Development of Knowledge Management System MENTAL

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Abstract. *The article is based on the defence research project "Network Enabled Capability (NEC) Knowledge Management of the Army of the Czech Republic (ACR) – MENTAL", which is the first research project dealing with the theme of Knowledge Management at the Ministry of Defence (MoD). The theoretical basis of the project is Topic Maps. The key issue for the project solution is designing and creating a suitable ontology.*

The paper describes the procedure from the selection of an Upper Ontology through the Core Ontology design to the processing of the Domain Ontology. Ontology definitions are stated and their meaning is explained.

The project aims to create a Knowledge Management System under the ACR NEC administration. The article describes the structure of the system, its elements and relations among them, the functions of these elements and the technology components by means of which the functions are implemented.

Keywords

Upper, Core, and Domain Ontology, Knowledge Management System (KMS), MENTAL, Network Enabled Capability (NEC), methodology, architecture, technology component, function.

1. Introduction

The defence research project "Knowledge Management of the ACR NEC - MENTAL" [1] will result in a Knowledge Management System (KMS). The aim of the MENTAL is "to carry out the analysis of knowledge approaches, ontologies and ontology languages, and to assess their suitability for using them in the Army of the Czech Republic (ACR); to evaluate the security state solution; to formalize the ACR NEC strategy and develop an encyclopaedia of NEC terms; to propose a methodology for knowledge systems development in the ACR; to elaborate a knowledge system proposal in the ACR NEC administration and to implement it." The accomplishment of the project is assured by successful cooperation of researchers from the University of Defence with the TOVEK and AION CZ companies [4].

The most important activity concerning the knowledge-based system is the design and development of an appropriate ontology, which constitutes a formal framework for storing the knowledge, creating links between knowledge and ontology concepts, and establishing connections to concepts and pieces of knowledge of vital documents, which are connected with the area in focus. Ontology itself, without using the known definitions, can be considered an abstract model of a part of reality - domain for which the knowledge-based system is created. Part of the project is the validation of the methodology for ontology creation. One of the underlying methodological postulates for designing ontology is a logical procedure from an Upper Ontology through a Core Ontology to a Domain Ontology.

2. Upper Ontology selection

In information science, an Upper Ontology (Top-Level Ontology or Foundation Ontology) is an ontology which describes very general concepts that are the same across all knowledge domains. The most important function of an Upper Ontology is to support very broad semantic interoperability between a large numbers of ontologies accessible "under" this Upper Ontology. The following ontologies are now competing to be used as the foundation for standard [Wikipedia]:

- IFF Foundation Ontology.
- Suggested Upper Merged Ontology.
- OpenCyc.
- Lattice of Theories including the above and the 4D ontology based on ISO 15926.
- The Multi-Source Ontology.

Based on recommendations by the cooperating companies, we have selected the Upper Ontology with the theme of Competition Intelligence for the MENTAL project. The general concepts here are PERSON, ORGANIZATION, ACTIVITY, RULE, SOURCE, THING, THEME, EVENT and PLACE; see Fig. 1. This

ontology corresponds with the NEC theme, which is being solved, and therefore with respect to the Upper Ontology, the ontology can be linked to all projects with a similar approach.

3. Core Ontology meaning and role

In philosophy, a Core Ontology is a basic and minimal ontology consisting only of the minimal concepts required to understand the other concepts. It must be based on a core glossary in a human language, so that humans can comprehend the concepts and distinctions made. Such a Core Ontology is a key pre-requisite to more complete ontology foundation, or a more general philosophical sense of ontology. Core Ontology is a concept that is used in information science as well [Wikipedia].
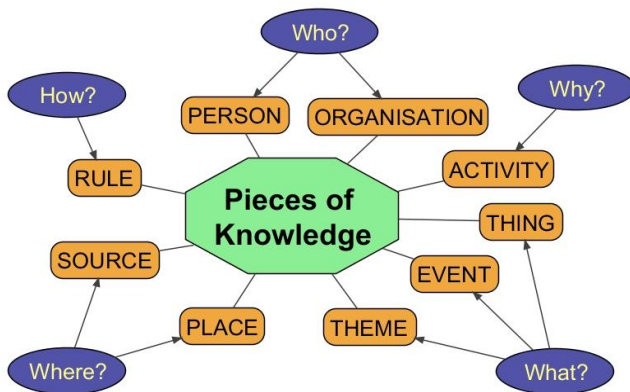

