Design of the Semantic Benchmark Experiment

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IKS

Interactive Knowledge Stack for Semantic Content Management Systems

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IKS in a Nutshell

"Interactive Knowledge Stack" (IKS) is an integrating project targeting small to medium Content Management Systems (CMS) providers in Europe providing technology platforms for content and knowledge management to thousands of end user organizations. Current CMS technology platforms lack the capability for semantic web enabled, intelligent content, and therefore lack the capacity for users[1] to interact with the content at the user's knowledge level. The objective of IKS therefore, is to bring semantic capabilities to current CMS frameworks. IKS puts forward the "Semantic CMS Technology Stack" which merges the advances in semantic web infrastructure and services with CMS industry needs of coherent architectures that fit into existing technology landscapes. IKS will provide the specifications and at least one Open Source Reference Implementation of the full IKS Stack. To validate the IKS Stack prototype solutions for industrial use cases ranging from ambient intelligence infotainment, project management and controlling to an online holiday booking system will be developed.

1 Executive Summary

The objective of this deliverable is to design a benchmark model for CMSs in order to identify relevant requirements for IKS. The Interactive Knowledge Stack will be a layered set of software components and specifications with the goal to improve the interaction with knowledge objects of CMSs by using Semantic Web technologies. In contrast to projects that benchmarked rather technical aspects of CMSs, we propose a model that evaluates CMSs consistently from the business perspective down to the technology layer. This approach is based on IT alignment theory that states that higher degrees of fit between business needs and IT result in increased business performance. Accordingly, IT executives of organizations that provide CMSs and IT executives[2] of organizations that use CMSs as well as CMS developers are taken into account covering both business and technical aspects.

The deliverable is structured as follows. First, we introduce the IKS project and pose relevant research questions that the IKS benchmark model for CMSs must address. Then, related work on CMS benchmarks, semantic technologies and applications is discussed from which shortcomings of exiting benchmarks are derived and implications for the design of the IKS benchmark model are drawn. Afterwards, we present the IKS benchmark model for CMSs, which describes a study-driven and experiment-driven approach to compare CMSs. Consistent with the model, questionnaire items for the study targeted at IT executives of CMS customer and provider organizations and implementation tasks for the experiment targeted at CMS developers are provided. Finally, we conclude this deliverable by a summary and an outlook on the next steps within the IKS project.

2 Introduction

IKS is a large-scale integrating project that is co-funded by the European Union. It targets hundreds of small and medium enterprises, which provide CMS to thousands of end-user or-

[1] In this document, the term user refers to organisations using CMSs, content consumers, CMS developers, authors or administrators of CMSs

[2] In some organizations, the IT department is not the business owner of the CMS but rather the marketing department or other business units.

ganizations. Downstream, hundred thousands of corporate end-users and millions of content consumers are affected by the quality of service provided through these technology platforms. The majority of these platforms lack the capability for making use of the Semantic Web-enabled, intelligent content, and therefore, lack the capacity for users to interact with the content at the user's knowledge level.
The major technological result of this project will be the "Interactive Knowledge Stack" (IKS for short), a layered set of software components and specifications. A rough overview of the stack is shown in Figure 1, which compares the IKS layers with the LAMP (Linux, Apache, MySQL, PHP / Perl / Python) software solution stack and JEE (Java Enterprise Edition) technologies. The IKS will make traditional CMS platforms capable of dealing with Semantic Web technologies. Hence, the grand vision of future CMSs is to have semantically enriched contents that can interoperate in a flexible and semantically meaningful way. This vision is one of our main motivations for the benchmarking of CMSs, in order to identify where semantic technology will make a difference to knowledge- and content management systems.

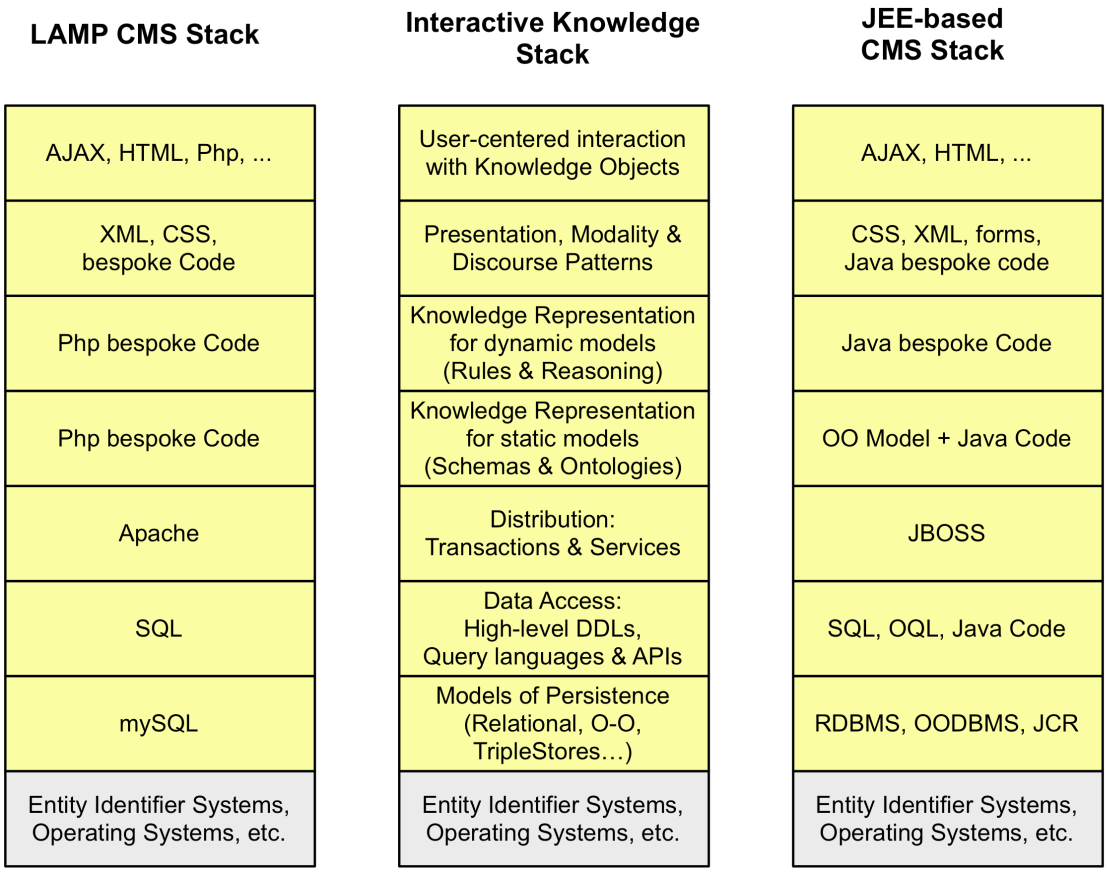

Figure 1: The Interactive Knowledge Stack in comparison with LAMP and JEE technologies

When people talk naively about “semantic” systems they often give the impression that other software systems have no semantics at all and are therefore “dumb” systems, whereas “semantic” systems are somehow “intelligent” and thus, always preferable to non-semantic systems. The first serious mistake we could make in benchmarking would be to assume that other systems have no knowledge of their domain. Therefore, we clarify our assumptions with respect to semantic CMSs here: All systems are “semantic”, but their semantics differ in explicitness and in the choice of implementation technology.
We distinguish five dimensions of “semanticity” in systems as shown in *Table 1*. Any utility of a system must be seen as “fitness for purpose” versus cost. Therefore, whether a purpose is achieved via a “semantic” system or a “less-semantic” is not of great interest to users. How-

ever, if we can demonstrate for specific areas of application, that utility, i.e. fitness for purpose versus cost has high correlation with "best practice in semantic systems" and if our benchmarks have good predictive power for suppliers of "semantic" CMSs then we have realised our potential in the IKS project.

Table 1 - Perspectives on "semanticity" in IKS

Perspective	Description
Degree of compliance with semantic web standards	There are a number of semantic technologies such as RDF, OWL, various reasoners and rule language notations and rule engines. Several of these have undergone some standardisation process, e.g. by W3C. One way of measuring semantic capability is by simply asking which of the notations and engines are supported by a particular system.
Ability to model and execute semantic functions (according to a taxonomy of semantic functions)	If a system is programmed to interpret time intervals, e.g. being able to schedule and synchronise a set of media files for delivery then we can say it supports the semantic function of "scheduling". Similarly, a system that is able to interpret defined workflows implements the semantic function of process modelling and process execution. Given a taxonomy of basic ontological elements, we can measure Semanticity by assessing the coverage of semantic functions as supported by a system.
Ability to make use of these semantic functions for a defined set of benchmarks	Given a set of semantic functions and given a specific purpose we can measure to what extent the semantic functions are capable of serving the specific purpose. Many benchmarks can be regarded as the definition of such a specific purpose and we can then measure to what extent the semantic functions (on the x-axis) of our system can support the purpose defined by the benchmark (on the y-axis) of the matrix.
Assessment of users concerning the utility of the system	Irrespective of how functionality is implemented, users can give an assessment whether the system is well suited to their work. So, we can use the assessment of the users with regard to system functions, as an indicator for semantic capability of a system.
Attribution of user assessment to semantic features of the system (standards, functional coverage, ease of use for developers, administrators, end users)	Given some user assessment of a system, we can make an attempt at correlating the user assessment with semantic technologies employed in the system. Finding positive or negative correlations may help us to understand whether a "semantic" technology is also a "useful" or a "mature" technology.

The main objective of this deliverable is to design a benchmark model for CMSs from which relevant requirements for the IKS can be derived. In order to achieve this goal, the model must address the following questions (the motivation for the questions is stated below each question):

1. To which degree satisfy CMSs the business needs of organizations that use them and provide / develop them?
   The gap indicates that there may exist relevant requirements for the IKS.
2. Which CMS features are desired or should be optimized?
   Desired or improvable CMS features are potential requirements for the IKS.
3. Can the IKS benchmark model help researchers and users identifying appropriate semantic technologies? If yes, for which CMS features (e.g. search, personalization, etc.) are semantic technologies in particular useful and why?
   The latter question helps to rate the relevance of potential requirements for the IKS.
4. Assuming that we can show some value of semantic technologies for the development of CMSs, how can we assist organizations that develop and provide CMSs in adopting these technologies for their daily work?
   How-To's or exercises may help these organizations to implement relevant IKS requirements and semantic technologies.
5. Can the IKS benchmark model identify inhibitors for the adoption of semantic technologies by industry?
   There may be some requirements relevant for the IKS but not for the industry (e.g., content that can be managed independently of the underlying CMS.

In this deliverable, we start with existing, widely accepted CMS benchmark models and extend them to a CMS benchmarking methodology that will help us answer these questions.

3 Related Work – CMS Benchmarks and Semantics

This section gives an overview of approaches towards existing benchmarks for CMSs and points at benchmarks currently used for semantic technologies. The challenge is to identify ways of benchmarking the semantic capabilities of CMSs. With the advent of social software on the one hand, and semantically enhanced content systems on the other, we are also faced with some "new kids on the block" such as semantic wikis and advanced semantic search tools which begin to succeed in semi-intelligent content aggregation and presentation.

3.1 Current Benchmarks for CMS

From the engineering perspective, benchmarking is defined as a "procedure, problem, or test that can be used to compare systems or components to each other or to a standard" (IEEE 1990, p. 12). By contrast, Horvath and Herter (1992) define benchmarking as an on-going process, in which products, services, processes and methods of organizational functions are compared among several firms. The latter definition takes also organizational processes into account which is consistent with the work of Camp (1989). Correspondingly, benchmarking objectives are manifold. Thus, benchmarking is used to show differences among firms, reveal the reasons for these differences, highlight opportunities for improvements to develop new strategic goals (Horvath and Herter 1992), reduce operating costs, increase awareness of changing customer needs, encourage innovation (Margherita and Klein 2007), and finally to overcome resistance to change (Shafer and Coate 1992).
In the IKS project, the benchmark objects are CMSs. There already exists prior work (Stahl and Maass 2003) and web-based portals (CMS Matrix by Plain-Black-Corporation 2009, June; CMS Review by Doyle 2009, June; CMS Benchmarks by BNP-Consulting 2007) that can be used to compare several CMSs according to a variety of benchmarking dimensions. *Table 2* consolidates and summarizes these dimensions with their corresponding evaluation criteria. The full summary of benchmarking dimensions and evaluation criteria is given in Table 7 (see Annex 7.1).

Table 2 - Consolidated benchmarking dimensions and criteria from current benchmarks[3].

