

Knowledge Management System Based on Lessons Learned Documents

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Abstract—The paper describes the creation of the Knowledge Management System (KMS) based on Lessons Learned documents that were prepared at the Institute of Doctrine of the Military Academy. The objective of the KMS is to provide an access to the available information for the preparation of troops for foreign missions in a user-friendly way. The paper presents the research methodology, the analysis of the documents, the creation of ontology and the KMS development. One of the requirements for the solution was the implementation of the batch information input and the automation of the information context creation.

Keywords—Knowledge Management System; Lessons Learned; methodology; ontology; Topic Maps; AION; AToM

I. INTRODUCTION

The defence research project ‘Network Enabled Capability (NEC) Knowledge Management System (KMS) in the Army of the Czech Republic (ACR) – MENTAL’ was the first project (2008-2011) dealing with Knowledge Management at the Ministry of Defence in the Czech Republic [4]. The results of the project were published at the MCC conferences in 2009 – 2011; see [1-3].

Working on the MENTAL project, the team members were also inspired by other topics suitable for the knowledge system development. One of them is the topic of Lessons Learned (LL) from operations, which is being pursued in the ACR at the Institute of Doctrine at the Training Command – Military Academy (TC-MA) in Vyškov. NATO is paying substantial attention to LL; its Joint Analysis and Lessons Learned Centre (JALLC) runs the portal and database of the experience from operations (<https://nllp.jallc.nato.int>). The LL is mostly organized as a database solution; our knowledge approach is an original approach. When presenting the results of the MENTAL project at the MCC-2009 conference [3] in Prague, this idea was discussed and recommended.

The members of the defense sector, to whom the results of the MENTAL project were presented, mostly found the AToM [5] software interesting and suitable for creating knowledge systems; however, no one signed up for working with the

KMS. Therefore, the research team decided to create another knowledge base to strengthen the arguments in favor of the appropriateness of the technology applied for practical utilization. After several discussions and presentations the team chose a set of documents of LL provided by the Institute of Doctrine at TC-VA.

In addition to creating a KMS that would facilitate an access to information to users, we wanted to verify new streamlining procedures in the AToM software for the KMS development at the maximum degree, such as the batch information input and the automation of the information context creation (linking relationships between the source documents and the knowledge layer).

We have verified the following methodological procedure:

- The initial analysis of documents and the selection of concepts for ontology (classes and occurrences).
- The division of documents into sub-sections (articles) and the creation of the first part of ontology.
- The development of ontology by extending the ontology of LL documents.
- The selection and insertion of significant class instances into the KMS.
- Linking the knowledge layer instances with articles (automation).

II. INITIAL ANALYSIS OF DOCUMENTS

Since 2007, the Institute of Doctrine at TC-VA has been annually issuing several studies focusing on the experience from missions. They represent a total of 31 documents published in PDF format, totaling up to 2000 pages (one document has from 60 to 100 pages). The topics include the experience from conducting operations of their own units (e.g., ‘Mission planning’, ‘100 days in an operation’, ‘Escalation of power’, ‘Patrol activity’, ‘Base protection’, ‘Searching operation’, ‘Snipers’), the description of adversaries and their combat (such as ‘Muslim culture’, ‘Tactics of insurgent fight’, ‘Taliban’) and evaluating information (for example, ‘Experience of the LL’, ‘Information extraction’).