Fig. 1. The Upper Ontology for MENTAL

Core Ontology has a basic position in the interoperability area. It is a central ontology for systems that integrates many ideas from various points of view of the same problem. Other view on the Core Ontology corresponds with the work of representatives from various communities with the goal of harmonizing their knowledge perspectives [2]. The next solution of the Core Ontology is connected with the integration of dictionaries from many fields of the same theme, for example in medicine, in an attempt to find the core part that is the same (or similar) in all fields [3].

In the MENTAL project the Core Ontology is a general model of the military at the Czech Ministry of Defence, see Fig. 2. This ontology should integrate all ideas concerning knowledge management in ACR.

4. Domain Ontology creation

A Domain Ontology (or Domain-Specific Ontology) models a specific domain, or a part of the world. It represents particular meanings of terms as they apply to that domain. Since Domain Ontologies represent concepts in very specific and often eclectic ways, they are often incompatible. As systems that rely on Domain Ontologies expand, they often need to merge Domain Ontologies into a more general representation. This presents a challenge to the ontology designer. Different ontologies in the same domain can also arise due to different perceptions of the domain based on cultural background, education, ideology, or because a different representation language was chosen [Wikipedia].
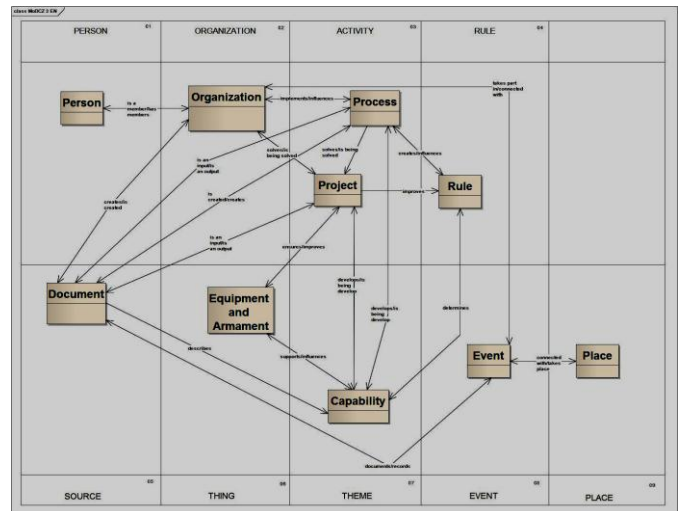

Fig. 2. The MoD Core Ontology

The NEC Domain Ontology is based on the CR Ministry of Defence Core Ontology. The methodology for creating the ontology should include a preparatory stage, in which a set of documents that sufficiently describes a given domain (document base) will be collected. At this stage, the project team members were trained in the fundamentals of ontology, and tried to create a working version of their own ontology. Furthermore, it is necessary to clarify the basic concepts of the subject area in focus; for instance, by means of the analysis of the document base, which characterizes the selected domain. Basic concepts of the domain are arranged, e. g. into taxonomy.
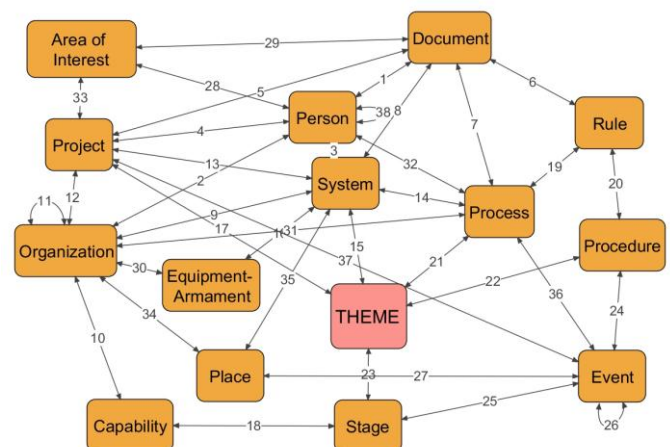

Fig. 3. The NEC Domain Ontology

Taxonomy is a set of concepts, where concepts of higher levels can be further developed by concepts of lower levels. The depth of the hierarchical structure is set by goals

for which the ontology is created. Our research team uses the TOVEK (www.tovek.cz) products for this purpose, especially Tovek Tools Analyst Pack. The document base should be put into a unified form, which assumes the selection of documents by language and format.