No.	Dimension	Criteria / Features
1	Description	Product Name, Product website, Company Name, Company website, Company's description, Type (enterprise content management system, web content management system, cross media publishing system, news portal, blog, wiki), Reference implementations (at least 3 examples)
2	Technology	License (Open-source, Proprietary, which), platform (Windows, Linux, Mac, other), web server (Apache HTTP, Microsoft IIS, etc.), Application Framework (Perl, Python, .NET, J2EE, PHP, Cold Fusion, Ruby, other), CMS Framework (AxKit, Cocoon, Midgard, Zope, Ruby on Rails, other), programming language (Java, Perl, VB, PHP, Python, other), Persistence storage / databases (Oracle, SQL Server, MySQL, PostgreSQL, any ODBC, other), API (public to allow extensibility, non public, other), Code skeletons/templates for Plug-in development (yes/no), Test framework available (e.g., unit tests, smoke tests), Architecture (scalability, modularity), use of different server platforms for creation/staging/testing/delivery
3	Status	CMS-Release, year introduced, number of installations, number of downloads
4	Marketing	Price / License (per CPU, per user, other), average costs of implementation (incl. license), market position (revenues, competitors), company's size by the number of

[3] Note: some of the criteria can be assigned to several dimensions (e.g., user manuals can be assigned to the dimensions support and usability)

No.	Dimension	Criteria / Features
		employees, sales methods (sales force, online), number of sales personnel, support contracts, consultants, online demos / screen casts, sandbox, trial, prototype, proof of concept
5	Installation	Online how to, hours/days for typical install, documentation (online, printed), download site / CD-ROMs, Code commented, Root access required (yes, no), Shell access required (yes, no), Professional hosting available (yes, no)
6	Support	Certification program, number of developers, online help, training classes (free, commercial, other), tutorials (free, commercial, other), screen casts (free, commercial, other), commercial support, commercial customization available, commercial administration available, manuals (free, commercial, other), help desk, independent consultants, developer community (website, mailing list, forum, wiki, other), third-party developer community (website, mailing list, forum, wiki, other), user community (conference, website, mailing list, forum, wiki, other), context-sensitive help
7	Out-of-the-Box functionality, Built-in Applications, functional features	Workflow management (authoring of workflows, email notifications, status/stage in workflow, comments at each stage,), media asset repository (documents, images, sounds, Flash, video, etc.), information retrieval / search engine, blog, chat, email, classifieds, contact management, data entry, data warehousing, database reports, discussion / forum, document management, events calendar, events management, expense reports, FAQ management, file distribution, graphs and charts, groupware, guest book, help desk / bug reporting, HTTP proxy, In / Out board, job postings, link management, mail form, matrix (e.g., for product comparisons), my page / dashboard, newsletter, photo gallery, polls, product management, project tracking, site map, stock quotes, surveys, tests / quizzes, time tracking, user contributions, weather, web services front end, wiki, affiliate tracking, inventory / asset management, pluggable payments, pluggable shipping, pluggable Tax, Point of Sale, Shopping Cart, Subscriptions, wish lists, integrated web services (e.g., currency conversion), UDDI tools, clipboard, content scheduling, content staging, inline content editing, administration (online, offline, combination, other), Package Deployment, sub-sites / roots, themes / skins, trash, web-based style/template management, Web-based Translation Management, Workflow Engine, WYSIWYG editor, source editor, Structured Fields editor, XML editor, spell checker, template editor, merge tools, diff tools, open page on web (edit this page), automatic file lock on open, conflict resolution (who is working on it), replication functionality / synchronization of mirror sites, metadata management (thesaurus, taxonomies and ontologies), digital rights management, business process management, multi-channel publishing
8	Security	audit trail, captcha, content approval, email verification, role management (writers, editors, graphic artists, rights managers, publisher, etc.), granular privileges (per user, folder, role, file, content element, other), Kerberos authentication, LDAP authentication, login history, NIS authentication, NTLM authentication, pluggable authentication, problem notification sandbox, session management, SMB authentication, SSL compatible, SSL logins, SSL pages, firewall rules, single source of truth (single sign on, single authentication), versioning (scheduling and expiration, all elements date / time stamped, archive with rollback (per file, per site, other)), backup (onsite and offsite, files and databases, to non-volatile media, disaster recovery plan), records policy, privacy policy, flexible assignments of privileges to workflow, creator automatic owner of content, user subscription to workflow
9	Reporting	Chrono workflow and by worker, WebTrends-style for whole site, performance (page delivery times), Web statistics
10	Performance	Caching functionality (page caching, static content export), database replication, load balancing
11	Interoperability	Content Syndication (RDF, RSS, Webservices), FTP Support, iCal, UTF-8 Support, WAI Compliant, WebDAV Support, XHTML Compliant, migration Tools (from another CMS), Conversion tools (e.g.,Word to XML “chunks”), RDF ontology support (e.g., Dublin Core), multi-lingual content integration, multi-channel publishing
12	Flexibility	CGI-mode support, content reuse, extensible user profiles, interface localization, metadata, multi-lingual content, multi-site deployment, URL rewriting, multi-channel publishing
13	Usability	Drag-N-Drop Content, email to discussion, friendly URLs, image resizing, macro language, mass upload, prototyping, server page language (e.g., use of an existing PHP script), site setup wizard, spell checker, style wizard, subscriptions, template language, UI levels, undo, WYSIWYG editor, upload of Zip archives, time and effort for training, online help, tutorials (free, commercial, other), screen casts (free, commercial, other), manuals (free, commercial, other), help desk, independent consultants, context-sensitive help

No.	Dimension	Criteria / Features
14	Storage	Format (text, HTML, XML), Database only, Files only, Files and Database, Native support for file types, multiple file transfers (FTP, site import), mandatory metadata tagging (force structure and semantics)
15	Personalization	Identity management, relationship management (History), actions tracking, session / click / behaviour analysis

The dimensions and criteria described in *Table 2* have several limitations. First, different kinds of users of CMSs are not considered explicitly. For example, IT executives of CMS customers have other priorities than end users such as authors, content consumers or developers that directly work with CMSs. Correspondingly, the dimensions and criteria focus predominantly on a technical and functional level of CMSs, whereas a service perspective at the level of business executives is missing. We suggest that a valid benchmark model should explicitly indicate to which degree a CMS supports or enables capabilities of organizations or users to solve business problems. For IKS it must be said, that the usage of semantic technologies is only covered to a small degree by the CMS Review model (Doyle 2009, June). We conclude that the evaluation of CMSs from a business-driven perspective that also considers semantic web technologies is not feasible with the current benchmark models. However, since we want to engage in a dialogue with CMS technorati, we take the route of starting with existing benchmark models and gradually extending them towards the assessment of semantic technologies for CMS..

3.2 Benchmarking Semantic Web Technologies

At present, much of the work in benchmarking semantic web applications is related to interoperability. The benchmarking of Semantic Web technologies can be viewed from a methodological or a technological perspective (Garcia-Castro 2008). From a methodological perspective, there are at least three open issues:

1. the lack of a genuine semantic benchmarking methodology,
2. the difficulty of using current evaluation and improvement methodologies when benchmarking Semantic Web technologies,
3. the absence of integrated methods and techniques supporting the complex task of benchmarking Semantic Web technologies.

Several custom characterizations have been proposed under the perspective of the type of the Semantic Web technology to be benchmarked (i.e. ontology engineering tools, ontology matching tools (merge and alignment), ontology-based annotation tools, ontology storage and reasoning systems, semantic search tools, etc.), but the approaches used to benchmark one type of technology are difficult to reuse and maintain since they are specific to that type of technology or even specific to a certain tool or set of tools.

We also lack tools that support the benchmarking of different types of Semantic Web technologies and support the different tasks that have to be performed in these benchmarking activities. At the same time, if we explicitly look at future CMSs and stay focused on benchmarking semantic capabilities of these CMSs, then a variety of related fields need to be considered:

1. metadata,
2. Semantic Web languages (e.g. RDF(S), OWL),
3. logics and semantic reasoning mechanisms (i.e. Sesame 2, BRAHMS, OWLIM, OWLJessKB, Racer, RacerPro, KAON2, Pellet, FaCT++) and
4. tools (e.g., Protege: frames and OWL, KAON and KAON2, WebODE, Corese, Jena, Sesame, GATE, SemTalk, SWI-Prolog).

Still missing is a standard methodology and/or framework for benchmarking real semantic capabilities of CMSs. In order to arrive at such a methodology, we start by reviewing some of today's semantic benchmarking approaches such as:

1. The Berlin SPARQL Benchmark system (BSBM) is a benchmark for comparing the performance of storage systems that expose SPARQL endpoints. The BSBM has been running against (Bizer and Schultz 2008):
   a. four RDF stores such as Virtuoso[4] Version 5.0.10, Sesame[5] Version 2.2.4, Jena TDB[6] Version 0.72, Jena SDB[7] Version 1.2.0, and
   b. two relational database-to-RDF wrappers, such as D2R Server[8] Version 0.6 and Virtuoso - RDF Views[9] Version 5.0.10.
2. The Lehigh University Benchmark system (LUBM) for benchmarking Semantic Web reasoners, which is based on well-established practices for benchmarking database, but is extended to support the unique properties of the Semantic Web (Guo et al. 2004). It is based on an OWL Lite ontology for the University domain.
3. The University Ontology Benchmark system (UOBM) that extends the LUBM benchmark in terms of inference and scalability testing by adding extra TBox axioms making use of all of OWL Lite (UOBM Lite) and OWL DL (UOBM DL) (Ma et al. 2006).
4. The first methodology for benchmarking Semantic Web technologies proposed by Garcia Castro (2008) is useful in evaluating ontological tools, but provides less information on how to benchmark knowledge based systems with respect to extensional queries against large-scale instance data. Therefore, the LUBM can be seen as complementary to the work of Garcia-Castro.

The summary of the identified benchmarking dimensions, their corresponding evaluation criteria and the fundamental metrics is given in Table 3.

Table 3. Current semantic benchmarking dimensions, criteria and metrics

Source	Dimension	Criteria	Metrics
The Berlin SPARQL Benchmark (Bizer and Schultz 2008)	RDF data model (pure RDF triple representation)	(1) Find products for a given set of generic features; (2) Retrieve basic information about a specific product for display purposes; (3) Find products having some specific features and not having one feature; (4) Find products matching two different sets of features; (5) Find products that are similar to a given product; (6) Find products having a label that contains a specific string; (7) Retrieve in-depth information about a specific product including offers and reviews; (8) Give me recent reviews in English for a specific product; (9) Get information about a reviewer; (10) Get offers for a given product which fulfil specific requirements; (11) Get all information about an offer; (12) Export information about an offer	(1) Queries per Seconds - Average Query Execution Time - Queries per Second - Min/Max Query Execution Time (2) Query Mixes per Hour - Composite Query Execution Time - Average Query Execution Time over all Queries (3) Overall Runtime (4) The Price/Performance metric for the Complete System Under Test

[4] http://virtuoso.openlinksw.com/dataspace/dav/wiki/Main/
[5] http://www.openrdf.org/about.jsp
[6] http://jena.hpl.hp.com/wiki/SDB
[7] http://jena.hpl.hp.com/wiki/SDB
[8] http://www4.wiwiss.fu-berlin.de/bizer/d2r-server/
[9] http://virtuoso.openlinksw.com/dataspace/dav/wiki/Main/

		into another schemata.	
	Named Graphs data model	The same criteria as for the RDF data model (work in progress – 15. June 2009)	The same metric as for the RDF data model
	Relational data model	The same criteria as for the RDF data model (work in progress – 15. June 2009)	The same metric as for the RDF data model
The Lehigh University Benchmark (Guo et al. 2004)	Reasoning capabilities (i.e. RDFS, OWL Lite)	Input size; Selectivity; Complexity; Assumed hierarchy information; Assumed inference	(1) Load time (2) Size after loading (3) Query answering time (4) Completeness and soundness regarding the queries (5) Combined metric for query answering time and answering completeness and soundness
	Storage mechanisms (i.e. memory-based systems like Sesame and OWL-JessKB, and/or systems with persistent storage like database-based Sesame and DLDB-OWL)	The same criteria as for measuring the reasoning capabilities	The same metric as for measuring the reasoning capabilities
The University Ontology Benchmark (Ma et al. 2006)	OWL Lite, OWL DL ontologies covering a complete set of OWL Lite and DL constructs	Classes, Datatype property, Object property, Individuals in TBox, Statements per University, Individuals per University	(1) Load time (2) Query response time (3) Completeness and soundness (Completeness measures the recall of a system's answer to a query and soundness measures its precision.)
Methodology for benchmarking Semantic Web technologies (Garcia-Castro 2008)	RDF(S) Interoperability	Modelling (yes/no); Execution (ok/fail); Information added; Information lost	The measurement metric is based on analysis of the RDF(S) interoperability capabilities of the tool such as KAON RDF(S), Protégé-Frames RDF(S), WebODE RDF(S).
	RDF(S) Import	Modelling (yes/no); Execution (ok/fail); Information added; Information lost	… based on analysis of the RDF(S) import capabilities of the tool such as KAON RDF(S), Protégé-Frames RDF(S), WebODE RDF(S), RDF repositories such as Corese, Jena, Sesame
	RDF(S) Export	Modelling (yes/no); Execution (ok/fail); Information added; Information lost	… based on analysis of the RDF(S) export capabilities of the tool such as KAON RDF(S), Protégé-Frames RDF(S), WebODE RDF(S), RDF repositories such as Corese, Jena, Sesame
	OWL Interoperability	Execution (ok/fail/comparer error/not executed); Information added; Information lost; Interchange (same/different/no if execution is failed, comparer error or not executed)	GATE OWL, Jena OWL, KAON2 OWL, Protégé-Frames OWL, Protégé-OWL, SemTalk OWL, SWI-Prolog OWL, WebODE OWL

3.3 "New Kids on the Block" – Semantic Systems with CMS Capabilities

Up to now, a huge amount of research efforts can be found around the Semantic Web technologies, but even today we identify few of the Semantic Web-based CMSs or properly documented ideas of developing such a system. Recently, some CMS and wiki systems have started incorporate semantic metadata modules such as Drupal RDF modules[10] or the RDF Tools for Wordpress[11]. We have analyzed three such semantically enriched CMSs: Octapy 3, ONKI and Rhizomer. The results are presented in Table 4.