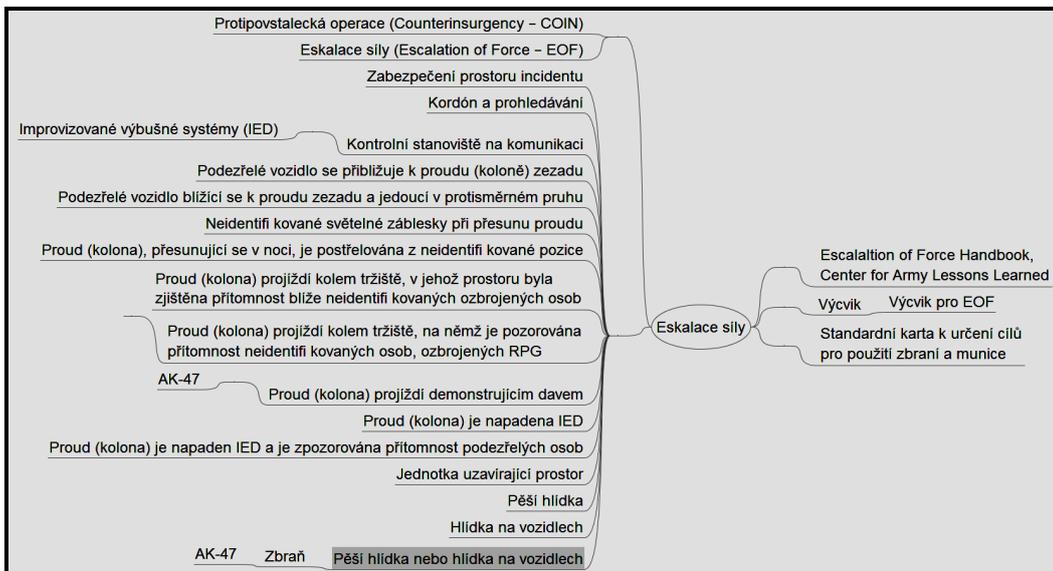


Figure 1. The Analytical outcomes – taxonomy view

As a starting point of our solution we were given documents on broad experience of military and humanitarian operations; some of them were adopted from foreign military units' experience. We have carried out deep analysis of these documents. During this process, we have prepared taxonomy tables consisting of classes and their typical occurrences. As examples we can mention typical – and the most important – classes that we have found: person, organization, place, activity, rule, document, topic or event.

The purpose of the document analysis is to select the concepts for the KMS knowledge layer and ontology, in which, according to the principle of Topic Maps, are classes and their attributes, as well as relationships between classes and their occurrences. The research team divided a set of documents into smaller parts and each member worked on the assigned documents. The results of the analysis are illustrated in Figure 1 (units' activities in the escalation of power in the form of taxonomy) and Figure 2 (classes and their occurrences in matrix arrangement – person, organization, place, activity and rule).

The research team, in addition to the content information in documents, discovered a number of duplicate data, links and relationships between documents and their parts, which is precisely the ideal basis for the consolidation of information in the knowledge base, compared to the normal set of documents. Users who want to learn from the LL documents must study all of them to see their detailed content; whereas when working with the knowledge system they can only focus on the knowledge and experience that is integrated in one place.

As an example, we can mention the analysis of the class 'Organization'. We have found more than 130 organizations in the LL documents. Organization can be divided into many important types: military, police, agency, head quarter facility, C2 facility, centre, office, team, group, station, religion, university, tribe ...

PROHLEDÁVACÍ OPERACE		
osoba	organizace	místo
osoba	týmy EOD	Irák
nepřítel	týmy zdravotnického zabezpečení	Afghanistan
kmenový vůdce	týmy Psy Ops	Stanoviště pro řízení provozu
významná osoba	týmy CIMIC	Shromažďovací prostory
náboženský vůdce		Kontrolní místa
modrý		Předsunutě shromaždiště
červený		Trasy
velitel		
zkratka	význam	
ABF	attack-by-fire position	
AGI Smart Card	chytré karty k vedení společných operací	
BP	battle position	
CALL	Centre of Army Lessons Learned	
CAS	close air support	
CASEVAC	odsun ztrát	
CCA	close combat attack	
CI	counter-intelligence	
CSAR	bojové pátrání a záchrana osob	
FRAGO	fragmentary order	
FSO	Fire Support Officer	
HUMINT	zpravodajství z lidských zdrojů	
IED	improvizovaná výbušná zařízení	
LPH	letecké pohonné hmoty	
MASCAL	hromadné ztráty	
NFAs	no fire areas	

Figure 2. The Analytical outcomes – tabular view

Every organization can be defined in the model by the following attributes: name, abbreviation, description, etc., and can be connected to other classes by associations, for example: document/chapter being in, country/area, etc.

The LL documents were analyzed from the perspective of the class 'Document'. Document is any information source, which is referred to in LL, or that is used there. Sixty-three occurrences were recognized during our analysis.

Due to the large number of occurrences, it was necessary to establish criteria for their classification. For the purpose of the division, a criterion of the origin was applied, which means the organization that created the document, and the purpose for which the documents are intended. After the application of these two criteria, the occurrences have been divided into 5 groups:

1. NATO documents.
2. US Army or Canadian Army documents.
3. Documents relating to the planning activities.
4. Muslim cultural and social practices.
5. Public available information sources.

