the Knowledge Expert. The Knowledge User was identified as an actor who needs different options for the planning and implementation of a solution to a specific problem. The Knowledge User in this case will typically be the Head of Division from the client-side. The Knowledge Broker was identified as an actor who is responsible for routing client queries to appropriate Experts or knowledge products. So the Knowledge Broker gets a request from a Knowledge User ant transmits it to the right Expert. The Knowledge Broker can either be a computer system or a person. In the case that the Knowledge Broker is a person this role would be taken over by PLEY's internal knowledge management support office. The Knowledge Expert was identified as an actor who answers a specific question of a Knowledge User at best knowledge. The Knowledge Expert will provide different information to the Knowledge User according to the question of the Knowledge User and will help to develop a solution for his problem. This will take place in different interactions between the Knowledge User and the Knowledge Expert.

In the next step of the methodology (*Interaction Design*) the interactions within the scope of the Option Planning between those three roles will be identified and described. The interaction design is based on the basic consulting process: (1) In the first step the Knowledge

[1] The company was formed following the merger of PLANET S. A. and the Southeast Europe Management Consulting network of Ernst & Young.

User who wants an Option Planning for his specific problem formulates a specific question according to his problem. This Question is transmitted to the Knowledge Broker, who tries to understand the question to be able to find the right Knowledge Expert to answer the question. (2) According to the question asked the Knowledge Broker interacts with the different Knowledge Experts who are skilled to answer the question in order to find the best expert to answer the question of the Knowledge User. In this step many interactions between different Knowledge Experts and the Knowledge Broker can take place until the right Knowledge Expert is found. (3) In this step the Knowledge Expert gets in touch with the Knowledge User and provides different possible solutions according to the initial question of the Knowledge User. (4) The Knowledge User and the Knowledge Expert are discussing the problem and make a preliminary problem diagnosis. (5) The Knowledge User verifies the preliminary problem diagnosis and the Knowledge Expert and the Knowledge User are discussing the terms of a possible consulting contract. (6) The Knowledge Expert develops a solution and proposes it to the Knowledge User and the implementation will be discussed. (7) Possible follow-up plans are discussed.

<Insert figure 1 here>

A detailed process map of these interactions is drawn in the next step of the methodology (*Process Design*) – not presented here for economy of space. Finally, in *Service Design*, the services the platform should provides to support the customer's interaction are elaborated: (1) A private area on the homepage where the Knowledge User can save his search results and the documents of the document collection, which seem important to him. (2) Another service is the intelligent search. This should be a search, which allows the Knowledge User to select different core areas, and industries he wants to search in and to phrase a concrete question. The search should take into context the profile of the Knowledge User. (3) The platform needs to be able to create all the compound documents (document collection) automatically. (4) In the intention phase the Knowledge User verifies the documents and tools he got from his search request. During the intention phase the Knowledge User will develop a clearer view of his needs and will redefine his search if necessary. (5) In the contracting phase the Knowledge User will decide if he wants to engage a Knowledge Expert to get more information about different options or to start a consulting process. (6) In the settlement phase the Knowledge User gets in touch with the Knowledge Expert and the Option Planning process begins. (7) A service for creating Knowledge User profiles is needed in order for intelligent search to function.

<Insert figure 2 here>

A more detailed description of the technical implementation of the aforementioned services is given in the next section.

4The INKASS Research Approach and Software Platform

As already mentioned, the INKASS research approach builds on the Business Media Framework (Schmid, 1998), a theoretical foundation for designing business media and supporting software platforms. According to it, the trading lifecycle of a knowledge product from creation to consumption, can be considered as a sequence of 4 phases, Information, Intention, Contracting and Settlement.

In INKASS, the *Information Phase* refers to the tracking of the best-suited knowledge product for the user need. This phase is the most important phase in the case of consulting companies, because the user need is rather vague and often can't be clearly expressed. In this phase, the user is able to retrieve knowledge about the documents and services of a consulting. The problem of vague queries is solved by the use of an ontological model described in section 4. The result of this phase is the establishment of sufficient knowledge by an agent in order to conclude if and how interaction with the consulting company will occur.

In the *Intention Phase*, the agents signal their intentions derived from the knowledge in the knowledge phase and from their desires and goals. Offer, counter offer and demand are the prevailing form of expressed intentions in a consulting company. In the intention phase, the system designed provides a variety of workflows to be executed by the company and the client. The Request For Quotation workflow for instance, concerns two agents, the buyer and the seller, and realises an iterative negotiation process between the two agents aiming to reach an agreement between the buyer and the seller.