Table 4. Semantically enriched CMSs

CMS	Purpose	Implementation	Functionalities
Octapy 3[12]	to manage cartographic document and RDF(S) serialization of documents and different content types	- written in Python, - uses the Zope Application Server - uses the Plone CMS as web publishing tool	- to organize collections of (semi) structured digital documents into archives and/or cooperating archives; - to create web based applications that use W3C protocols for the Web services and content access; - to deploy open standards such as Dublin Core (DC), RDF, OWL, Simple Object Access Protocol (SOAP), Universal Description, Discovery and Integration (UDDI)
ONKI[13]	to support ontological representation of a knowledge, ontology manipulation as well	- implemented as a Java Servlet using the Jena Semantic Web Framework, Direct Web Remoting (DWR) library for implementing the AJAX communication between the user interface and the ONKI Server - Lucene text search engine	- concept search - implemented as an AJAX component that transforms ordinary text fields into ontological concept search and fetching fields; - concept browser - implemented as a web application used for traversing the ontology between related concepts; - provides Web Service API and supports downloading ontologies as files
Rhizomer[14]	to develop a multimedia CMS combined with a fully featured semantic data repository with reasoning capabilities	- based on Resource Oriented Approach (RESTful) and Semantic Web technologies - offers a generic RDF to HTML transformation that makes it possible to navigate through semantic metadata and the associate ontologies. - actions implemented by means of Semantic Web services associated to the resources by a matching process based on their semantic descriptions	- content retrieval - metadata browsing - editing metadata - content uploading and annotation

[10] http://drupal.org/node/222788
[11] http://bnode.org/blog/2008/01/15/rdf-tools-an-rdf-store-for-wordpress
[12] http://octapycms.remuna.org/
[13] http://www.seco.tkk.fi/services/onki/
[14] http://rhizomik.ne/rhizomer

Today almost all large-community CMSs have an integrated wiki module. Wikis come in three flavours: plain, structured and fully semantic:

1. The collaborative encyclopaedia Wikipedia[15] is one of the best-known plain wikis.
2. Structured wikis: They enable creating wiki applications for very specific needs, such as call-center status boards, to-do lists, inventory systems, employee handbooks, bug trackers, blog applications and more. Some examples of the structured wiki are the following:
   - TWiki pioneered the structured wiki concept. It is a flexible, powerful, and easy to use enterprise wiki and collaboration platform. TWiki with Plugins and add-ons has many features such as action tracking, barcode generation, blogging, calendaring, charting, conditional text, database access, Extreme Programming tracking, global search & replace, image gallery, LaTeX support, mail into wiki pages, page hierarchy, platform to build wiki applications, slideshow presentations, spreadsheet calculations, table editor, tagging, web form handling and reporting, word alias support, XML and XSL transformations, and more.
   - MediaWiki (www.wikia.com) is software that runs Wikipedia, one of the world's largest websites that has an excellent range of features and support for high-traffic websites using multiple servers.
   - Confluence is designed for enterprise use with unlimited wikis, enhanced social features, networks, macro browser, detailed security, an easy learning curve, edit in Word, rich text editing, document management, flexible search, blogs, RSS, email archives, labels, HTML / PDF / Word export, clustering and a remote API. Plugins provide custom themes, multiple languages, Office integration, advanced PDF generation, document workflow/reviews, advanced templates, attachment checkout, access as a network drive and integration with software development tools.
3. Semantic wikis: They represent the extensible environments for creating a "knowledge layer" adding new capability in searching and navigation of the underlying content. Content in the semantic wikis is defined by using concepts, attributes and relationships. Some examples of the semantic wikis are the following:
   - Kiwi[16] is a new approach to knowledge management that combines the wiki philosophy with the intelligence and methods of the Semantic Web;
   - Semantic MediaWiki[17] is an extension to MediaWiki[18] that allows annotation of the semantic data[19] within wiki pages;
   - AceWiki[20] uses the controlled natural language ACE[21] in order to help authors to write correct ACE sentences.

To summarize, there are content-related, semantics-based applications emerging, which could either be a long-term threat to traditional CMS technology, or which could result in a significant innovative push to current CMS technology. IKS is attempting to support the latter, because it seems to offer a faster route to market, for innovation, and because it would strengthen an industry with which Europe is well able to compete in the global economy.

[15] http://en.wikipedia.org/wiki/Wikipedia
[16] http://www.kiwi-project.eu/
[17] http://semantic-mediawiki.org
[18] http://www.mediawiki.org
[19] http://en.wikipedia.org/wiki/Semantic_web
[20] http://attempto.ifi.uzh.ch/acewiki/
[21] http://attempto.ifi.uzh.ch/

4 IKS Benchmark Model for CMSs

In this section, we describe the benchmark model for CMSs (see Figure 2). The core of the model consists of five consecutive layers that describe a top-down approach from the business needs down to the technology perspective:

1. **Business needs** of organizations (e.g., increase customer reach)
2. **Capabilities** of organizations (e.g., broadening communication with potential customers)
3. **CMS services** (e.g., multi-channel advertising)
4. **CMS functions** (e.g., formatting ads for mobile devices)
5. **CMS technologies** (e.g., Java, PHP, .Net, CSS)

The top layer represents business needs (also known as business problems) that organizations are confronted with. In order to solve these problems, organizational and information systems infrastructure capabilities (Layer 2) are required (Henderson and Venkatraman 1993, Hevner et al. 2004). On the third layer, CMSs provide services that either support existing or enable new capabilities. These services are composed of low-level functions (Layer 4), usually denoted as CMS features in traditional CMS benchmark projects. And finally, each of the CMS functions is realized by a variety of technologies (Layer 5). To summarize the core of our benchmark model, business problems and capabilities are directly connected to organizations that use CMSs, whereas the remaining layers, i.e., services, functions and technology are rather related to CMSs vendor companies.
Based upon this core model, we adopt a two-way approach for benchmarking CMSs. The first approach is study-driven and targets IT executives of customers and providers of CMSs (e.g., CIOs or CTOs). By contrast, the second approach is experiment-driven and targets the developers of CMS vendors. Each approach has its benefits and therefore, we elected to use them both: the study-driven approach on the one hand, allows us to identify current and future business needs of both customers and vendors of CMS together with CMS features that are desired as of today and in the future. Correspondingly, we can measure the fit between business needs and CMSs. The result of the study-driven approach is two-fold. First, CMSs are benchmarked regarding their business alignment and second, we can provide a pool of current and future business needs, necessary capabilities, services and technologies that can directly be used for the requirements analysis of the IKS.
On the other hand, the experiment-driven approach provides detailed insights into the architecture and technology of CMSs. Starting with business-level objectives, we agreed on an initial set of seven CMS functionalities for which CMS providers already have customer solutions. We now pose implementation challenges and we ask the CMS providers to use their current frameworks for the prospective solutions. The following outcomes and consequences are possible:

a) *experiment result:* the current tools are adequate to create very good solutions.
   consequence: it is unlikely that semantic technologies will add value in this challenge.
b) *experiment result:* the current tools are just about capable of solving the problem, but the solutions are awkward to maintain and extend.
   consequence: semantic technologies should be investigated for this challenge
c) *experiment result:* the current tools completely fail at solving the problem.
   consequence: semantic technologies may provide a solution, but the problem may be too poorly understood to be solved, at present.

We expect outcomes of the benchmark challenges at three levels:

i. design-level assessment of the developers whether they will be able to solve the problem posed, given their CMS technology.

ii. prototype demo system using the CMS providers' existing technology

iii. extended prototype making use of bespoke extensions to solve the posed problem, or using semantic technologies, already.

Through this experiment-driven approach, we are able to derive architectural and technical requirements for the IKS. In addition to the results of each approach, we will match both sets of results and will validate them in order to determine for which CMS services the use of semantic technologies has relative advantages over traditional CMS technologies. The application of both approaches holds the promise that IKS will be able to develop relevant services in the form of reusable, semantics-based modules for CMSs.
In summary, the IKS benchmark model for CMSs together with an example is shown in Figure 2. The following sections explain the two approaches in detail.

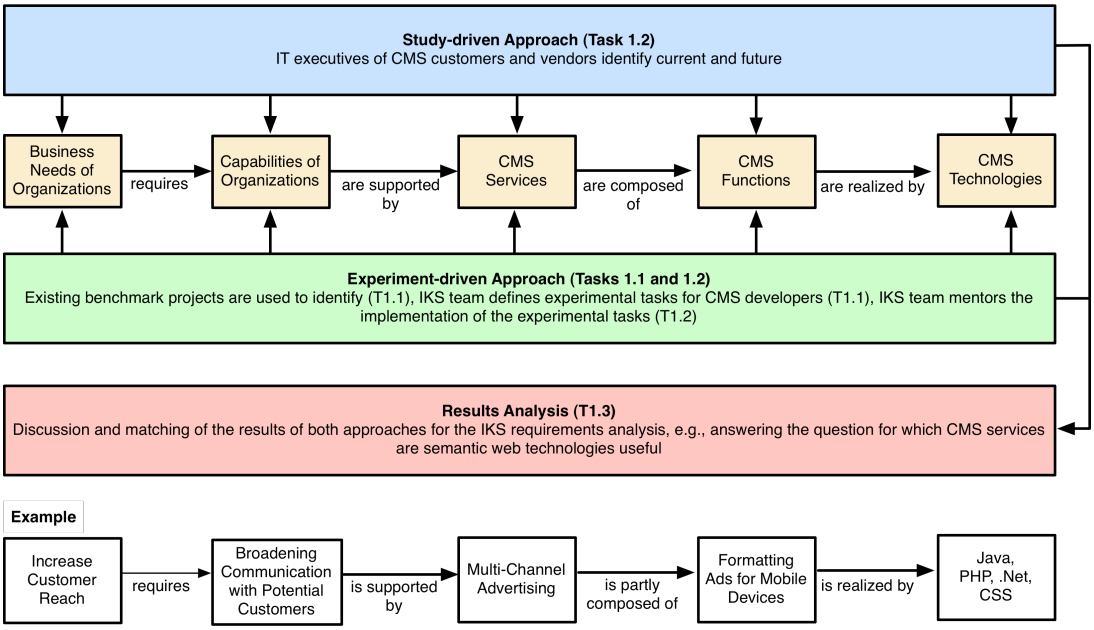

Figure 2. IKS benchmark model with corresponding example[22]

4.1 Study-driven Approach: Evaluating the Fit between CMS and Business Needs

The fit of business needs with IT leads to more focused and strategic use of IT which, in turn, leads to increased business performance of organizations (Chan et al. 2006). Several studies (e.g., Chan et al. 1997, de Leede et al. 2002, Irani 2002, Kearns and Lederer 2003) support the hypothesis that “those organizations that successfully align their business strategy with their IT strategy will outperform those that do not” (Chan and Reich 2007, p.298). Thus, alignment of business and IT is a prime concern for executives of organizations (Luftman et al. 2005). Accordingly, our goal is to benchmark CMSs (as a particular IT artefact) by determining the degree to which they support the needs of (business) organizations.
In order to achieve our goal and remain consistent with the CMS benchmark framework, we follow a top down approach from a senior executive’s perspective. Two kinds of executives are involved in judging the business value of CMSs. The first group are IT executives of organizations that use a particular CMS. They are able to judge the degree to which their chosen CMS supports capabilities required to implement their business strategy. By contrast, IT executives of CMS provider organizations belong to the second user group that develop and customize CMSs for their customers. They judge the degree to which their CMS product

[22] Note: T1.x indicates, in which task of IKS WP1 the description within the boxes are conducted

supports capabilities to implement their own business strategies as well as those of their customers. As both user groups differ by nature, we need separate evaluation criteria to capture their assessments. First, we propose a research model for the CMS *customers*, before we discuss the model for IT executives of CMS *providers*.

4.1.1 IT executives of CMS customer

CMSs can provide a core business value for information-intense firms, because they cultivate processes of information generation, acquisition, conversion, distribution and presentation (see Johannessen et al. 2001, p.3). Thus, it is crucial in the evaluation of the business value of a CMS to measure the information intensity of the value chains of organizations that use a CMS. Thus, we include the evaluation criteria *information intensity* in our evaluation, which is defined as the significance of the information component in value chain activities and is demonstrated by the level of accuracy, frequency of updates, and the magnitude and extent information employed in operations (see Busch et al. 1991, Teo and King 1997). Regarding the IT alignment model of Kearns and Lederer (2003), information intensity influences the fit between IT and business indirectly through the CIO's participation in business planning meetings. As information intensity strongly correlates with the CIO's participation in business planning, we state the following hypothesis in order to measure the fit between CMS and business needs:

H1: The information intensity of the value chain of CMS customers is positively associated with the fit between their CMS and their business needs.

Second, the business utility of CMSs is measured by its contribution to net benefits as formulated by the updated D&M IS success model (DeLone and McLean 2003). Here, net benefits are the outcomes of CMS use and increase competitive advantage of the CMS customers. Thus, the use of a CMS for competitive advantage "is a performance variable measured by items that directly influence and defend against Porter's (1980) five competitive forces" (Kearns and Lederer 2003, p. 8). Accordingly, IT-based strategies can lower product and service costs, improve productivity, profitability and the quality of products or services, combat competitors, create product differentiation, increase customer switching-costs, and raise market entry barriers (Bergeron et al. 2004, Parsons 1983). Consistent with Kearns and Lederer (2003) we therefore hypothesize the following relationship in the context of CMSs:

H2: The fit between a CMS and business needs of a CMS customer is positively associated with the use of that CMS to provide a competitive advantage.

Our research model to benchmark CMSs from the perspective of IT executives of CMS customers is presented in Figure 3. It allows us to identify the information intensity of the value chains of CMS customers, the fit between their CMS and business needs and their competitive advantage that is increased by the use of CMSs as of today.
But we are also interested in CMS services that need to be improved or that are still missing in order to increase the fit and thus also increase competitive advantage. In this sense, we will ask CMS customers for improvements of existing or new CMS services and that are not only required now but will also have a strong impact on competitive advantage in the future. The results will help and guide the requirements engineering of relevant IKS components.

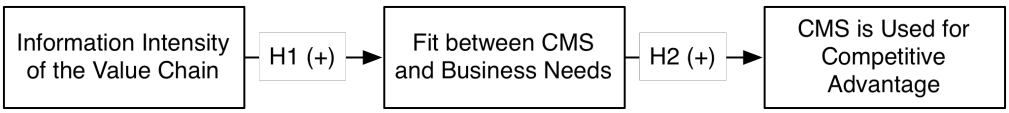

Figure 3. Model for evaluation of CMSs from the IT executive perspective of CMS customers.

We will conduct a study with IT executives of organizations that use CMSs to test the research model and to identify the CMS aspects, i.e., services, that need to be optimized or that are desired today and in the future. Questionnaire items regarding the research model are taken and adapted from the IT alignment measurement instruments of Kearns and Lederer (2003) and Bergeron et al. (2004). We will use a 7-point Likert scale ranging from strongly disagree (1) to strongly agree (7) to measure the extent to which these items apply to each CMS customer taking part in the survey. In addition, we provide three questionnaire items to ask for relevant CMS aspects, as there exist no prior research. In summary, all items are presented in Table 5. Furthermore, as many organizations run more than one CMS or even more than ten, the participants will be asked to choose at least one CMS (usually the CMS of our industrial partners) and to provide a detailed description of its application within the value chain of the organization. In addition, each organization is characterized with regard to its products, industry as well as organizational and technical infrastructure. In this sense, we are able to compare the results (in particular the qualitative results) more objectively and therefore reduce the bias at the same time. Using StatsDirect[23], a sample size of 14 was calculated, which would be good enough to detect Pearson correlation coefficients with very large effect sizes (f^2=.70) and a significance level of .05. A statistical power of .80 was used for calculation, which is common in the management of information systems research (Baroudi and Orlikowski 1989, Cohen 1977).