For further processing only the most important occurrences in this class were selected. The final choice was taken into account because of the importance of the Czech Republic membership in NATO. Furthermore, we selected the occurrence of the planning activities of units with which the ACR can cooperate.

The LL documents were further analyzed in terms of the class 'Rule'. The rule means standard, recommendation, prescription, methodology or method that is used in the LL. It was also necessary to determine the criteria for the division of nearly 70 occurrences. All recognized occurrences were divided into the groups according to their focus on:

- Value and Security.
- Effects-Based Process – EBP.
- Rules of Engagement – ROE.

For further processing were selected occurrences with a focus on ROE. When analyzing the LL documents, it is sometimes difficult to determine to which class the found item belongs. It should be taken in mind that the subjective view of the process may be wrong. For this reason, the assessment of the process design appears to be effective in a wider research team. During the analysis of all documents, it is important to note any documents. It is advisable to take notice of all document links to further resources. To create a complete picture, it is necessary to include maximum resources available.

When analyzing the 'Process' class, up to 32 of its various occurrences were identified. For the purpose of the division, the criterion including the type, purpose and nature of the operation was applied; based on it, all the occurrences were divided into four groups:

1. Combat operations;
2. Counter Insurgency (COIN);
3. Peace Support Operations (PSO);
4. Peacetime Military Engagement (PME).

Another aspect of a possible division of the operations was the division by the use in the area of responsibility into the

operations that were carried out in accordance with Article 5 of the Washington Treaty and other operations. This division could not be strictly applied because some of the operations may belong, according to the political assignment, to both groups. Also, the division of operations by the alliance and national documents was taken into account. It was found out that this division has been observed in the analyzed LL documents, thus no new piece of knowledge has been identified.

The class division could correspond with any point of view of the classification. This is the advantage of the knowledge based access, because the particular classification can be added as a note.

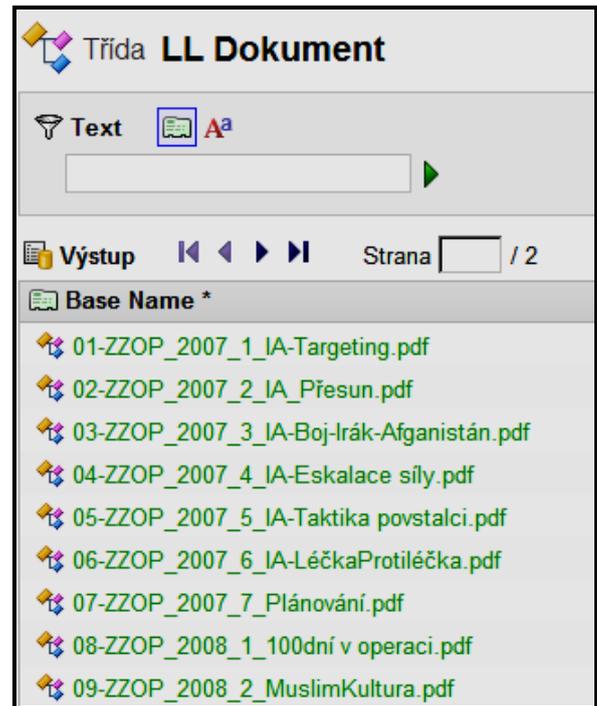


Figure 3. Listing of a set of the LL documents

III. DIVISION OF DOCUMENTS INTO SUB-SECTIONS

A LL document usually describes one topic; however, it includes a number of partial, often little related parts. These parts (in LL called articles) have to be separated to be individually connected to the knowledge layer. This is a relatively laborious process when the document is converted into an XML format, while the major parts are automatically identified. Nevertheless, the final processing depends on human eyes and experience. Figure 3 shows the listing of LL sets of documents stored in the knowledge base. Figure 4 presents the division of a document into sub-sections (articles).

IV. DEVELOPMENT OF THE ONTOLOGY

The ontology design about the LL documents includes classes, attributes and relationships between classes. The ontology created is based on several resources that shape the overall view on the knowledge domain.

The ontology sources are:

1. Ontology and data about the LL documents.
2. Ontology and CIA World Factbook data.
3. Outcomes of the analytical activities of the team.

