

Support of Collective Decision-making for Forecasting of Energy Technology

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Abstract— The article considers a methodological approach for organizing the distributed work of scientific and expert groups and knowledge management in the implementation of joint projects for forecasting energy technologies. Collaboration is based on a system of ontologies and documents based on hierarchical structures. Documents and their parts are considered in three representations: as keywords, as annotations and as full texts. Experts gain access to various sections based on an access control system. The basic technologies and tools that are used in the implementation of the information system are considered.

Keywords — *knowledge management, energy development forecasting, research support, collective expert activity, joint document creation.*

I. INTRODUCTION

Scientific institutes and expert groups with great experience and authority are regularly attracted to provide advice, formulate recommendations and develop strategic policies in various fields, etc. Usually, these works are required to be carried out in a limited time and with the involvement of various specialists. Collective expert activity is an important component in the work of expert groups. Such activity is carried out mainly on the basis of the negotiation process within the group. The rapid growth of telecommunication technologies allowed us to solve the problem of remote communications and push the boundaries of the growth of organizations, and, as a result, the geographical distribution of experts involved in the work. The further development of Internet technologies again raises the question of finding new methods and tools to effectively support the development of joint solutions by experts.

II. ENERGY TECHNOLOGY FORECASTING

Since 2003, an international working group of leading scientists from the USA, Europe and East Asia has been coordinating research on the Future Oriented Technology Analysis [1]. Research is carried out in such closely related areas such as: Technology Monitoring, Watch, Alerts; Technical and Competitive Intelligence; Technological Forecasting; Strategic Technology Assessment; Technology Roadmapping;

Technology Foresight and other. Many different methods, tools and their combinations have been developed to solve problems in the framework of these areas: expert opinion, trend analysis, mathematical and simulation modelling, statistical, scenario, educational, descriptive, intellectual, etc. The final goal of such studies is to develop means of intellectual support for a systematic process of substantiating possible ways of developing science and technologies in various fields, assessing the prospective impact of new technologies on society and the world, including specific industry infrastructures, as well as supporting the development of “moving” strategic solutions for innovative development from the world or national level to the level of interests of specific technology companies.

Collective expert activity is an important component in scientific work. The implementation of such large-scale work is impossible without the involvement of a huge circle of experts. Moreover, in recent years there has been a tendency to unite groups of researchers from various scientific institutes for work on complex scientific projects, each of which has its own store of knowledge and skills. But due to the geographical distribution of experts, the size and number of participating organizations, and other factors, a one-time meeting of experts in one place to formulate the proposed scientific solution in the framework of the seminar is becoming increasingly difficult and time-consuming. To reduce costs and simplify the process of carrying out such activities, achievements in the field of communication technologies are actively used to ensure collaboration [2].

The possibility of organizing the workflow of geographically remote participants has obvious advantages: the selection of personnel to a much lesser extent depends on the physical location of the candidates; it becomes possible to concentrate primarily on their professional qualities and skills, as well as the possibility of using resources, access to which is geographically limited. An example of such resources for scientific teams can be unique equipment. But what advantages distributed work would not bring, it entails inevitable problems. For example, each remote group should receive timely

information on the current status of the project, the results of intermediate studies and planned tasks. An important aspect in collective work is the distribution of tasks and their synchronization. This is due to the interdependence of participants. One of the features of collective work on complex scientific projects, which include experts from various subject areas, is the problem of uniform perception of information by all members of the scientific group.

III. PROBLEMS SUPPORTING EXPERT COLLABORATION

Collaboration support systems are a broad concept that includes many technologies and programs. Unfortunately, there is currently no established term for designating such systems. In the scientific literature there are such definitions as collaborative software, groupware, workgroup support systems and group support systems.

Modern software for collaboration activities is mainly developed in the following areas:

- 1) Social networks with enhanced functionality. These systems are focused on real-time discussions. They allow you to unite the participants in the discussion in a "virtual room" and share files. Examples of such systems are Facebook, VK, Google+.
- 2) Set of integrated components. Such systems are separate applications for file sharing, discussion, monitoring the progress of the project, etc. It is deployed on the same server and with a single authorization subsystem. Some mutual integration allows adding files from the repository to the discussion through a special interface. Such systems include 1C-Bitrix [3], Webasys [4].
- 3) Online office [5] focused on collective editing of documents, for which they have many built-in tools similar to those supplied in the Microsoft Office. Office Web Apps has similar functionality. The most interesting representative of the class of such systems is Google Docs, which allows you to collectively edit documents. Gmail allows you to exchange emails. There are also many chats, forums and online repositories with the ability to provide file access to multiple users.