Table 5. Study constructs and questionnaire items

No	Construct	Questionnaire Item	Supporting Research
II1	Information Intensity of the value chain	Information is used to a great extent in our production or service operations.	Busch et al. 1991, Teo and King 1997
II2		Information used in our production or service operations is frequently updated.	
II3		Information used in our production or service operations is usually accurate.	
II4		Many steps in our production or service operations require frequent use of information.	
F1	Fit between CMS and business needs	The CMS supports the business plan mission.	King 1978
F2		The CMS supports the business plan goals.	Tallon et al. 2000, King 1978
F3		The CMS supports the business strategies.	Tallon et al. 2000, King 1978
F4		The CMS recognizes external business environment forces	Burns and Szeto 2000, Johnston and Carrico 1988
F5		The CMS reflects the business plan resource constraints	Johnston and Carrico 1988
CA1	The CMS is used for competitive advantage	With respect to our company's core products or services and major customers and suppliers, the CMS is used … to reduce costs or product differentiation.	Bergeron et al. 2004, Parsons 1983, Porter 1980
CA2		to make substantial savings	
CA3		to improve your firm's productivity	
CA4		to increase your firms's profitability	
CA5		to improve the quality of your products or services	
CA6		to respect the deadlines requested by your customers	
CA7		for product differentiation	
CA8		to make it more costly for our customers to change suppliers.	
CA9		to establish electronic links with suppliers and customers.	
CA10		to create barriers to keep competitors from entering our markets.	
CA11		to influence the buyer's decision to switch to our products.	

[23] StatsDirect, Version 2.7.5, http://www.statsdirect.com

BNNSS	Business needs not sufficiently supported by a CMS as of today	Which existing business needs are not sufficiently supported by your CMS to increase competitive advantage for your company as of today? Note: Each business need stated must be rated on a 7-point Likert scale according to its relevance to increase competitive advantage and the CMS shortcoming should be described shortly.	N/A
BNNS	Business needs not supported at all by a CMS as of today	Which existing business needs are not supported at all by your CMS to increase competitive advantage for your company as of today? Note: Each business need stated must be rated on a 7-point Likert scale according to its relevance to increase competitive advantage and the desired CMS features should be described briefly.	N/A
DCS	Desired CMS support for future business needs	Which business problems are relevant for your company in 3 to 5 years? Note: Each business problem stated must be rated on a 7-point Likert scale according to its relevance to increase competitive advantage and secondly, the desired future CMS features that would solve this problem (partly) should be described briefly.	N/A

4.1.2 IT executives of CMS providers

In the following, we adapt the research model proposed in the last section such that they are applicable for CMS providers. The core business of CMS providers is the development of CMSs to increase their own competitive advantage. Accordingly, to provide the right CMS services to their customers, they need to consider the right technologies and skills of their employees as of today and for the future. And these considerations are also driven by business needs that their own CMS should address. In this sense, the business needs of CMS providers differ to some extent compared to the needs of CMS customers. Accordingly, CMSs can be evaluated by determining their fit with the CMS providers' business needs. In contrast to the research model developed for CMS customers (see Figure 3), we do not measure the information intensity of the value chain, because we assume that this value chain is information-intense per se as it represents a software engineering activity. Therefore, we state only the following hypothesis:

H3: The fit between the CMS and business needs of a CMS provider is positively associated with the use of that CMS to provide competitive advantage.

A study with IT executives of CMS providers will be conducted to test the third hypothesis and to get qualitative results from the CMS providers. Accordingly, we will ask them to indicate business needs, which their CMS does not support sufficiently as of today and secondly, we will ask for CMS aspects that are required in the future to solve their business needs. This will give us the opportunity not only to capture requirements from the customer perspective but also from the provider's point of view. We therefore reuse the corresponding questionnaire items from Table 5 with the exception of the items concerning the information-intense construct, i.e., II1 to II5.

4.2 Experiment-driven Approach: Evaluating the Architecture and Technology of CMSs

In this section, we describe how the architecture and technology of CMSs are evaluated for the development of business relevant CMS services. In contrast to the study-driven approach, the services are pre-defined and directly derived from prior benchmark projects and

feedback of the industrial partners of IKS (see Annex 7.2). In the following, we develop a set of experimental tasks:

- Finding relevant information fast, in different usage contexts (Semantic Search)
- Intelligent Content Authoring and Content Aggregating (Intelligent Authoring)
- Combining Content Services with Work Flows (Business Processes and Content)
- Customizing Content Services for Customer Groups/Channels (Multi-channel Publishing)
- Complex Content Aggregation for Product Configuration (Context-sensitive Content)
- Making events visible in ambient environments (Spatio-temporal, semantic content)
- Building up business intelligence about the customer base (community semantics)

Each of the experimental tasks is rooted in a business setting and there are practical user stories, which relate the task to a real-world usage scenario. The IKS team of researchers assists and mentors this implementation of the experimental tasks.

For each task there is a set of questions at the end in order to assess the degree to which the CMS in question is capable of representing the necessary semantics. While this may not be scientifically fully valid, it is progress beyond the state of the art, because we are relating business needs with CMS functionality and we are relating a finite set of semantic concepts to those business needs. This is more than what currently established CMS benchmarks are offering and it is a first step towards establishing an agreed notion of “semantics” in relation to content management.

Criticising our benchmarks is welcome – this is why we explain them thoroughly.

The semanticity of a CMS is a percentage figure established as follows:

1) Do the experimental tasks as described
2) Deploy the software for the experimental for open scrutiny
3) Make a self-assessment of your compliance by answering the task related questions
4) Use yes (100%) and no (0%) for binary questions
5) Use steps of 30% (some) or 60% (a fair amount) or 90% (nearly completely) for questions that are fuzzy, such as “To what degree can you specify a product configuration?”
6) Normalise the result for each task, i.e. make the sum and divide by the number of questions asked.
7) Plot the result against the Portfolio of (currently seven) experimental tasks
8) Normalise the overall result, i.e. make the sum of all tasks, and divide by 7 (currently).

The next task in IKS is doing the experiments. Thereafter, we will validate the results.

Experiment 1 – Finding relevant information fast, in different usage contexts

Business Need / Problem
Retrieving relevant information fast and efficiently for decision making / to solve problems

Required Capability
Repository of content, metadata, IS infrastructure / CMS-service that supports the retrieval of information

Derived CMS-service (high-level requirement description)
Search service

Required CMS-Functions (low-level requirement description, hints for useful technologies)
- *Query construction:* constructing (un)structured queries that can be applied to data mining, text analysis, information retrieval (IR), faceted classification, tagging, combining precise structure queries with imprecise keyword search, etc.
- *Search algorithm:* applying particular sort of search algorithms like free text search based on using natural language (NL) indexing; list search (hash tables, binary search); tree search algorithm for structured data; graph search, etc.
- *Presentation of results:* visualization of search results that are specified by a relevance metric or metadata attributes
- *Interaction with results:* categorizing results; personalization according to the context

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Usability: user interface
Functional features: repository, information retrieval, content syndication, knowledge management
CMS Matrix
Interoperability: content syndication
Flexibility: metadata
Built-in Applications: search engine, syndicated content
CMS Review
Content acquisition: mandatory metadata tagging, RDF ontology support
Content aggregation: incoming syndication feeds, metadata management, integrated web services
Tag editor: drop-down menus of all tags, metadata thesaurus, taxonomies / ontologies online
Help online: context-sensitive help
Associations: hierarchy, taxonomy, index, cross reference
CMS Benchmark
Technological criteria: architecture, security
User criteria: usability, search capabilities, personalization
Business criteria: open standards

Experimental task described by an exemplary user story
- I have a collection of 30'000 documents, and I want to find the five documents that talk about or were edited by John Smith. Problem is, there are three John Smiths in my company, and the two others appear in lots of documents.
- When visiting a house rental website, I can formulate queries like “recent pages that talk about houses to rent in the french part of Switzerland” and the website search engine understands them.
- I'm working with a digital asset management system, and I want to find images that are similar to the one I'm looking at, either in terms of the real-world objects that the images represent, or in terms or graphical similarity (colours, shapes, etc.).
- My customers do not understand each detail of my product descriptions and thus need help on the fly. I want my content to be self-descriptive, such that rarely used terms of my product descriptions are linked to Wikipedia or other external resources (see http://opencalais.com for an example)

Possible application domains
This is a generic functionality needed in all CMS. Contextualisation of search is a likely driver of productivity.

Experiment 2 – Intelligent Content Authoring and Content Aggregating

Business Need / Problem
Creation of business relevant information that can be shared fast and efficiently among employees and customers / Making implicit knowledge explicit to increase competitive advantage

Required Capability
Implicit knowledge and skills of Employees, documents, IS infrastructure / CMS-service that supports the creation and exchange of information.

Derived CMS-service (high-level requirement description)
Content creation and presentation service

Required CMS-Functions (low-level requirement description, hints for useful technologies)
- *Content identification and segmentation:* designing the information spaces based on existing content; linking new content with the existing information spaces
- *Content management:* content transformation in sense of different visualization and categorization of the same content; content authoring; applying content policy; access control and security of the content; version archiving
- *Content presentation:* semantic content, aesthetic content
- *Interaction with the content:* user-specific interaction, device-specific or environment-specific interaction.

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Usability: user interface
Functional features: content creation
CMS Matrix
Ease of use: site setup wizard, spell checker, style wizard, template language, WYSIWYG Editor, undo
Management: clipboard, trash, themes / skins, web-based style / template management
Interoparability: content syndication
Flexibility: content reuse, metadata, multi-lingual content, multi-lingual content integration, events calendar, events management, link management, my page / dashboard, photo gallery
CMS Review
Content acquisition: native support for file types, FTP, migration tools, conversation tools, rights management, mandatory metadata tagging (fore structure and semantics), RDF ontology support
Content element editors: WYSIWYG through-the-web, structured field editor, spell checker, content objects use templates, media asset repository
Template editors: WYSIWYG through-the-web editor, template gallery
Tag editor: Drop-down menus of all tags, metadata thesaurus, taxonomies / ontologies online
Access permission levels: creator automatic owner of content, check In / check out
workflow: open page on web (edit this page), automatic file lock on open, conflict resolution, merge tools, diff tools
CMS Benchmark
Technological criteria: architecture, security
User criteria: usability, integration to client tools
Business criteria: open standards

Experimental task described by an exemplary user story
I am a product manager. When I write a newsletter for my customers, I want to make sure that each person, each product or each location mentioned in the newsletter can be enriched (semi-automatic or automatic) with the right meta information (e.g., the geographical location of a city) such that those enriched entities can be found easily again.

Possible application domains
Media publishing (e.g., employee or customer portal)

Experiment 3 – Combining Content Services with Work Processes

Business Need / Problem
Assure quality standards for business processes

Required Capability
Quality management standards, roles, business processes, IS infrastructure / CMS-service that supports quality management of business processes

Derived CMS-service (high-level requirement description)
Workflow service

Required CMS-Functions (low-level requirement description, hints for useful technologies)
- Workflow design: designing the workflow space that explains process activities, transition conditions, roles…; annotation and indexing of process definition elements
- Running and tracking the execution of workflow service: workflow management: running the workflow service, annotating and tracking the execution, etc.

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Usability: user interface
Functional features: workflow management
CMS Matrix
Security: content approval, granular privileges
Ease of use: template language
Management: content scheduling, web-based style / template management, workflow engine
Interoperability: XHTML Compliant
Flexibility: metadata
Built-in applications: document management, groupware
CMS Review
Content acquisition: rights management
Template editors: WYSIWYG through-the-web editor, template gallery
Access Permission Levels: flexible assignments to workflow, user subscription to workflow, check in / check out
Workflow: automatic file lock on open, conflict resolution
Arbitrary Roles: writers, editors, etc.
Reporting: chronological workflow and by worker
Metadata management: business process management
CMS Benchmark
Technological criteria: architecture, security
User criteria: workflow, usability, integration to client tools
Business criteria: open standards

Experimental task described by an exemplary user story
As a publisher, I want to make sure, that each article is reviewed by at least two editors, before it is published.

Possible application domains
Media publishing (e.g., news articles)

Experiment 4 – Customizing Content Services for Customer Groups/Channels

Business Need / Problem
Increase contacts with potential customers (reach in marketing) to acquire new customers or to increase customer loyalty

Required Capability
Knowledge about media channels for content distribution, specifications of these media channels / end-user devices, repository of content, IS infrastructure / CMS-service that supports the design and distribution of content via different media channels.

Derived CMS-service (high-level requirement description)
Multi-channel publishing service

Required CMS-Functions (low-level requirement description, hints for useful technologies)
- *Create catalogue of available services and related information:* customizable interface to update the catalogue
- *Publish multi-channel catalogue:* XML publishing; semantic publishing

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Usability: user interface,
Functional features: publishing and presentation, cross media database
CMS Matrix
Ease of use: site setup wizard, style wizard, template language,
Management: themes / skins, web-based style / template management, workflow engine,
Interoparability: XHTML Compliant
Flexibility: content reuse
CMS Review
Template editors: WYSIWYG through-the-web editor, template gallery,
Publishing: Multi-channel publishing to different clients
CMS Benchmark
Technological criteria: architecture, security
User criteria: usability, integration to client tools,
Business criteria: open standards

Experimental task described by an exemplary user story
I am a media publisher and I want my content to be perfectly adapted to the media channel used by my customers, i.e., my content should be formatted on the fly for a (1) desktop-sized computer display, (2) small-sized display of a mobile device, or (3) printout

Possible application domains
Media publishing (e.g., advertising)

Experiment 5 – Complex Content Aggregation for Product Configuration

Business Need / Problem
Selling complex products, which are required to be configured individually, fast and efficiently

Required Capability
Repository of available components, organizational knowledge about possible product configurations, IS infrastructure / CMS-service that supports the declaration of components by authors and configuration of components by end users, etc.