The overview of the resulting classes and attributes is described in the following section. Table 1 gives an overview of relationships. The definition of classes, attributes and relationships were subsequently implemented in the AToM Schema Editor, the KMS implementation environment.

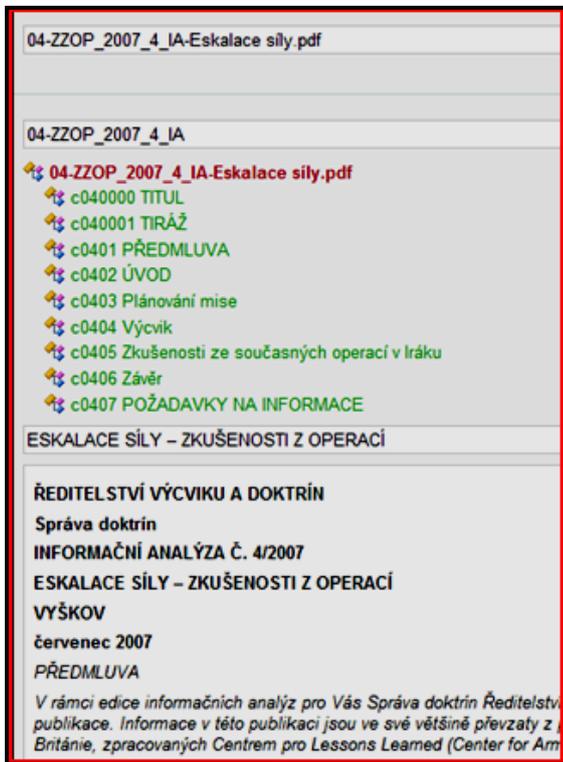


Figure 4. The structure of the document

- Part of the ontology about the LL documents*
 LL-DOCUMENT; An issued document with the LL topic.
 LL-ARTICLE; A part of a LL document with the topic.
- CIA World Factbook part of ontology*
 ORGANIZATION; Referred to in CIA World Factbook.
 COUNTRY; Referred to in CIA World Factbook.
- 3. Part of ontology – the outcome of analytical activities*
 PROCESS; Described in LL, can be structured.
 THING; Described in LL, weapons and equipment.
 RULE; Rules and procedures to execute processes.
 DOCUMENT; Referred to in LL, regulation, order, etc.
 ORGANIZATIONS; Referred to in LL, army structure.
 FUNCTION; Function, such as an interpreter.

PERSON; Mentioned as a member of an organization.
 REGION; Part of a country referred to in LL.
 TOWN; Located in country and region.

TABLE I. ONTOLOGY RELATIONSHIPS

Class 1	Relationship	Class 2
PROCESS	hierarchy of processes	PROCESS
PROCESS	using things in process	THING
PROCESS	executing the process	RULE
ORGANIZATION	has members role/function	PERSON FUNCTION
COUNTRY REGION	location of the areas in the region	REGION REGION
PROCESS THING RULE DOCUMENT ORGANIZATION PERSON FUNCTION REGION TOWN	is referred to	LL-ARTICLE

D. ONTOLOGY ATTRIBUTES

Base Name – name of the object, a required entry.
 Other Names – variants of the the Base Name for retrieval.
 Abbreviation – in selected classes.
 Description – short text describing each class.

V. SELECTION OF CLASS INSTANCES AND THEIR INSERTION IN THE KNOWLEDGE LAYER

At the research team meetings, significant instances of the assumed utmost importance for the user were selected from each class. These were mainly DOCUMENT, RULE, ORGANIZATION and PROCESS; and then also topographic and other data. Figure 5 shows the set of selected instances.