Significantly expand the capabilities of such Web-services allowed the model of software distribution SaaS [6] (Software as a Service), on the basis of which many server applications work. Such applications are almost inferior to their desktop counterparts (for example, Microsoft Office). SaaS is a business model for selling and using software, in which the provider develops and manages the Web-application, providing the customer access to the software via the Internet. The main advantage of the SaaS model for service consumers is the absence of costs associated with the installation, updating and maintenance of the equipment and the software running on it. It is the SaaS business model that underlies the online office

and is based on it many integrated solutions in the field of collaboration.

Unfortunately, such open systems cannot be used by experts, primarily for reasons of cybersecurity, as well as due to insufficient functionality. In addition, the unresolved issue of joint coordination in the preparation of the resulting documents remains. To ensure the joint work of experts, more complex solutions are required than separate forums, file storages and electronic conferences. Support tools for managing group activities include integrated solutions provided in the form of SaaS (Software as a Service). In addition, it is advisable to use the principles of a network-centric approach and situational awareness when implementing tools to support collective expert activity.

IV. SUPPORT COLLECTIVE EXPERT ACTIVITY

It is necessary to solve organizational, informational and methodological problems when conducting interdisciplinary research [7]: to form the subject and object of research in such a way that they can be studied by means of all participating disciplines, and the results obtained can be refined and improved. In addition, the solution to these problems is exacerbated by the difference in the "basic level of knowledge" of individual experts. Usually, experts specialize in one or several areas of knowledge, and regarding the areas of knowledge of other experts that are part of the research team, they have only general ideas.

There are two main ways of coordinating the knowledge of researchers in a fairly large and diverse scientific team. The first of these is peer-to-peer education. The second is a comparison of knowledge on the basis of general abstract concepts. Both of these methods have their advantages and their disadvantages. A rational solution is to combine these two approaches: simultaneous interpenetration and juxtaposition of explicit knowledge [8, 9]. According to the authors, the most effective approach is to organize research, at the beginning of which the scientific team developed a common ontological basis, on the basis of which all interaction of the distributed group will be built in the future.

As a result of ontological modelling, an ontological space is created [10, 11], which includes a set of ontologies that allows you to work with data and knowledge [12]. Researchers from different subject areas working on a common scientific project can develop their ontologies and compare the concepts from them with the concepts of the ontology system, which is common to all research carried out within the project.

V. REPORTING THE RESULTS OF THE WORK OF THE EXPERT GROUP

The result of the activities of the expert group is developed and agreed solution, which should be framed in the form of the resulting document. A vivid example of such a collective decision in the field of energy development may be the tumult of the

Roadmap “EnergyNet” of National Technology Initiative of Russia [13]. This document is very large and consists of several dozen sections. The total volume of the document is more than 140 pages.

Considering any scientific document, for example this article, we can distinguish some basic parts: title, annotation, keywords and the main text. As you can see, all of four components are interconnected. The shortest presentation of a document is its title. The most complete representation of the document is its text. An abstract of the document briefly characterizes it. Keywords very briefly describe the main content of the document. The rational way to create a complex document is to move from simpler to more complex representations. It is very simple to first come up with a title, then think over its contents, define a list of basic entities (keywords), briefly describe the document by abstract, and then present it in full. It is this approach that the authors propose to create large documents by a group of experts. In this case, it will be possible to present the entire document not only as text, but also as a set of keywords and annotations of individual sections.

VI. TECHNOLOGY FOR COLLECTIVE DOCUMENT DEVELOPMENT BY THE GROUP OF EXPERTS

Usually the scientific group consists of a leader and participants who need to develop some document or an array of documents. To achieve the result, the supervisor must divide the upcoming work into sections and distribute them among the group members.

The authors in this approach propose to make the document composite: the leader assigns each member of the group a corresponding section, which will be edited independently by different members of the scientific team. Only the leader can view and edit the entire document in the process of its creation when working in the information system. The remaining members of the group are limited by the granted rights and can view and edit only the sections assigned to them.

Each section is a structure containing keywords, annotation, and body text. Keywords are necessary for the formation of a common conceptual basis for each of the members of the research team and a uniform understanding of scientific terms throughout the project. Each of the terms collected in the keywords section is the essence of the ontological model, necessary for the formation of the common understanding of the project by all members of the team and a description of the specifics of individual sections. The ontological model developed at the initial stage is not rigid and can be supplemented and modified as the project progresses.