Derived CMS-service (high-level requirement description)
Product configuration service

Required CMS-Functions (low-level requirement description, hints for useful technologies)

- *Product construction/design:* controlled values of the product components, free text input, add-ons/extras, rules
- *Presentation of a product:* semantic networks, semantic spaces, topic models, multimodal representation
- *Interaction with the product:* user model, content model, context model

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Usability: user interface
Functional features: publishing and presentation, repository, e-Commerce, information retrieval
CMS Matrix
Ease of use: drag-n-drop content
Management: asset management, product management
Commerce: shopping card, wish lists
CMS Review
Arbitrary Roles: authors, end users
Associations: hierarchy, taxonomy, cross reference
CMS Benchmark
Technological criteria: architecture, security
User criteria: usability, search capabilities
Business criteria: open standards

Experimental task described by an exemplary user story
I am a PC vendor and I want to implement a PC configuration page that guides the user in an intelligent way to avoid impossible combinations of components. The possible combinations are defined declaratively, I don't want to write code to describe them.

Possible application domains

- Industry (see user story),
- Tourism (travel package),
- Media publishing (bundles of paid content, e.g. get songs for two)

Experiment 6 – Making events visible in ambient environments

Business Need / Problem
Communication of events to attract new customers and to inform / take care of existing ones

Required Capability
Marketing department, event management capabilities, IS infrastructure / CMS-service that supports the communication and distribution of event information

Derived CMS-service (high-level requirement description)
Event distribution service

Required CMS-Functions (low-level requirement description, hints for useful technologies)

- *Creation of customized event lists:* customization based on event type, location; personalization; contextualization; creation of alerts and reminders about the events
- *Informing the audience:* informing based on event type, location, etc.

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Functional features: content creation, publishing and presentation, content syndication
CMS Matrix
Management: advertising management, workflow engine
Interoperability: content syndication, iCal
Flexibility: metadata, multi-lingual content
Built-in Applications: events calendar, events management, syndicated content
CMS Review
Content element editors: structured fields editor, content objects use templates
Syndication: RDF and RSS syndicated news feeds
Associations: cross reference
CMS Benchmark
Technological criteria: architecture
User criteria: workflow, integration to client tools
Business criteria: open standards

Experimental task described by an exemplary user story
I'm a hotel manager and I'm adding info about a music show that takes place in my hotel next Friday. Internet users should be able to find this info using queries like "events that take place at the end of next week within 10km of where I am now", without having to know about my website.

Possible application domains
Media Publishing (e.g., Advertising, Ticketing Services)

Experiment 7 - Building up business intelligence about the customer base

Business Need / Problem
Personalized customer relationship management to skim consumer surplus24

Required Capability
Data acquisition of current and historic information about the customer, IS infrastructure / CMS-service that supports the acquisition of customer data and distribution of personalized content (e.g., offerings, its layout)

Derived CMS-service (high-level requirement description)
Personalization service

Required CMS-Functions (low-level requirement description, hints for useful technologies)

- *Collecting information about customers and customer interactions:* uploading and storing information
- *Tracking customer interaction:* collecting information about policies, processes and strategies, trends, cultural norms, etc.
- (customer model…)

Relevance of the task based on existing benchmark criteria (see Section 7.1)
Stahl and Maass 2003
Functional features: content creation, publishing and presentation, content syndication
CMS Matrix
Management: advertising management, themes/skins, web-based style/template management, workflow engine
Interoperability: content syndication, WAI compliant
Flexibility: extensible user profiles, interface localizations, metadata, multi-lingual content, multi-lingual content integration
Built-in Applications: chat, contact management, FAQ management, my page / dashboard, newsletter, syndicated content, user contributions, wiki
Commerce: wish lists
CMS Review
Content aggregation: incoming syndication feeds, metadata management, fields editor, content objects use templates
Personalization: identity management, relationship management (history), actions tracking, session / click / behaviour analysis
Personalization: multilingual server, multilingual user interface
CMS Benchmark
Technological criteria: architecture
User criteria: personalization
Business criteria: open standards

Experimental task described by an exemplary user story
I am a provider of digital movies and I want to make personalized offerings with regard to the loyalty of my customers. Thus the price of a movie depends on the number of movie rentals per month for each customer.
or:
I want to promote product features my customers are most interested in. Thus, I need to configure / personalize offerings according to the preferences of each customers.

Possible application domains
- Industry (personalized product offerings),
- Tourism (personalized travel package),
- Media publishing (loyalty discount for consumers of music)

[24] Note: *to skim the consumer surplus* is a term from economics referring to the fact that some customers are willing to pay a higher price for some product and personalisation may allow a vendor to determine that price level more accurately.

5 Summary and Next Steps

In this deliverable, we proposed a business-oriented benchmark model for CMSs, denoted as the IKS benchmark model, after we had identified shortcomings of existing CMS benchmark projects. The IKS benchmark model uses a study-driven and an experiment-driven approach to evaluate CMSs consistently from the business perspective down to the technology layer. Accordingly, research models and questionnaire items were presented for the study-based approach that targets IT executives of both customers and providers of CMSs. Likewise, experimental tasks were developed for the experiment-driven approach targeting CMS developers.

As a next step, the study as well as the exercises will be conducted as part of IKS Task 1.2. Results of both approaches will then be analysed and integrated in Task 1.3. In particular, we will then be able to provide answers to the questions stated in the introduction. Thus, we will discuss (1) the fit between CMSs and business needs (and likewise the corresponding gaps), (2) desired and improvable CMS features, (3) which CMS features can be improved significantly or implemented mainly through the use of semantic technologies and which features are still more suited to be implemented by traditional technologies, (4) whether the experimental tasks can be used as a foundation for how-to's or exercises that help CMS developers implementing semantic technologies, and (5) inhibitors of the adoption of semantic technologies by industry.

IKS is developing specifications and a reference implementation of a "semantics-based" stack of CMS functionalities. The designing of a benchmarking methodology for such systems serves at least three purposes: firstly, we wanted to connect the world of commercial CMS with the world of semantic (web) technologies. Secondly, we need to understand the nature of "semantic" applications in order to distinguish them from "traditional" applications. However, the danger is that soon, every that already works is called "traditional" and everything that does not (yet) work will be called "semantic". This is a recipe for research disaster as was witnessed in artificial intelligence in the 60s and 70s – when it worked they called it DBMS and search algorithms or query optimisation, and when it did not work then it was called "the unfulfilled promises of AI" ☺. Thirdly, we use the benchmarking exercise as a method of gathering further functional requirements for "semantic" CMS. This deliverable is the first step of IKS, into the world of measurable progress beyond the state of the Art in all kinds of content management systems. In Sports terms: this is the "first sector" timing, but not the final lap. We invite the community for feedback how to improve our sector timing in the next lap, and we are now progressing to the second sector: trying to build seven "semantic system components", on the basis of traditional technology, with semantic elements used where the CMS providers consider this useful. Follow us on www.iks-project.eu !

6 References

Baroudi, J. J., & Orlikowski, W. J. (1989). The Problem of Statistical Power in MIS Research. MIS Quarterly, 13(1), 7-106.

Bergeron, F., Raymond, L., & Rivard, S. (2004). Ideal Patterns of Strategic Alignment and Business Performance. *Information & Management, 41*(8), 1003-1020.

Bizer, C., & Schultz, A. (2008). The Berlin SPARQL Benchmark (BSBM) Specification - V2.0, from http://www4.wiwiss.fu-berlin.de/bizer/BerlinSPARQLBenchmark/spec/index.html#metrics

BNP-Consulting (2007). CMS Benchmark, from http://www.bnp.dk/121.0.html

Burns, J. M., & Szeto, C. (2000). A Comparison of the Views of Business and IT Management on Success Factors for Strategic Alignment *Information and Management, 37*, 197-216.

Busch, E., Jarvenpaa, S., Tractinsky, N., & Glick, W. (1991). *External versus Internal Perspectives in Determining a Firm's Progressive Use of Information Technology*. 12th International Conference on Information Systems (ICIS 1991). New York, USA

Camp, R. C. (1989). *Benchmarking: The Search for Industry Best Practices that Lead to Superior Performance* Milwaukee, Wisconsin: Productivity Press.

Chan, Y. E., Huff, S. L., Barclay, D. W., & Copeland, D. G. (1997). Business Strategic Orientation, Information Systems Strategic Orientation, and Strategic Alignment. *Information Systems Research, 8*(2), 125-150.

Chan, Y. E., & Reich, B. H. (2007). IT alignment: what have we learned? *Journal of Information Technology, 22*, 297-315.

Chan, Y. E., Sabherwal, R., & Thatcher, J. B. (2006). Antecedents and Outcomes of Strategic IS Alignment: An empirical investigation. *IEEE Transactions on Engineering Management, 51*(3), 27-47.

Cohen, J. (1977). *Statistical Power Analysis for the Behavioral Sciences*. New York, USA: Academic Press.

de Leede, J., Looise, J. C., & Alders, B. (2002). Innovation, Improvement and Operations: An exploration of the management of alignment. *International Journal of Technology Management, 23*(4), 353-368.

DeLone, W. H., & McLean, E. R. (2003). The DeLone and Mc Lean Model of Information Systems Success: A Ten-Year Update. *Journal of Management Information Systems, 19*(4), 9-30.

Doyle, B. (2009, June). CMS Review, from http://www.cmsreview.com

Garcia-Castro, R. (2008). *Benchmarking Semantic Web Technology.* Universidad Politechnica de Madrid, Madrid, Spain.

Guo, Y., Pan, Z., & Heflin, J. (2004). *LUBM: A Benchmark for OWL Knowledge Base Systems*. 3rd International Semantic Web Conference (ISWC 2004). Hiroshima, Japan

Henderson, J., & Venkatraman, N. (1993). Strategic Alignment: Leveraging Information Technology for Transforming Organizations. *IBM Systems Journal, 32*(1).

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly, 28*(1), 75-105.

Horvath, P., & Herter, R. N. (1992). Benchmarking: Vergleich mit den Besten der Besten. *Controlling*(1), 4-11.

IEEE (1990). IEEE Standard Glossary of Software Engineering Terminology. New York, NY, USA: The Institute of Electrical and Electronics Engineers.

Irani, Z. (2002). Information Systems Evaluation: Navigating through the problem domain. *Information Management, 40*(1), 11-24.

Johannessen, J., Olaisen, J., & Olsen, B. (2001). Mismanagement of tacit knowledge: The importance of tacit knowledge, the danger of information technology, and what to do about it. *International Journal of Information Management, 21*(1), 3-20.

Johnston, R. H., & Carrico, S. R. (1988). Developing Capabilities to Use Information Strategically. *MIS Quarterly, 12*(2), 37-48.

Kearns, G. S., & Lederer, A. L. (2003). A Resource-Based View of Strategic IT Alignment: How knowledge sharing creates competitive advantage. *Decision Sciences, 34*(1), 1-29.

King, W. R. (1978). Strategic Planning for Management Information Systems. *MIS Quarterly, 2*(1), 27-37.

Luftman, J., Kempaiah, R., & Nash, E. (2005). Key Issues for IT Executives 2005. *MIS Quarterly Executive, 5*(2), 81-101.

Ma, L., Yang, Y., Qiu, Z., Xie, G., Pan, Y., & Liu, S. (2006). Towards a Complete OWL Ontology Benchmark. In Y. Sure & J. Domingue (Eds.), *Proc. of the 3rd European Semantic Web Conference (ESWC'06), Budva, Montenegro* (Vol. 4011 of LNCS, pp. 125-139). Heidelberg, Germany: Springer.

Margherita, A., & Klein, M. (2007). An e-handbook for designing and implementing a benchmarking project. *International Journal of Process Management and Benchmarking, 2*(1), 10-28.

Parsons, G. L. (1983). Information Technology: A New Competitive Weapon. *Sloan Management Review, 25*(1), 3-14.

Plain-Black-Corporation (2009, June). CMS Matrix, from http://www.cmsmatrix.org/

Porter, M. E. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York: Free Press.

Shafer, B. S., & Coate, L. E. (1992). Benchmarking in Higher Education: A Tool for Improving Quality and Reducing Cost. *Business Officer, 26*(5), 28-35.

Stahl, F., & Maass, W. (2003). *Content Management Handbuch*. St. Gallen: NetAcademy Press.

Tallon, P. P., Kraemer, K. L., & Gurbaxani, V. (2000). Executives' Perceptions of the Business Value of Information Technology: A Process-oriented Approach. *Journal of Management Information Systems, 16*(4), 145-173.