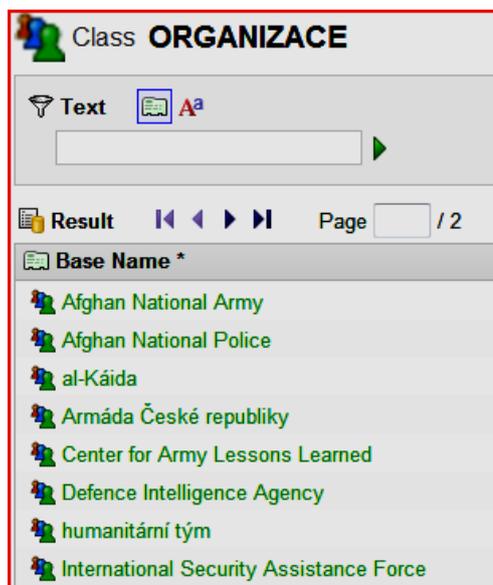


Figure 5. Set of ORGANIZATION class instances

Concurrently, the batch input, which is part of the AToM software used for the KMS development, was verified. For a batch input, it is necessary to prepare the data in tabular form, in the structure given by ontology; see Table 2, for example. It is possible to insert class instances with attributes and to connect them by a corresponding relationship.

TABLE II. ONTOLOGY RELATIONSHIPS

Class	Base Name	Belongs to a country
TOWN	Baraki Barak	Afghanistan
TOWN	Jalalabad	Afghanistan
TOWN	Laghman	Afghanistan
TOWN	Asadabad	Afghanistan
TOWN	Hoffenfels	Germany
TOWN	Nábulus	Israel
TOWN	Fallujah	Iraq

VI. CONNECTING KNOWLEDGE LAYER INSTANCES WITH ARTICLES

One of the challenges of the knowledge engineer is to create and maintain a knowledge base. This activity involves amount of work that is routine and time-consuming. One of these activities is to find and create links between resources in the information base and objects in the knowledge base. To facilitate the work of the knowledge engineer, a set of tools that automate the creation of links has been created. Figure 6 shows the concept of links between the two bases.

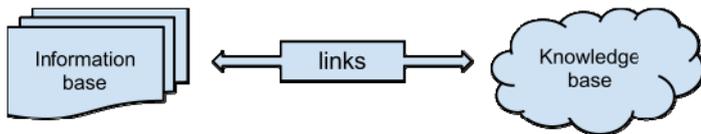


Figure 6. Links between the knowledge and information bases

The knowledge engineer applies the following workflow (see Figure 7):

1. Export of documents and the knowledge layer outside the KMS in XML and TXT formats.
2. Searching the relationships between the knowledge and information layers in the exported dose.
3. Relationships found are imported back into the knowledge system.

In the first step, a list of topics (instances) of the selected class with possible variants is exported from the knowledge base (abbreviations, grammatical forms, language variants). The reason for that is that we do not have a lemmatization tool, so it is necessary to store various shapes of the searched topics. This list is used as input to the search engine, which gradually goes through the basis of documents, and in case it finds an occurrence in the document, the link is added to a list of new links.

The export outside the knowledge system is needed because the AToM software is still a closed system and any functionality is exclusively added by the supply company. The data export tool is created independently of the particular system. So, while maintaining the input and output formats, it can be used for any knowledge-based application.

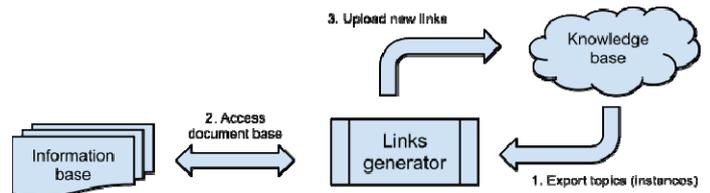


Figure 7. Automation of generating new links

In the second step, the documents of the exported database are searched; in the case of LL documents, there were approximately 2000 of their fragments (articles). The names of the exported occurrences were searched, then their Base Name; abbreviation; or Other Names that are stored at occurrences.

Figure 8. Rule 'Escalation of power'

Figure 9. Rule 'Escalation of power in terms of time and distance'

Thus, the created list of links was then imported back into the knowledge base. For a given topic, a set of links to documents and articles was created. Finally, let's mention that the documents in the text base are classified according to the

structure of the document at the level of individual chapters (by titles), so the generated links are connected to these chapters.

The resulting KMS includes both the original LL documents, their division into articles by their content focus, and then the knowledge layer, constituted by ontology, significant class instances and their links to the articles in which they are mentioned. Thus, such integrated information brings much greater benefit to potential users looking for the information on the experience from foreign missions.

The following two examples present the structure of the integrated information in the KMS. The first example shows the class 'Rule' with a selection of the 'Escalation of power' occurrences. Figure 8 shows the articles in which the escalation of power is described and explained. If we are interested, e.g., in such explanations as 'Escalation of power in terms of time and distance', we can go the article referred to as c12030206 (see Figure 9), in which everything is explained.