Work on each section can be supervised by the leader who can not only follow the writing process, but also make some changes, remarks, and comments. The main features of the developed system for editing text fragments are text formatting, creating tables and

inserting illustrations, in addition, hyperlinks to external resources are supported.

Consider the typical structure of the document: draft document is hierarchy of sections, subsections, etc., each of which, in addition to the main text, can be characterized by keywords and annotations. The simplest case is the document structure consisting of sections of one level. In the process of working on a large section, it may be necessary to divide it into several subsections. The member of the research team responsible for this section can create subsections and appoint additional participants to write them or develop them independently (Fig. 1). A subsection or section of the second level has the same structure as the section of the first level: keywords, annotation, and body text. The head of the entire project, as well as the participant responsible for the first level section, have access to edit and view subsections.

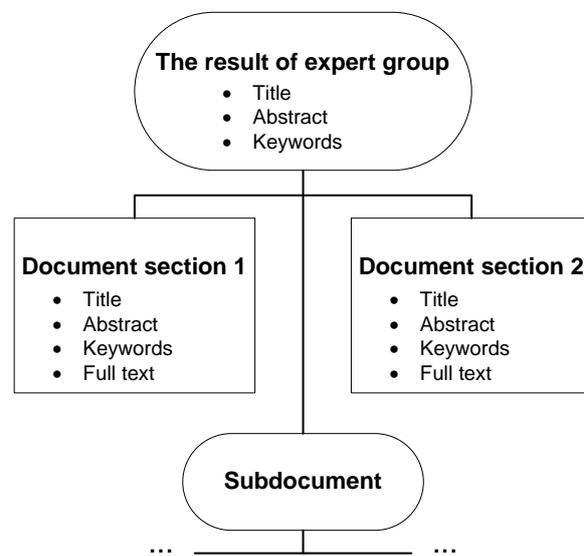


Fig. 1. Example of composite document structure

Some sections may represent separate extensive areas of work when working on complex projects. In this case, it is advisable to create separate draft documents in which these works will be carried out and to link the created projects with the main ones using links (Fig. 1). Creating a separate document is also necessary if separate team of researchers will be engaged in its work.

We have identified two basic rules for successful teamwork on documents. The first rule is that all participants in the process must understand their role in the document being developed and have a complete understanding of the general direction of the research. The second rule implies that the leader of the research team must fully understand the objectives of the project and be able to correlate them with the capabilities of each participant.

The main actions that need to be performed by the team leader at the beginning of the project are to determine the general direction and name, as well as assigning keywords and creating annotations. In the next step, the leader is invited to determine the

proposed structure of the future document and distribute the participants. If necessary, the leader can assign additional rights to some participants in the project. The leader of the scientific group within the framework of his project may allow or prohibit certain actions to group members.

Implementation of the Web-application for collaborative distributed work on a document is performed using technologies such as JavaScript (jQuery, Bootstrap, etc.), HTML5, Spring Thymeleaf. Server components are implemented in PHP and Java. The CKEditor component [14] is used to edit document text bodies. This component is a free WYSIWYG editor that can be used on Web-pages [15]. A feature of the CKEditor is its small size without the need for client-side installation. The CKEditor has a wide variety of functions. It is designed in the style of Microsoft Word, which makes handling it more familiar. The implementation of the client RIA-part of Web-applications is performed on the Java platform as the most suitable and convenient for development. For this we use Java Web Start technology and the Java Network Launching Protocol to download and run applications. The FishTail Server is used to store and manage RDF-triplets that are associated with some knowledge and concepts in the ontology system. The FishTail can be used to enrich new RDF-triples based on some predefined rules (axioms) and existing RDF-triples.

An implementation of the ontology building environment based on the core of the GrModeling graphic modelling system [16] was performed to support the proposed technique. In addition to graphical modelling, the construction environment implements functions for analyzing, transforming and using ontologies, including uploading them to XML and RDF format.

VII. CONCLUSION

The paper discusses a methodological approach to the implementation of tools in the form of a Web-service for supporting and organizing joint distributed work on text documents, which include, for example, reports on the work of expert groups, scientific articles, etc. An ontological approach is used as a basis for integration and description of knowledge. The application of this approach makes it possible to effectively manage the formation of decisions by a group of experts. Testing of the proposed approach and tools is carried out in the implementation of projects on scientific and technological forecasting and the study of cybersecurity of energy facilities.

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