A design of an ontology scheme follows above mention analytic proces; see Fig. 3. A prerequisite to an appropriate ontology design is a good understanding of the subject area (domain) of the future knowledge-based system. This is an iterative "top-down and bottom-up" procedure which leads to continuous improvement of the original proposal. The main criterion for the quality of the ontology will be an effective and user-friendly knowledge application.

The ontology design contains a set of ontology classes (concepts): area of interest, project, process, document, person, organization, system, equipment and armament, theme, place, capability, stage, rule, procedure and event. Each class has its own definition and attributes that it characterize. The relations between classes (in the diagram in Figure 3 numbered only) and their names and meanings are described in a separate document, the size of which exceeds the possibilities of the article published.

5. Structure of the Knowledge Management System

The description of the structure of the knowledge management system (KMS) is based on the complex approach. The system elements, their functions and relations among the system elements are explained. The structure is depicted by an architectural scheme (see Fig. 4). Technological elements and a functional view of KMS are analyzed. A list of elements of knowledge-based system follows.

- Controlled information sources (selected documents in NEC area, which present a direct source for the knowledge and pieces of knowledge base, expert documentation, ontology and taxonomy, interoperability dictionary).
- Uncontrolled information sources (set of other documents, information systems, web pages on NEC and KMS).
- Knowledge and pieces of knowledge base (NEC ontology, findings obtained from controlled information sources and knowledge gained from experts).
- Knowledge-based portal for access to the knowledge and pieces of knowledge base and information sources on the ACR NEC.
- Analytical workshop (development of the knowledge and pieces of knowledge base, adding information sources, user management).

- Knowledge management system software (see technology elements).

KMS software (SW) comprises the following componets:

- WEBnet Content Management System (CMS),
- Tovek Server (TS),
- Tovek Tools (TT),
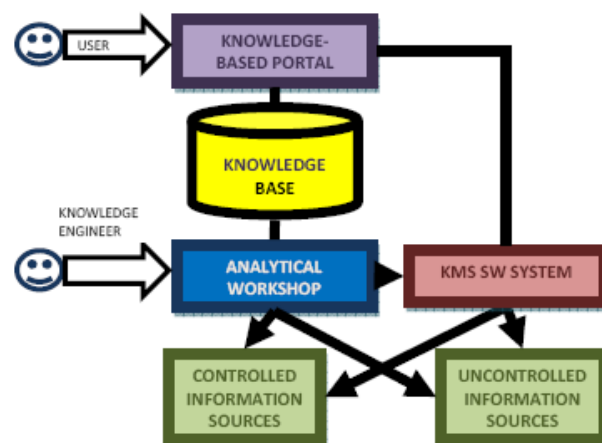- AToM2 (AT),
- WEBnet Knowledge Portal (KP).

Fig. 4. The KMS scheme

CMS is a complex system for content management. It is based on a document which is built into a topic tree. It operates in client/server mode; web browser is the client.

TS is an application for processing of unstructured data; it offers unified approach to miscellaneous data sources. Its functions include indexing, searching and categorizing.

TT are a set of client applications for carrying out analyses. Its application includes Index manager, Tovek Agent, InfoRating, Query Editor, and Tovek Harvester.

AT is an application which produces knowledge deposit created and organized in line with Topic Maps standard. It facilitates knowledge base creation management and development.

KP is a presentation layer of the KMS content. It enables users to see information in the context. It solves the user administration and interconnection with other knowledge bases.

Tools for full text analysis and visualization (TS, TT) will be used to analyze the content of information sources. The tool for content analysis will enable to find key concepts in the large content. The tool for context analysis will aid organizing pieces of information related to the selected concepts. The result of full text analysis will be the knowledge map describing key concepts and relations between them as well as related information resources. The knowledge map will be then visualized and consolidated

using a tool for visual analysis including net analysis and charting. The important part of the knowledge map will be "dynamic occurrences" – a full text queries that will allow users of to find resources related to NEC key concepts. These queries will be also used for automated categorization of the information assets by the full text server.