In the *Contracting Phase*, and in cases where new knowledge is to be created, the agents create contracts as service level agreements, starting from the agreement reached in the end of the intention phase The contracting phase is implemented as a separate interoperable e-contracting model implemented on XML and Java, providing the capability to be adjusted to any consulting company's operational needs. The result of this phase is a legally binding contract which documents the agreed upon obligations of supplier and buyer as far as they are not already defined in the protocols.

In the *Settlement Phase* the agents have to act according to the negotiated contract. This includes the payment for the products or services purchased and the delivery to the buyer which may involve the use of specialised services. The result of this phase is the correct termination of a knowledge transaction (i.e. a successfully executed contract or a mutually agreed form of cancellation of the transaction). INKASS is providing a workspace, shared between the buyer and the seller, as an ad-hoc means for submitting deliverables and communicating messages related to the work specified in the contract.

<Insert figure 3 here>

5An Information Ontology for Knowledge Trading

The concept of Information Ontology, introduced by (Abecker et al., 1998) in the Knowledge Management area, is used in INKASS as a frame to "package" and "label" the knowledge carrying goods: documents and services (services are typically, like in the PLEY case, consulting projects). These goods are represented by *Information Objects (IO)*. In order to be practically usable, a collection of such IOs, requires for every IO a description e.g. of their content, application potential, potential value, etc. Without descriptions, a collection of IOs is like a mass of blank cardboard boxes, and no chance to see what is in any of them. The INKASS Information Ontology declaratively specifies the knowledge representation schema used to describe IOs and related background knowledge. Descriptions based on the Information Ontology allow for:

- content-type specific characterizations of IOs that allow to search and retrieve them, and assess their value, in order to find (previously unknown) knowledge for the solution of a (known) problems;
- semantic machine support for all handling of IOs, like intelligent support, perhaps even learning from searching behaviour, for searchers (e.g. in the areas of collaborative filtering, or elaborated versioning and evaluation mechanisms) and mining of potentially useful patterns for administrators;
- transportability of an encapsulated IO from one trading platform to another (because it is self-contained to a certain extent).

The demand for such metadata had already been recognized and to some extent been answered in different research communities, like Digital Libraries (e.g., in the Dublin Core approach), E-Learning (LOM, see below), Lessons Learned systems (van Heijst et al., 1998), Software Requirements (Tschaitschian et al., 1997), or Organizational Memories (Abecker et al., 1998; Kingston & Macintosh, 2000). However, the INKASS survey of existing knowledge marketplaces (Kafentzis et al., 2003) revealed about marketplace metadata sets that: (1) Representation of *knowledge content* is –though partially very interesting– usually weak. References to potential usage context (often different from a pure content description, think of "aspirin" versus "headache") is very seldom considered. (2) Many other aspects (like evaluation of knowledge quality, community aspects, feedback, etc.) are purpose-built or neglected. (3) There are no approaches to make information objects more self-contained to allow move them out of their home-marketplace to others. (4) No effort towards reusable, standardisable metadata schema sets is visible. Existing metadata standards or e-Commerce ontologies seem not be used or integrated.

These shortcoming of existing approaches are attacked with the INKASS Information Ontology. For its design four sources were tapped and combined: First, the current state of practice and the acquired requirements of the INKASS pilot environment at PLEY. Second, prior research and customer projects done at DFKI and Empolis. Third, the state of the art in the scientific literature, in particular the Dublin Core initiative and the IEEE Learning Object Metadata standard (LOM), as well as some specific approaches for special problems, like IPR representation or contract representation. Fourth, we used WordNet (Miller, 1990), which helped us to group and structure certain aspects of content and context descriptions.

<Insert figure 4 here>

Showing more than the top-level structure of the Information Ontology would go far beyond the scope of this paper. However, this top-level distinction into ten so-called *facets* should provide an impression of how the description of IOs can be organized meaningfully. Figure 4 below shows the INKASS information ontology metadata facets. This top-level structure is discussed in detail in (Maass et al., 2003; Abecker et al., 2003).

The vision behind this faceted description is: If all the facets are sufficiently described, it should be possible to assess the content and potential usage and value of an Information Object comprehensively, to support all processes, transactions and modifications during the lifetime of an IO, and to ship such an IO as a self--contained object, thus transferring it with its complete creation and modification history from one marketplace to another one, without loosing information, without getting into legal or business problems because of changed contextual factors on another platform, etc.