Teo, T. S. H., & King, W. R. (1997). Integration between Business Planning and Information Systems Planning: An Evolutionary-contingency Perspective. *Journal of Management Information*

7 Annex

7.1 Benchmarking Dimensions and Criteria Listed by Reference

Table 7. Benchmarking dimensions and corresponding evaluation criteria

Reference	Dimension	Criteria
Stahl and Maass (2003)	Future proofness	number of installations, average costs of implementation incl. license, number of developers and sales personnel, firm's size by the number of employees, handling of technology trends
	Level of technological innovativeness	the degree the CMS can be embedded into other systems (such as Groupware or CRM systems), scalability, modularity, interoperability, architecture and basis technology
	Usability	user interface, documentation, time and effort for training
	Customization	content management workflow, user administration, functionality
	Customer feedback	satisfaction with the customer support, performance of the system, quality and degree of customization support, attainment of the specified objectives
	Functional features	Content Creation, Storing and Development, Publishing and Presentation, Workflow Management, Repository, Information Retrieval, Content Syndication, E-Commerce, Portal- and Community Building, Data and Document Warehousing, Knowledge Management, Cross Media Database
CMS Matrix, (Plain-Black-Corporation 2009, June)[25]	System Requirements	Application Server, Approximate Cost, Database, License, Operating System, Programming Language, Root Access, Shell Access, Web Server
	Security	Audit Trail, Captcha, Content Approval, Email Verification, Granular Privileges, Kerberos Authentication, LDAP Authentication, Login History, NIS Authentication, NTLM Authentication, Pluggable Authentication, Problem Notification Sandbox, Session Management, SMB Authentication, SSL Compatible, SSL Logins, SSL Pages, Versioning
	Support	Certification Program, Code Skeletons, Commercial Manuals, Commercial Support, Commercial Training, Developer Community, Online Help, Pluggable API, Professional Hosting, Professional Services, Public Forum, Public Mailing List, Test Framework, Third-Party Developers, Users Conference
	Ease of Use	Drag-N-Drop Content, Email To Discussion, Friendly URLs, Image Resizing, Macro Language, Mass Upload, Prototyping, Server Page Language, Site Setup Wizard, Spell Checker, Style Wizard, Subscriptions, Template Language, UI Levels, Undo, WYSIWYG Editor, Zip Archives
	Performance	Advanced Caching, Database Replication, Load Balancing, Page Caching, Static Content Export
	Management	Advertising Management, Asset Management, Clipboard, Content Scheduling, Content Staging, Inline Administration, Online Administration, Package Deployment, Sub-sites / Roots, Themes / Skins, Trash, Web Statistics, Web-based Style/Template Management, Web-based Translation Management, Workflow Engine
	Interoperability	Content Syndication (RSS), FTP Support, iCal, UTF-8 Support, WAI Compliant, WebDAV Support, XHTML Compliant
	Flexibility	CGI-mode Support, Content Reuse, Extensible User Profiles, Interface Localization, Metadata, Multi-lingual Content, Multi-lingual Content Integration, Multi-Site Deployment, URL Rewriting
	Built-in Applications	Blog, Chat, Classifieds, Contact Management, Data Entry, Database Reports, Discussion / Forum, Document Management, Events Calendar, Events Management, Expense Reports, FAQ Management, File Distribution, Graphs and Charts, Groupware, Guest Book, Help Desk / Bug Reporting, HTTP Proxy, In/Out Board, Job Postings, Link Management, Mail

[25] For a detailed description of the items see http://www.cmsmatrix.org/uploads/9E/7n/9E7ny_zM3rRruTSOamP_cA/Fields-and-Descriptions.xls

Reference	Dimension	Criteria
		Form, Matrix, My Page / Dashboard, Newsletter, Photo Gallery, Polls, Product Management, Project Tracking, Search Engine, Site Map, Stock Quotes, Surveys, Syndicated Content (RSS), Tests / Quizzes, Time Tracking, User Contributions, Weather, Web Services Front End, Wiki
	Commerce	Affiliate Tracking, Inventory Management, Pluggable Payments, Pluggable Shipping, Pluggable Tax, Point of Sale, Shopping Cart, Subscriptions, Wish Lists
CMS Review (Doyle 2009, June)	Description	Product Name, Company Name, Company/Organization website, Product web page, Company's description, Our Description
	Technology	License (Open-source, Proprietary, which), Type (General CMS, Framework, Front end (UI), News Portal, Blog, Wiki), Platform (Windows, Linux, Mac, etc.), Web Server (IIS, Apache, etc.), Application Framework (Perl, Python, .NET, J2EE, PHP, Cold Fusion, etc.), CMS Framework (AxKit, Cocoon, Midgard, Zope, etc.), Programming Languages (Perl, VB, Java, PHP, Python, etc.), Databases (Oracle, SQL Server, MySQL, PostgreSQL, any ODBC, etc.), API (public to allow extensibility).
	Status	Release (2.0, etc.), Year introduced, Number of Installs and /or Downloads, Developer Community (website?, mail list?)
	Marketing	Price, License (per CPU, per user, etc.), Market Position (Revenues, Competitors), Sales Methods (Sales Force, Online), Support Contracts, Consultants, Online Demos, Sandbox, Trial, Prototype, Proof of Concept
	Installation	Online How To, Hours/Days for Typical Install, Documentation online/printed, Download site/CD-ROMs, Code Commented
	Support	Online Help, Tutorials, Training Classes, Cost, Commercial Contracts, Help Desks, Independent Consultants
	Content acquisition	Native support for filetypes, Multiple file transfers (FTP, site import), Migration Tools (from another CMS), Conversion tools (e.g.,Word to XML "chunks"), Rights management, Mandatory metadata tagging (force structure and semantics), RDF ontology support (e.g., Dublin Core)
	Content aggregation	Incoming syndication feeds, Metadata management (read incoming metadata), Integrated Web Services (e.g., currency conversion), UDDI tools
	Content element editors	WYSIWYG Through-The-Web Editor, Source Editor, Structured Fields Editor, XML Editor, Spell checker, Content objects use templates, Media asset repository (images, sounds, Flash, video, etc.)
	Template editors	WYSIWYG Through-The-Web, Template Gallery, XML Editor
	Tag editor	Drop-down menus of all tags, Metadata Thesaurus, Taxonomies / Ontologies online
	Help online	Context-sensitive help, Documentation, Examples
	Access Permission Levels (Privilege granularity), Workflow	Number of levels, Per User / Folder / Role / file / Content Element, Flexible assignments to workflow, Creator automatic owner of content, User subscription to workflow, LDAP Support
	Check In/Check Out, Workflow	Open page on web (Edit this page), Automatic file lock on open, Conflict Resolution (who has it?), Instant Messaging (email, phones), Merge Tools, Diff Tools
	Workflow messaging	Email notifications (links to work), Status (stage in workflow), Comments at each stage, Audit trail (workflow log)
	Arbitrary Roles, Workflow	Writers, Editors, Graphic Artists, Rights Managers, Publishers, etc.
	Versioning	Scheduling and Expiration, All elements - templates date/time stamped, Archive with rollback (per file or site?)
	Personalization	Identity Management, Relationship Management (History), Actions tracking, Session/Click/Behavior analysis
	Localization	Multilingual server (Respond to browser language requests, Gist translation option), Workflow (Automatic notifications, Quality checkers), UI multilingual
	Reporting	Chrono workflow and by worker, WebTrends-style for whole site, Specific monitors, Performance (page delivery times)
	Storage	Format (text, HTML, XML), Database only, Files, Files and database
	Backup	Onsite and offsite, Files and database, To nonvolatile media, Disaster recovery plan
	Security	Firewall rules, Encrypted sessions
	Staging server for	Testing methodology, Replicates publishing environment

Reference	Dimension	Criteria
	QA	
	Publishing	Separate Delivery from Creation/Staging/Testing (Use different server platform?, Replication, Synchronization of mirror sites), Multi-channel Publishing to different clients (PDAs, Cell phones, Handicap accessibility)
	Syndication	RDF and RSS Syndicated News Feeds, Web services
	Publishing security	Audit Trails, Users, System, Network
	Business rules	Records Policy, Privacy Policy
	Integration	Single Source Of Truth (Single Sign On, Single Authentication), Enterprise portal, Legacy database reuse, Data warehousing
	Metadata management	Digital rights management, Business process management
	Associations	Hierarchy, taxonomy, Index, Cross reference
	Analysis	Analytic tools, Pattern recognition
	Search and Locate	
CMS Benchmark, BNP-Consulting 2007	Technological criteria	Architecture, Integration, Security, Customisation, Out-of-the-Box functionality
	User Criteria	Workflow, Usability, Search capabilities, Personalisation, Integration to client-tools
	Business criteria	Partners within technology, Focus on third party development, Price/Structure, References, Open standards

7.2 Preliminary Feedback from the IKS Industrial Partners

In addition to existing CMS benchmark projects, we conducted a preliminary survey with the industrial partners of IKS to identify relevant aspects of CMSs for IKS and our benchmark framework. These CMS aspects include high-level business needs such as information, communication, collaboration and security needs as well as content elements (e.g., text and audio files), services, processes and workflows of CMS as well as CMS elements used to describe situations relevant for the AmI use case of IKS.

Additional Notes:

- **Mean:** Mean value of the preceding figures, i.e., it ranges from 1 to 3 and from 1 to 5 according to the questions.
- **St. Mean:** Standardized value of the mean value, i.e., it ranges from 0 to 1.
- **Weighted Score:** The number of answers is included as relevance factor: St. Mean multiplied with the number of answers divided by the maximum number of answers (6). Thus, it corresponds to the St. Mean value if each of the industrial partners provided an answer

7.2.1 Results of the survey: needs

Table 8: Needs ranked regarding the results of the survey.

Priorized regarding customers' use		Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software				
Needs		**Our Customers and their customers** have the following needs regarding our CMS/KMS.									
		Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.							Mean	St. Mean	**Weighted Score**
Information needs		2	3	2	1	2	2		2,000	0,667	**0,667**
Communication needs		2	2	2	1	2	1		1,667	0,556	**0,556**
Collaboration needs		3	1	1	1	1	3		1,667	0,556	**0,556**
Security needs		2	1	1	1	1	1		1,167	0,389	**0,389**

7.2.2 Results of the survey: content elements

Table 9: Content elements ranked regarding the results of the survey (current status).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software	Mean	St. Mean	Weighted Score
Content Object	**Our Customers** manage the following content objects in our CMS/KMS.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.								
Images	2	2	3	3	3	1	2,333	0,778	**0,778**
Articles	2	3	3	1	3	1	2,167	0,722	**0,722**
Products	1	1	1	3	3	1	1,667	0,556	**0,556**
People (e.g., Users, Customers, etc.)	2	2	1	2	2	1	1,667	0,556	**0,556**
Videos, Live-Stream, Movies	1	1	3	-	2	1	1,600	0,533	**0,444**
Contracts	2	2	1	1	1	1	1,333	0,444	**0,444**
Projects and Project Elements	1	2	3	-	2	-	2,000	0,667	**0,444**
Events (e.g., Concerts)	-	1	2	2	3	-	2,000	0,667	**0,444**
Music	1	-	1	-	1	1	1,000	0,333	**0,222**
Tickets	-	-	1	2	1	-	1,333	0,444	**0,222**
Reservations	-	1	1	-	1	-	1,000	0,333	**0,167**
Formats of Content	**Our customers** use the following formats of content objects in our CMS/KMS.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.						Mean	St. Mean	Weighted Score
Image files	3	3	3	3	3	2	2,833	0,944	**0,944**
Text files	3	3	2	2	3	1	2,333	0,778	**0,778**
Video files	1	1	3	-	2	2	1,800	0,600	**0,500**
Audio files	1	1	1	-	1	2	1,200	0,400	**0,333**
Atoms of Content	-	-	1	-	1	3	1,667	0,556	**0,278**
Metadata of Content	**Our customers** attach the following metadata to content objects in your CMS…								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.						Mean	St. Mean	Weighted Score
Title	3	3	2	3	3	3	2,833	0,944	**0,944**
Description	3	3	2	3	3	3	2,833	0,944	**0,944**
Date and time (can be implicit)	3	3	2	3	3	3	2,833	0,944	**0,944**
Author	3	3	2	2	3	3	2,667	0,889	**0,889**
Keywords or tags	2	2	3	2	3	3	2,500	0,833	**0,833**
Access rights / restrictions	2	2	1	3	3	3	2,333	0,778	**0,778**
Format (can be implicit)	3	2	2	-	3	3	2,600	0,867	**0,722**
Location	1	2	1	3	3	3	2,167	0,722	**0,722**
Related content (e.g., through links)	1	1	3	1	3	3	2,000	0,667	**0,667**
Language	1	1	1	2	3	3	1,833	0,611	**0,611**

Table 10: Content elements ranked regarding the results of the survey (future expectations).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software	Mean	St. Mean	Weighted Score
Content Object	**In general**, the following content objects have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	Weighted Score
Images	4	5	4	5	5	5	4,667	0,933	**0,933**
Articles	5	5	5	2	5	5	4,500	0,900	**0,900**
Products	5	3	2	5	5	5	4,167	0,833	**0,833**
People (e.g., Users, Customers, etc.)	4	1	2	-	3	5	3,000	0,600	**0,500**
Videos, Live-Stream, Movies	4	1	4	2	5	5	3,500	0,700	**0,700**
Contracts	5	2	1	2	3	4	2,833	0,567	**0,567**
Projects and Project Elements	2	3	5	-	5	5	4,000	0,800	**0,667**
Events (e.g., Concerts)	-	4	1	5	5	3	3,600	0,720	**0,600**
Music	2	-	2	2	2	5	2,600	0,520	**0,433**
Tickets	-	-	1	5	2	3	2,750	0,550	**0,367**
Reservations	-	2	1	1	3	-	1,750	0,350	**0,233**
Formats of Content	**In general**, the following content formats have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	Weighted Score
Image files	5	5	5	5	5	5	5,000	1,000	**1,000**
Text files	5	5	5	5	5	5	5,000	1,000	**1,000**
Video files	4	1	5	-	3	5	3,600	0,720	**0,600**
Audio files	2	1	1	-	1	5	2,000	0,400	**0,333**
Atoms of Content	2	-	1	-	-	5	2,667	0,533	**0,267**
Metadata of Content	In general, the following metadata has a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	Weighted Score
Title	3	5	3	3	5	5	4,000	0,800	**0,800**
Description	4	4	3	5	5	5	4,333	0,867	**0,867**
Date and time (can be implicit)	4	4	3	5	5	1	3,667	0,733	**0,733**
Author	5	4	3	3	3	5	3,833	0,767	**0,767**
Keywords or tags	5	3	5	5	5	5	4,667	0,933	**0,933**
Access rights / restrictions	4	2	1	3	3	5	3,000	0,600	**0,600**
Format (can be implicit)	2	3	3	-	4	5	3,400	0,680	**0,567**
Location	4	3	1	5	5	5	3,833	0,767	**0,767**
Related content (e.g., through links)	5	4	5	5	5	5	4,833	0,967	**0,967**
Language	2	2	1	-	5	3	2,600	0,520	**0,433**