The Knowledge Map created by using analytical tools will be the basis of the knowledge base, where the Knowledge Map will be stored, managed and updated in the Topic Maps (TM) format. The TM format is very suitable for this case, as it is tailored to describe concepts, relations between them and related information resources. TM also enables to combine pieces of the knowledge map easily and to define faceted views for different users and groups.

The WEBnet Knowledge Portal will enable the users to navigate through the knowledge base and to insert dynamic occurrences represented by structured queries. KP will enable users to search information, and to browse information resources related to key NEC concepts. This will enable users of the system to see all available information about NEC in the context. The context helps users to deduce findings for the decision support.

6. Functions of the Knowledge Management System

Functions of the KMS are divided into groups; each group contains some functions that are carried out through user roles. The sets of groups:

- Organization of information about NEC, the users and their access
- Finding and disclosure of information about NEC
- Creation and development of knowledge, knowledge and information bases
- Cooperation in NEC development
- Creating Communities of Interest
- Processes of command and control, staff training, operational efficiency
- Personal work, teaching, training and education
- Science, research, development, projects
- NEC in practice
- Decision support for NEC development
- NEC integrated environment build-up

Some of function groups are mentioned in detail.

Organization of information about NEC, the users and their access

- Arrangement by priority and importance, topics, sources, timeliness, state of solution, activities, organizational units, persons, annotation
- Documents and users profiling
- Users' management according to information and knowledge needs
- Providing relevant information for users and delivery

FUNCTION	COMPON.
Arrangement by priority …	AT, TS
Documents and users profiling	AT, TS
Users' management	AT
Providing relevant information	TS, KP
Search by priority and importance	AT, TS, TT
Creation of ontologies	AT
Development of ontologies	AT
Information updating	AT, CMS
Linking information to KB base	AT, TS
Annotation of documents inserted	AT
Supporting management of NEC	AT
Call for the task fulfilment	???
Proposals for the NEC plan	???
Inserting comments, experience	TS
Noticing a significant document	CMS
Recording of the NEC progress	AT
International cooperation	???

Tab. 1. Mapping functions to technology components

Creation and development of knowledge, knowledge and information bases

- Creation of ontologies, taxonomies, dictionaries
- Development of ontologies, taxonomies, dictionaries - driven by users
- Development of ontologies, taxonomies, dictionaries - data-driven
- Information updating (adding, editing, deleting)
- Linking information to knowledge base
- Annotation of documents inserted
- Criteria for the assessment of the ACR NEC state

The complete KMS structure is a result of cooperation between research team and SW companies – technology providers. Mapping functions to technology components is a process that compares potential system functions to

delivered technology components (see Tab. 1, only a part of functions). Some functions are not supported by components yet (see mark "???" in Tab. 1); and this is the task for future development.

7. Conclusion

The MENTAL project is still under progress. A significant part of the research task was finished and the same part is still to be developed. The team members are optimistic about the project success, because there is a very good cooperation with technology suppliers. During the project development new technology and tools were used. This is the first project dealing with the Knowledge Management theme at the MoD.

Acknowledgement

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About Author

Ladislav BUŘITA was born in Kutná Hora in 1945; studied at Military College in Vyškov; since 1970 has been holding command positions; 1970-1975 graduated from the Military Academy in Brno in the field of computer science; in 1975-1980 worked at the General Staff Computer Centre in Prague and in 1980-1987 at the Research Institute of the Military Topography Survey in Prague. Since 1987 has been working at the CIS Department at the Faculty of Military Technology (FMT) University of Defense (UoD) in Brno as an assistant professor, head of section, head of department, and academic worker (pensioner). Since 2007 has been a member of Thomas Bata University in Zlín, Faculty of Management and Economics. Finished his academic studies (for CSc. degree) in 1985; became an associate professor in 1991 and a professor in 2003. A member of the UoD and FMT Academic Board, a member of the MoD Board for Defense Research; has been in charge for the FMT Research Program and Defense Research Project MENTAL; has published several university textbooks and books in the fields of informatics, interoperability and project management; publishes papers and gives presentations at national and international conferences.