Though we do not expect to reach this vision completely already in the INKASS project, we expect to foster scientific progress, and to challenge the pilot users for using the possibilities provided by the tools. We should also mention, that the facets described, in particular the details of content and context representation are a *superset* of what will presumably be used in each specific application case.

6Discussion

The main technical considerations we addressed in the development of the INKASS software platform have been to:

(1) Integrate e-commerce with knowledge management software technology: INKASS has built on Empolis' e:kms, which is an E-Commerce middleware solution for intelligent retrieval and assistance, based on CBR technology, and the enhance it with the e-commerce transaction and workflow functionalities needed to implement the services described in sections 2 and 3 above.
(2) Focus on the critical questions which distinguish *knowledge trading* from other E-Commerce areas; for

this we developed: (i) A powerful, knowledge-based matchmaking mechanism comparing offers and demand, utilising the information Ontology described in section 4 above. (ii) Flexible, intuitive interfaces and intelligent assistance helping users to express their demands and interactively search for appropriate offers These include system-initiated dialogue-based retrieval, visualised topic-map navigation, clustering of retrieved results providing a combination of query-based search and navigation, and finally, human-initiated feedback on user queries.

(3) At the operational side, focus on how to cost-effectively use the platform for the *novel problem of trading knowledge*. In order to do this, we worked out: (i) The very basic ontological foundations for the utilization of E-Commerce systems for knowledge trading, plus cost-effective methods for up-front knowledge engineering. (ii) An overall Business Engineering and configuration of existing mechanisms (e.g. different pricing mechanisms) which take into account the particularities of knowledge trading in each case. (iii) Appropriate business models, roles, processes, and revenue models for installing and running knowledge trading platforms.

The platform that we used – based upon the Case-Based Retrieval approach to realize matchmaking between offers and demand (Cunningham et al., 2001) – provides expressive means for describing structures of knowledge-intensive products and services and background knowledge for retrieval. In order to represent in our knowledge trading platform the content, application potential, potential value, etc of knowledge to be sold and bought, we use *Information Objects* which are the tangible media that allow to trade such an inherently intangible good as knowledge is. Technically, since our knowledge-trading platform is based upon the *Case-Based Retrieval* paradigm, Information Objects become *Cases* in the software realization. The Information Ontology describes a class hierarchy of which each instance can be treated as a case in the CBR paradigm. Actually, the case base is a collection of *use cases* for information objects. Taxonomic structures and relations are translated into similarity measures for retrieval and complemented by adaptation rules to enable e.g. the transfer of a information object to a new use context. While operating the INKASS marketplace, each successful trade and application of a information object becomes a new case in its case base. Users specify their knowledge need by describing a information object that would ideally meet their requirements and use context. INKASS will then retrieve those information objects that are most similar to the specified need. The object finally selected together with the new use context will form the new case. Hence, the INKASS platform captures knowledge on the use of its information objects and thereby provides a new quality of retrieval and user guidance. The latter is achieved by a dynamically created user interaction strategy, which is derived on the basis of an information-gain calculus. The system e.g. will ask for aspects of the situational context that have not yet been specified by the user but would best distinguish between potentially useful information objects.

Regarding the Information Ontology developed, we should mention that the distinction between a *content* facet and a facet for describing potential usage *context* opens the possibility for an extremely powerful retrieval approach and reflects the fact that in many situations a customer may not know the details of a solution, but he knows the details of his problem. The presented Information Ontology is derived from a broad range of scientific and practical inputs thus guaranteeing a quite good coverage of applications. Nevertheless, this is work in progress which still needs much thought and experimentation. Early feedback form testing the system has indicated that at least the overall structure is much more comprehensive than other comparable approaches, and that all those facets are required in order to provide knowledge-enriched products and services over the Internet.

Regarding the piloting of INKASS in PLEY, practical experience has shown that we should not expect that selling knowledge in the digital domain include only explicit knowledge. With careful planning the selling of tacit knowledge could be accommodated, in terms of offering expert advice through physical (e.g. selling consulting time) or virtual (e.g. through on-line collaboration) channels. By consequence, a well-designed system, based on a stable model of knowledge resources, both explicit and tacit, can result in improvement of quality of service provided.