7.2.3 Results of the survey: services

Table 11: Services ranked regarding the results of the survey (current status).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software	Mean	St. Mean	**Weighted Score**
Basic Services	**Our Customers** use the following basic services in our CMS/KMS.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.								
Creating content	3	3	3	1	2	1	2,167	0,722	**0,722**
Storing content	3	3	2	1	3	1	2,167	0,722	**0,722**
Searching content	3	3	3	1	2	1	2,167	0,722	**0,722**
Controlling content (access rights and roles)	3	3	1	1	3	1	2,000	0,667	**0,667**
Providing content	2	1	3	1	3	1	1,833	0,611	**0,611**
Presenting content	1	2	2	1	3	1	1,667	0,556	**0,556**
Distributing content (content syndication)	2	1	2	1	3	1	1,667	0,556	**0,556**
Versioning and archiving content	2	1	1	-	1	1	1,200	0,400	**0,333**
Advanced Services	**Our customers** use the following advanced services in our CMS/KMS.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.						Mean	St. Mean	**Weighted Score**
Image Gallery service	3	3	2	1	1	1	1,833	0,611	**0,611**
Authentication service	3	2	1	-	3	1	2,000	0,667	**0,556**
Retrieving content from external sources (e.g., dbpedia or news providers)	1	1	1	1	3	1	1,333	0,444	**0,444**
Collaborative tagging service	2	2	1	-	1	1	1,400	0,467	**0,389**
Weblog service	2	1	1	-	1	1	1,200	0,400	**0,333**
Wiki service	2	1	1	-	1	1	1,200	0,400	**0,333**
Forum service	1	1	1	-	2	1	1,200	0,400	**0,333**
Social network service	2	1	1	-	1	1	1,200	0,400	**0,333**
Content translation service	1	1	1	-	2	1	1,200	0,400	**0,333**
Registration service	-	1	1	1	2	1	1,200	0,400	**0,333**
Project management service	1	1	1	-	2	1	1,200	0,400	**0,333**
Payment service (e.g., for credit card transactions)	-	1	1	1	1	1	1,000	0,333	**0,278**
Online shop service	-	1	1	1	1	1	1,000	0,333	**0,278**
Instant messaging service	1	1	1	-	1	-	1,000	0,333	**0,222**
Customer Relationship Management (CRM)	-	-	1	-	2	1	1,333	0,444	**0,222**
Enterprise Resource Planning (ERP)	-	-	-	-	1	-	1,000	0,333	**0,056**

Table 3: Services ranked regarding the results of the survey (future expectations).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software	Mean	St. Mean	Weighted Score
Basic Services	**In general**, the following basic services have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	Weighted Score
Creating content	5	5	5	5	5	5	5,000	1,000	**1,000**
Storing content	4	5	3	3	3	-	3,600	0,720	**0,600**
Searching content	5	4	5	5	5	5	4,833	0,967	**0,967**
Controlling content (access rights and roles)	5	2	1	3	2	-	2,600	0,520	**0,433**
Providing content	4	5	5	5	5	-	4,800	0,960	**0,800**
Presenting content	4	5	3	5	5	5	4,500	0,900	**0,900**
Distributing content (content syndication)	5	3	3	5	5	5	4,333	0,867	**0,867**
Versioning and archiving content	4	2	1	-	2	-	2,250	0,450	**0,300**
Advanced Services	**In general**, the following advanced services have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	Weighted Score
Image Gallery service	3	4	3	3	3	5	3,500	0,700	**0,700**
Authentication service	3	3	-	-	1	-	2,333	0,467	**0,233**
Retrieving content from external sources (e.g., dbpedia or news providers)	5	1	-	5	5	5	4,200	0,840	**0,700**
Collaborative tagging service	5	3	-	-	5	5	4,500	0,900	**0,600**
Weblog service	5	2	-	-	5	-	4,000	0,800	**0,400**
Wiki service	5	3	-	-	5	5	4,500	0,900	**0,600**
Forum service	4	2	-	-	3	5	3,500	0,700	**0,467**
Social network service	5	1	-	-	3	4	3,250	0,650	**0,433**
Content translation service	3	1	-	5	3	5	3,400	0,680	**0,567**
Registration service	3	1	-	-	2	-	2,000	0,400	**0,200**
Project management service	2	-	-	-	4	4	3,333	0,667	**0,333**
Payment service (e.g., for credit card transactions)	1	2	-	3	1	-	1,750	0,350	**0,233**
Online shop service	1	3	-	5	2	5	3,200	0,640	**0,533**
Instant messaging service	5	1	-	-	2	-	2,667	0,533	**0,267**
Customer Relationship Management (CRM)	-	-	-	-	4	5	4,500	0,900	**0,300**
Enterprise Resource Planning (ERP)	-	-	-	-	3	-	3,000	0,600	**0,100**

7.2.4 Results of the survey: processes

Table 4: Processes ranked regarding the results of the survey (current status).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software			
Processes (Workflows)	**Our Customers** model the following processes in our CMS/KMS to support users step by step in achieving their goals.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.						Mean	St. Mean	**Weighted Score**
Publish process (e.g., Write > Review > Distribute)	3	3	3	1	3	1	2,333	0,778	**0,778**
Search process (e.g., Keywords > Filter > Results)	3	3	3	1	2	1	2,167	0,722	**0,722**
Authentication process (e.g., register if applicable) > Provide Account data)	3	2	1	-	2	1	1,800	0,600	**0,500**
Media-coding process (e.g., automated coding of video clips)	1	1	3	-	1	1	1,400	0,467	**0,389**
Registration process (e.g., Provide Email > Get Confirmation > Confirm)	-	1	1	1	2	1	1,200	0,400	**0,333**
Payment process (e.g., select type of payment > Provide payment data > check data > confirm)	-	1	1	1	1	1	1,000	0,333	**0,278**
Checkout process (e.g., provide info on customer's shopping basket > payment process)	-	1	1	1	1	1	1,000	0,333	**0,278**
Booking process (selecting object > payment process)	-	1	1	1	1	1	1,000	0,333	**0,278**
Buying process (e.g., search a song > authenticate > checkout)	-	1	1	1	1	1	1,000	0,333	**0,278**

Table 5: Processes ranked regarding the results of the survey (future expectations).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software			
Processes (Workflows)	**In general**, the following processes have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.								
	Please rate from 1 (strongly disagree) to 5 (strongly agree).						Mean	St. Mean	**Weighted Score**
Publish process (e.g., Write > Review > Distribute)	4	5	5	5	5	5	4,833	0,967	**0,967**
Search process (e.g., Keywords > Filter > Results)	5	4	5	5	5	5	4,833	0,967	**0,967**
Authentication process (e.g., register if applicable) > Provide Account data)	1	1	1	-	2	1	1,200	0,240	**0,200**
Media-coding process (e.g., automated coding of video clips)	3	2	5	-	2	5	3,400	0,680	**0,567**
Registration process (e.g., Provide Email > Get Confirmation > Confirm)	1	1	1	5	2	4	2,333	0,467	**0,467**
Payment process (e.g., select type of payment > Provide payment data > check data > confirm)	1	1	1	2	1	3	1,500	0,300	**0,300**
Checkout process (e.g., provide info on customer's shopping basket > payment process)	1	1	1	2	1	3	1,500	0,300	**0,300**
Booking process (selecting object > payment process)	1	1	1	5	2	5	2,500	0,500	**0,500**
Buying process (e.g., search a song > authenticate > checkout)	1	1	1	5	1	5	2,333	0,467	**0,467**

7.2.5 Results of the survey: elements of situations

Table 6: Elements of situations ranked regarding the results of the survey (current status).

Priorized regarding customers' use	Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software	Mean	St. Mean	**Weighted Score**
Elements of Situations	**Our customers** model the following elements of a social system in our CMS/KMS to adapt their content to users needs.								
	Please rate from 1 (applicable to some customers) to 3 (applicable to almost all customers) if applicable.						Mean	St. Mean	**Weighted Score**
Role and Security Model (e.g., modelling roles and access rights)	3	-	2	-	3	1	2,250	0,750	**0,500**
Presentation Model (e.g., How is content presented on which device?)	-	-	3	-	2	1	2,000	0,667	**0,333**
Business Model (e.g., Modelling contracts for content objects, free vs. paid contents, content bundling, etc.)	3	-	-	-	1	1	1,667	0,556	**0,278**
Time Model (e.g., for time-based publication of contents)	1	-	-	1	2	1	1,250	0,417	**0,278**
Location Model (e.g., for language selection or tax adaptivity according to buyer's location)	1	-	-	-	3	1	1,667	0,556	**0,278**
User Model (modelling different users such as students, parents, etc.)	2	-	-	-	1	-	1,500	0,500	**0,167**
Device/Product Model (e.g., on which product/device can the content be presented)	-	-	-	-	2	1	1,500	0,500	**0,167**
Interaction Model (e.g., Which interactions are allowed with the content and the device in question?)	-	-	-	-	2	1	1,500	0,500	**0,167**
Situation Model (e.g., for defining a purchase situation, product information can be enriched with user reviews if only one buyer is present)	-	-	-	-	1	1	1,000	0,333	**0,111**

Table 7: Elements of situations ranked regarding the results of the survey (future expectations).

Priorized regarding customers' use		Nuxeo	Alkacon Software	TXT Polymedia	Pisano Holding	Nemein Oy	Day Software				
Elements of Situations		**In general**, the following elements of a social system have a great potential to be reused or traded within a business context or to be made more useful through explicit semantics.									
		Please rate from 1 (strongly disagree) to 5 (strongly agree).							Mean	St. Mean	**Weighted Score**
Role and Security Model (e.g., modelling roles and access rights)		4	-	3	-	3	4		3,500	0,700	**0,467**
Presentation Model (e.g., How is content presented on which device?)		4	-	5	-	3	3		3,750	0,750	**0,500**
Business Model (e.g., Modelling contracts for content objects, free vs. paid contents, content bundling, etc.)		5	-	-	-	4	5		4,667	0,933	**0,467**
Time Model (e.g., for time-based publication of contents)		5	-	-	2	3	3		3,250	0,650	**0,433**
Location Model (e.g., for language selection or tax adaptivity according to buyer's location)		5	-	-	-	5	5		5,000	1,000	**0,500**
User Model (modelling different users such as students, parents, etc.)		5	-	-	-	3	5		4,333	0,867	**0,433**
Device/Product Model (e.g., on which product/device can the content be presented)		4	-	-	-	3	4		3,667	0,733	**0,367**
Interaction Model (e.g., Which interactions are allowed with the content and the device in question?)		5	-	-	-	3	4		4,000	0,800	**0,400**
Situation Model (e.g., for defining a purchase situation, product information can be enriched with user reviews if only one buyer is present)		-	-	-	-	3	5		4,000	0,800	**0,267**

7.3 Detailed Task Descriptions for CMS Developers

This annex is intended as a guide for Task 1.2 of IKS: "Industrial Benchmark Exercise". We identified seven business goal-related tasks which could benefit from semantic technology:

- Finding relevant information fast, in different usage contexts (Semantic Search)
- Intelligent Content Authoring and Content Aggregating (Intelligent Authoring)
- Combining Content Services with Work Flows (Business Processes and Content)
- Customizing Content Services for Customer Groups/Channels (Multi-channel Publishing)
- Complex Content Aggregation for Product Configuration (Context-sensitive Content)
- Making events visible in ambient environments (Spatio-temporal, semantic content)
- Building up business intelligence about the customer base (community semantics)

Each of the experimental tasks is rooted in a business setting and there are practical user stories, which relate the task to a real-world usage scenario. The IKS team of researchers assists and mentors this implementation of the experimental tasks.

For each task there is a set of questions at the end in order to assess the degree to which the CMS in question is capable of representing the necessary semantics. While this may not be scientifically fully valid, it is progress beyond the state of the art, because we are relating business needs with CMS functionality and we are relating a finite set of semantic concepts to those business needs. This is more than what currently established CMS benchmarks are offering and it is a first step towards establishing an agreed notion of "semantics" in relation to content management.

The semanticity of a CMS is a percentage figure established as follows:

1. Do the experimental tasks as described
2. Deploy the software for the experimental for open scrutiny
3. Make a self-assessment of your compliance by answering the task related questions
4. Use yes (100%) and no (0%) for binary questions
5. Use steps of 30% (some) or 60% (a fair amount) or 90% (nearly completely) for questions that are fuzzy, such as "To what degree can you specify a product configuration?"
6. Normalise the result for each task, i.e. make the sum and divide by the number of questions asked.
7. Plot the result against the Portfolio of (currently seven) experimental tasks
8. Normalise the overall result, i.e. make the sum of all tasks, and divide by 7 (currently).

7.3.1 Semantic Search

Business Need

Retrieving relevant information fast and efficiently for decision making / to solve problems

Tasks / Procedure for a CMS supplier

1. Analyse the search application of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.

4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS
8. Answer the task-specific questions after you have done the development

Search phase	Feature	Functionality	Interface Components
Query construction	Free text input	keyword(s) natural language	Single text entry Property-specific fields
	Operators	boolean operators special purpose operators regular expressions	Application-specific syntax
	Controlled terms	Disambiguate input Restrict output Select predefined queries	Value list Faceted Graph
	User feedback	Pre-query disambiguation	Suggestion list Semantic auto completion
Search algorithm	Syntactic matching	Exact, prefix, substring match Minimal edit distance Stemming	Not applicable
	Semantic matching	thesauri expansion graph traversal RDFS/OWL reasoning	Not applicable
Presentation of results	Data selection	Selected property values class specific template display vocabulary	Text Graph Tag cloud Map Timeline Calender
	Ordering	Content and link structure based ranking	Ordered list
	Organization	Clustering by property or path Dynamic clustering	Tree Nested box structure Clustermap
	User feedback	Post-query disambiguation Query refinement Recommendation of related resources	Facets Tag cloud Value list
Interaction with Results/ Query Refinement	User model	User profiling / Personalisation Behaviour	Me-Widget Us-Widget Spheres of Life Peer Groups Exclusions
	Output/device model	Device specific syntax / representation	tbd
	Domain content model	Content type dependent representation (Aboutness and Format)	Semantic Zooming Format sensitive representation
	Truth maintenance	Control over query and search algorithms Query paradigms	Query parameter control panel

The table is based on the Semantic Search Survey[26] An analysis of search-based user interaction on the Semantic Web; M. Hildebrand, J.R. van Ossenbruggen, L. Hardman; 2007, INS-E0706, ISSN 1386-368[27] and has been extended with the phase "Interaction with Results/Query Refinements" by Wernher Behrendt and Andreas Gruber.