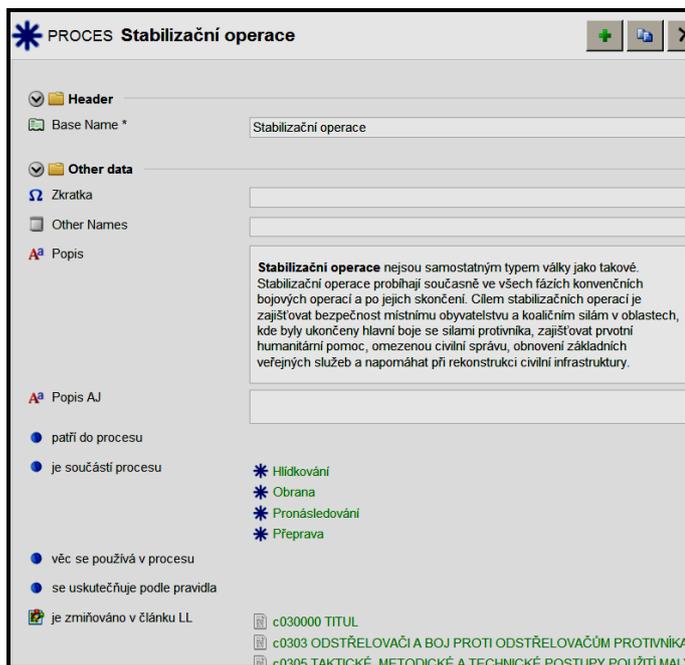


Figure 10. Process 'Stabilization operations'

Another example comes from the class 'Process', with the occurrence of 'Stabilization operations' (see Figure 10), where we can find out not only where these operations are mentioned in the articles, but we can also learn that an operation includes other operations (they are part of it); they involve 'Patrolling', 'Defence', 'Persecution' and 'Transportation'.

If we are interested in the 'Patrolling' occurrence, we need to move on to this sub-process (see Figure 11). We will find its definition; we can find out that it is part of other processes and that is described in the article referred to as c1004070205.

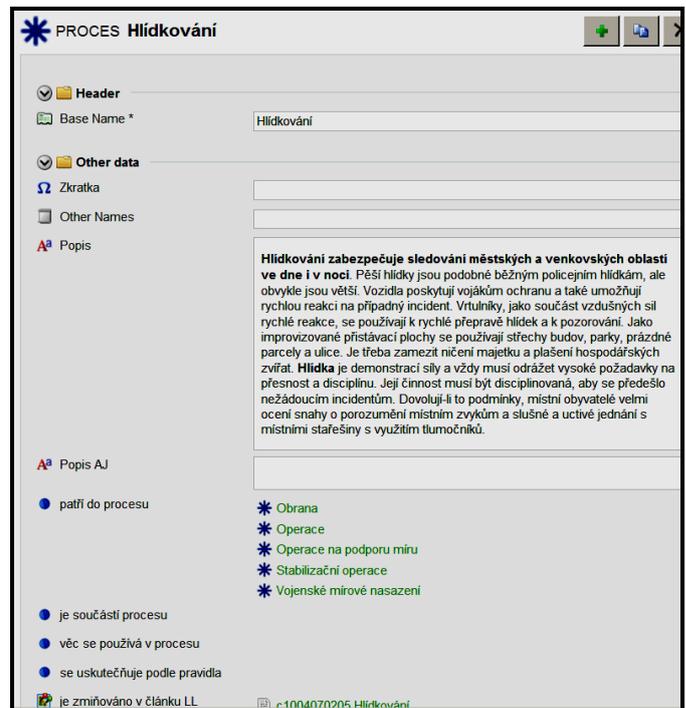


Figure 11. Process 'Patrolling'

VII. CONCLUSION

The enrichment of the knowledge management system for the ACR NEC by further applications extends the view on the ATOM software for creating knowledge systems and information management.

The LL system was developed based on the analysis of the issued documents. Their processing in the knowledge system facilitates obtaining information in a different way than studying dozens of documents; namely by the targeted approach to the integrated base of the articles from the LL documents that is 'wrapped up' by the knowledge layer allowing the navigation to information.

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