7Further work

The retrieving mechanism is to this point considered sufficient for the piloting needs. Nevertheless, issues like the maintenance of content, metadata annotations for the creation of new and management of existent content are major challenges for the INKASS system. Addressing the above during the next phase of our project – which is the piloting and evaluation of the software platform with real users - will enhance the INKASS system with a lifecycle model for ontologies in knowledge trading applications and a number of algorithms and supporting tools for maintaining and refining the information ontology based on user interaction and feedback.

Another long-term challenge for INKASS is the extension of the employed e-contracting module. Each contract consists of a number of clauses. Each clause is a separate issue of negotiation between the client and the consulting company. Basing the module implementation on an ontology will allow the development of independent software agents which will be able to automate the clause negotiation process on behalf of the seller and the buyer. INKASS vision is that these agents will be able to realise negotiation between

the client and a number of competitive sellers. As a result the system will support contracts specifying projects engaging a client and more than one knowledge sellers on the other part. The sellers will be bound by the contract to cooperate for client's benefit.

Finally, the knowledge trading Information Ontology will also be used as a basis for the design and development of Agora, a kind of meta-marketplace, which can be used as a means to interconnect different kinds of knowledge marketplace following the peer-to-peer model. Agora's aim is to act as a hub between the client and the INKASS marketplaces. Agora exploits the fact that the knowledge trading Informaion Ontology has a strict hierarchy starting from generic knowledge trading layers moving to application domain dependent ones. Using the upper level of the IO, Agora will allow navigation to all marketplaces of a selected domain and will provide routing of searches and improved retrieval facilities.

Acknowledgement

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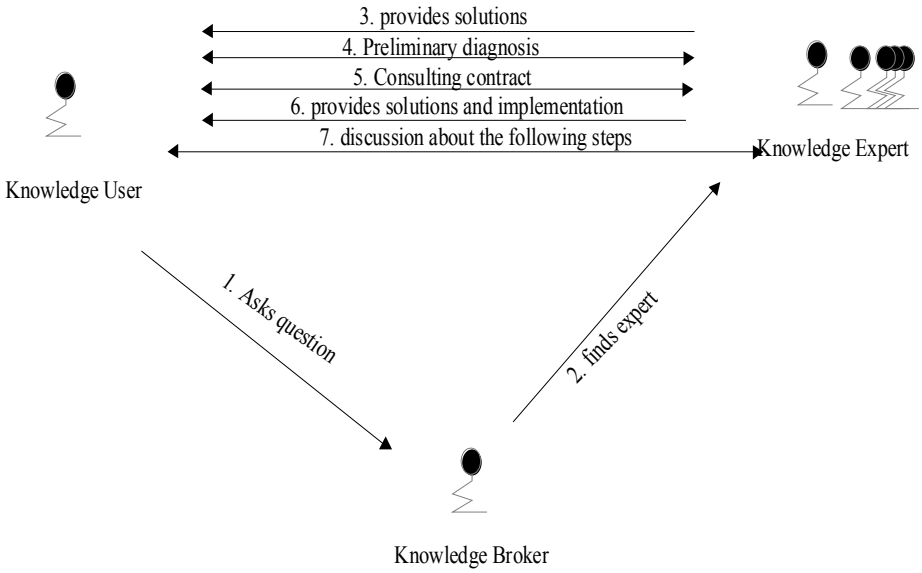