Related User Stories

I have a collection of 30'000 documents, and I want to find the five documents that talk about or where edited by John Smith. Problem is, there are three John Smiths in my company, and the two others appear in lots of documents.

When visiting a house rental website, I can formulate queries like “recent pages that talk about houses to rent in the french part of Switzerland” and the website search engine understands them.

I'm working with a digital asset management system, and I want to find images that are similar to the one I'm looking at, either in terms of the real-world objects that the images represent, or in terms or graphical similarity (colors, shapes, etc.).

Task-specific Questions

1. Can the user create a structured query?
2. Can the user formulate constraints such as “where x is one of <OPTIONSLIST>”
3. What are the precision and recall figures of your system, against three benchmark repositories of your choice?
4. Can the user formulate queries against a defined schema or taxonomy of terms?
5. Can the user specify a way in which query results should be presented?

7.3.2 Content Creation and Presentation Service

Business Need

Creation of business relevant information that can be shared fast and efficiently among employees and customers / Making implicit knowledge explicit to increase competitive advantage

Tasks / Procedure for a CMS supplier

Provide a service by which users can create a knowledge map (e.g., site map) of their content.

1. Analyse Content Creation and Presentation of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS

[26] http://swuiwiki.webscience.org/index.php/Semantic_Search_Survey
[27] http://db.cwi.nl/rapporten/abstract.php?abstractnr=2098

8. Answer the task-specific questions after you have done the development

Phases	Feature	Functionality	Interface components
Content identification and segmentation	Content types / categories	Managing specific content types; Managing content belonging to a field of knowledge	Grouping of content, meta data editor
	Content segments	e.g., splitting a video into sequences e.g., separating chapters, sections, paragraphs of a text	Video key frame recognition Structural analysis of text
	Content instances	Description of a content at the level of instances e.g. describing the content of video using some form of indexing or a meta data standard	Meta data editor Automatic tagging
Content management	Editing content	Creation of a new content Import of an existing content	Text Multimedia
	Administrating content	Assigning roles and responsibilities Tracking and managing multiple versions	User management: key users and their roles Editor for defining workflows tasks Management Console for the content repository
	Enriching content	Input of additional content or meta data Linking with existing content	Metadata (embedded metadata, associated metadata, third-party metadata)
Content presentation	User-specific content presentation	Semantic description of the presentation rules for some content	Metaphors for presentation models (e.g. “Juke Box” for Music repositories)
	Cultural norms and preferences	E.g. semantic description of Aesthetics of some content	“Skins” for user interfaces
Interaction with content	User specific interaction	User-adaptive filters	Metaphors for interaction
	Device specific interaction	Device interfaces	Patterns of interaction
	Environment specific interaction	Sensor networks Pervasive environments	Interaction constraints (e.g. Displays and data input for fire fighters)

Related User Stories

I am a product manager. When I write a newsletter for my customers, I want to make sure that each person, each product or each location mentioned in the newsletter can be enriched (semi-automatic or automatic) with the right meta information (e.g., the geographical location of a city) such that those enriched entities can be found easily again (e.g., through knowledge maps).

Task-specific Questions

1. Is there a way of defining a “knowledge map” (concepts without content) in the CMS?
2. Can the user connect content items with elements of the knowledge map?
3. Can users design the layout of their content presentations (e.g. CSS editor)?
4. Can users interact with certain content items according to the real-world meaning of the content item (e.g., changing the length of a work package in a work plan)?

5. Can users connect content items from different pages to form a new, aggregated page or sub-website (e.g., combining a youtube video with a wikipedia entry about a person seen in the video)?
6. Can users query / manage the rights associated with some content item (e.g., “show me all content items which fall under a creative commons license”)?

7.3.3 Workflow Service

Business Need

Management of business processes to increase the flexibility for changing customer needs or processes.

Tasks / Procedure for a CMS supplier

1. Analyse the workflow support of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS
8. Answer the task-specific questions after you have done the development

Phases	Feature	Functionality	Interface components
Workflow Design	Graphical Editor	Simplified usability & navigation • Drag & Drop of workflow elements • Undo/Redo actions • Auto-layout support Consistency validation checks Multi-language support	WYSIWYG design environment Guided editing dialogs
	Model Import	Multi-format workflow model import	Supported import formats • XPDL • BPMN • BPEL
	Model Export	Multi-format workflow model export	Supported export formats • Graphical formats (e.g.: bmp, jpeg, gif,…) • PDF
	Pattern	Pattern creation / management Pattern library28: • Basic Control Flow • Advanced Branching and Synchronization • Structural • Multiple Instances • State-based • Cancellation	Graphical composition environment Integration assistance dialog

[28] Wil van Der Aalst, Arthur H.M. Hofstede, Bartek Kiepuszewski, and Alistair P. Barros (2003). "Workflow Patterns". In: Distributed and Parallel Databases 14 (1): pp. 5-51

	Access Control	Rights management Arbitrary role concept	Role Editor
Running and tracking the execution of workflow service	Document Routing	Forward and backward moving of documents Reassigning of documents Inter-organizational workflows	Routing configuration panel Document flow view
	Monitoring	Scalability Tracking profiles Statistical reports	Multiple views / perspectives for monitoring: • Flowchart status view • List status view
	Alerts	Multi-channel notification	Supported notification channels for alerts: • E-Mail • SMS • Internal Application Message
	Versioning	Multiple document revisions Conflict management Archive with rollback	Editing features Customizable views

Related User Stories

As a publisher, I want to make sure, that each article is reviewed by at least two editors, before it is published.

Task-specific Questions

1. Can the user define a workflow for managing content in your CMS?
2. Can the user define a workflow for creating content in your CMS?
3. Can the user bind content types to actions in the workflow?
4. Can the user bind roles to actions in the workflow?
5. Is there a defined set of primitive actions with which workflows are built up?
6. Can you define conditional branching in the workflow?
7. Can you define parallel flows (forking)?
8. Can you define a graph (or a grammar) of defined workflows?
9. Can you execute workflows defined in other instances of your CMS?
10. Can you execute workflows imported from external systems?

7.3.4 Multi-channel Publishing Service

Business Need

Increase contacts with potential customers (reach in marketing) to acquire new customers or to increase customer loyalty

Tasks / Procedure for a CMS supplier

1. Analyse the multi-channel publishing of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS
8. Answer the task-specific questions after you have done the development

Phases	Feature	Functionality	Interface components
Create catalog of available services and related information (customizable interface to update the catalog)	Content repository	Layout-independent content creation / management Cross-format data storage Multi-format import	Adaptive import wizard for different formats of content(e.g.: office files video / audio formats raw data (csv, xml, …) databases)
	Semantic content	Metadata management RDF / OWL ontology support	Meta-data editor Ontology editor Automatic tagging
	Distribution channel	Media channel specification Technical configuration	Channel creation wizard Default specification values
	Transformation model	Style formats / template Channel-dependent transformation definitions	Style template creation wizard Semiautomatic transformation configuration
Publish multi-channel catalog (XML publishing; semantic publishing)	Conversion	Channel-specific stylized content	Styling configuration wizard Real-size preview
	Delivery	Multi-channel content distribution Semantic publishing	Supported distribution channels: • Mobile devices • eReader devices • Print media • Web • E-Mail

Related User Stories

I am a media publisher and I want my content to be perfectly adapted to the media channel used by my customers, i.e., my content should be formatted on the fly for a (1) desktop-sized computer display, (2) small-sized display of a mobile device, or (3) printout.

Task-specific Questions

1. Can the user of your CRM specify different output channels for content items?
2. Can the content rendering be adapted to specific out channels?
3. Can you make use of content meta-data for cross-channel publishing?
4. Which content distribution channels does your system support?
5. How does your system support WAI?

7.3.5 Product Configuration Service

Business Need

Selling complex products, which require individual, fast and efficient configuration.

Tasks / Procedure

1. Analyse the content-to-object mapping of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS.
8. Answer the task-specific questions after you have done the development

Phases	Feature	Functionality	Interface components
Product construction/ design	Controlled values of the product components	Selected predefined input Defined templates	Value lists and/or combo boxes Calendar Timeline Tags Facets
	Free text inputs	Keywords	Value lists
	Add-ons/ extras	Keywords Selected predefined input	Value lists Facets Graphs
	Rules	Expressions Restrictions Policies Intelligent matching mechanism	Application specific syntax Suggestion lists
Presentation of a product	Semantic network	Nodes Semantic relationships	Text Graph Maps Images
	Semantic spaces (spatial representation)	Points (product represented as points) Semantic associations LSA (Latent Semantic Analysis)	Text Graph Maps Images
	Topic model	Probabilistic topics (product represented as topics) Markov' models Topic detection and tracking	Text Maps
	Multimodal representation	Selected values and presentation templates	Text Graph

			Maps Tags Images
Interaction with the product	User model	Collecting user data User behaviour defined as a relationship between actions and cognitive processes	Click stream analysis and user tracking Rule-based models Experience-based models Pattern-based models Intuition-based models
	Content model	Corpus annotation Business processes	Text Tags Data clouds Business activities
	Context model	Device models Cultural models Activity models	Context-aware models BDI models Sound Light Space Other people Privacy Religion Law Activities (walking, driving, eating…)

Related User Stories

I'm a PC vendor and I want to implement a PC configuration page that guides the user in an intelligent way to avoid impossible combinations of components. The possible combinations are defined declaratively; I don't want to write code to describe them.

Task-specific Questions

1. Can the user specify a component-based hierarchy to describe a structured product?
2. Can the user specify content items that are associated with the components?
3. Can the user specify multiple options how content and product components are associated with each other? (e.g., display different “skins” for some software, or display the use of differently shaped / coloured knobs on some household appliance).
4. Can the user specify constraints describing which elements cannot be combined to a valid product configuration?
5. Can the consumer of the content interact with the configuration while obeying the specified constraints?

7.3.6 Experimental Task: Event Distribution Service

Business Need

Communication of events to attract new customers and to inform / take care of existing ones

Tasks / Procedure for a CMS supplier

1. Analyse the event related content management application of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.

6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS.
8. Answer the task-specific questions after you have done the development

Phases	Feature	Functionality	Interface components
Creation of customized event lists (customization based on event type, location; personalization; contextualization; creation of alerts and reminders about the events)	Description	Type-specific definition of events Template-based description	Event description wizard Event list view
	Customization	Event type templates Scalable location selection Date selection Target group / audience	General input support: • Suggestion list • Auto completion Context-specific input selection: • Map • Calendar
	Categorization	Event classification using keywords / topics	Value list Free text field
	Distribution	Configuration of push- & pull distribution Specification of distribution channels	Configuration panel Preselected distribution channels
Informing the audience (informing based on event type, location, etc.)	Announcing	Context-sensitive representation Multi-channel distribution	Search engine optimization Web-publishing Provided announcing channels: • E-Mail • SMS • Phone call • Letter
	Reminder	Multi-channel reminder Personalized alert customisation	Provided reminder channels: • E-Mail • SMS • Phone call • Letter
	Post-event communication	Networking between event attendees Information updates (multi media gallery)	Supported networking platforms: • User Profiles • Chat • Blogs • Communities

Related User Stories

I'm a hotel manager and I'm adding info about a music show that takes place in my hotel next Friday. Internet users should be able to find this info using queries like "events that take place at the end of next week within 10km of where I am now", without having to know about my website.

Task-specific Questions

1. Does your system manage “event objects”?
2. Can customers specify different kinds of events – if so, which?
3. Can customers place events on a map (e.g. show where the event will take place)?
4. Can your system recognise an event when it is found on an external web page?
5. Can your system push event information through different communication channels?

6. Can your system organise communities, which are associated with specific events?
7. Can your system collect and aggregate content that may be connected to an event?
8. Does your system support location, time, community, activity and content explicitly?

7.3.7 Customer Relationship Management Service (Personalization Service)

Business Need

Personalized customer relationship management to skim consumer surplus

Tasks / Procedure for a CMS supplier

1. Analyse the customer relationship management application of your CMS according to the table below.
2. Relate the business needs to features, which are typically offered in CMS.
3. Relate these features to functionalities, which your system offers at present.
4. Consider which features or functions would need new interface components.
5. Implement the most appropriate functionality / The implementation should not exceed 1 week of work.
6. Provide IKS members with access to a test system, demonstrating the functionality.
7. Report your experiences with implementing the functionality, to IKS.
8. Answer the task-specific questions after you have done the development

Features and Metrics for Personalisation and CRM

Personalisation phase	**Feature**	**Functionality**	**Interface Components**
Customer relationships configuration	user interaction model content-based interaction models roles model	user registration authentification service single sign on	input forms auto complete
	data collection and storage capturing user behaviours	logging single user interactions log and store transactions	not applicable
Interaction and presentation	online store / baskets notification content recommendations dynamic packaging according to user profile and behaviour subscriptions to events, contents localisation WAI compatibility wishlist comments reviews and ratings	package configurator email notification RSS feeds interaction history themes selector widgets configurator	user feedback form auto-suggestion pre-filled forms ratings vizualisation drag and drop presentation language selector
Learning and Exploitation	dynamic adaption of individual profiles user group segmentation business intelligence	trends analysis export of data merging data	charts other statistics representation reports

Related User Stories

IBM is offering a tool which does data mining in the connection histories of mobile phone users. The providers can identify networks of friends with high interconnectivity. When one of them moves to another provider then there is a probability of the others also being attracted by the competitor's offer. The provider can thus target the group with better offers ("SNAzzy - Social Network Analysis for Telecom Business Intelligence")[29].

Task-specific Questions

1) Does your system offer ways of developing user profiles for content consumers?
2) Does your system offer ways of analysing the content consumption behaviour of the content users?
3) Does your system offer the user ways of configuring and controlling their own usage traces?
4) Does your system offer ways of guiding users in complex information spaces, e.g. by recognising navigation or action loops?[30]

[29] http://domino.research.ibm.com/comm/research_projects.nsf/pages/snazzy.index.html
[30] An action loop may occur when a user is trying to achieve something, but fails, and therefore navigates to the same multiple times, in order to try out alternative inputs.