Figure 1: Interaction Design in the PLEY Case

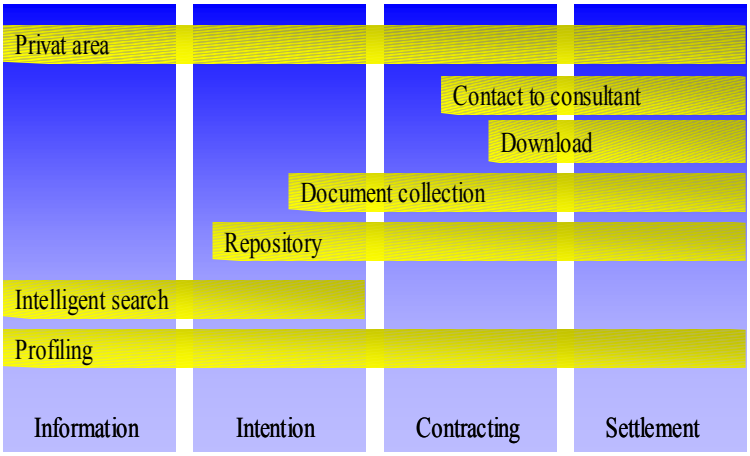

Figure 2: Services Design in the PLEY Case

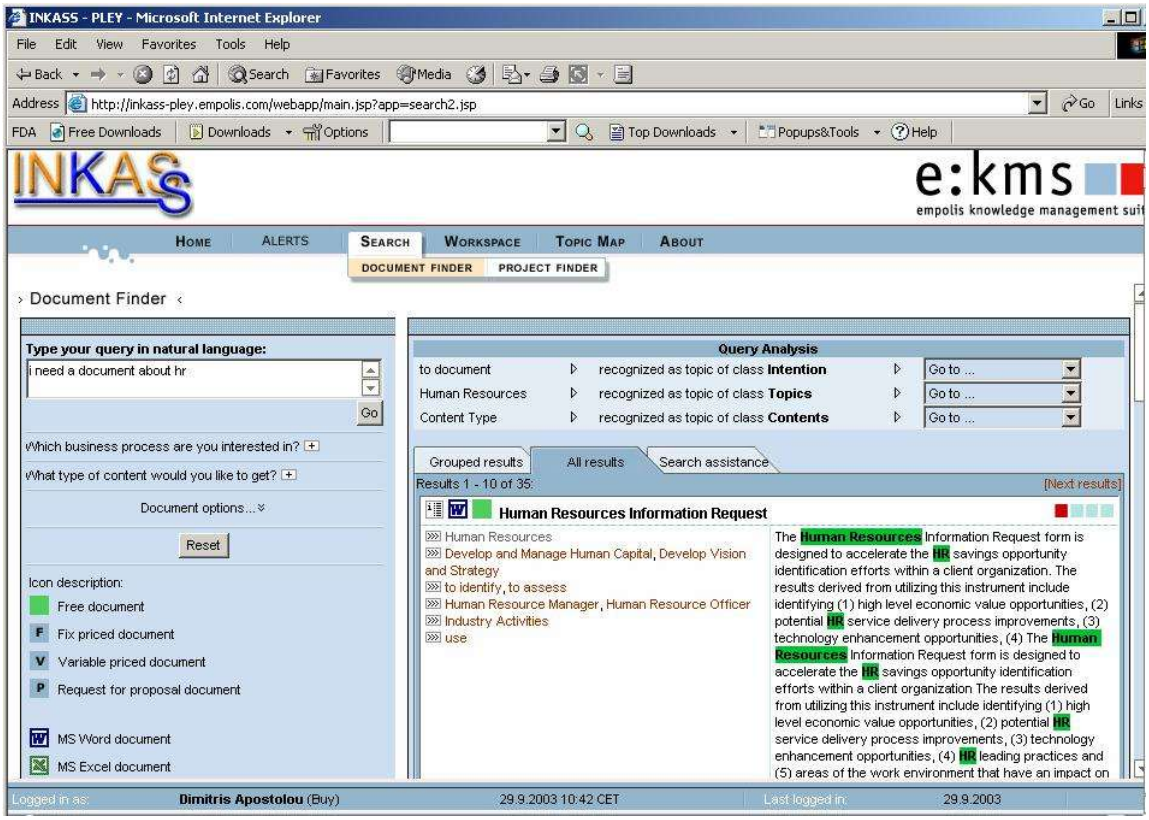

Figure 3: INKASS intelligent search for supporting the Information Phase

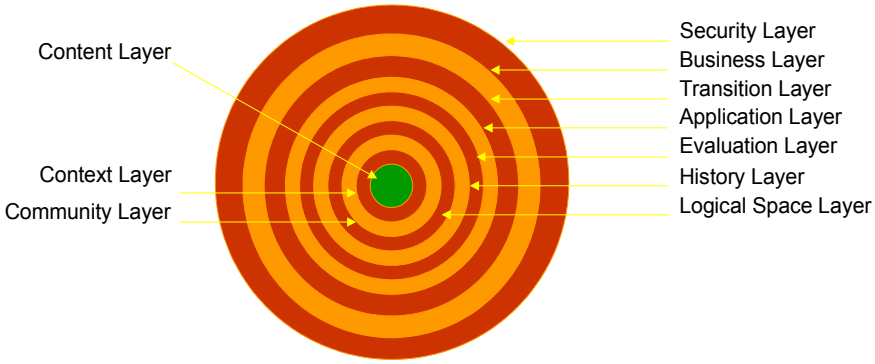

Figure 4: Overall structure of INKASS Information Ontology facets