

Model of An Intelligent Web-Based Multimedia Mass-Group Decision Support System

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Abstract

This article formalizes basic functions of the system called Forum Virtualis. The system represents an attempt for integration of several converging technologies including: group decision support systems, WWW, e-mail, multimedia presentation, data mining and intelligent systems, knowledge management and parliament decision processes. Based on a Mintzberg's strategic decision-making processes, we have developed a unique and innovative system that can be described as a use of Web technology to support large groups of people to solve their common problems with the aid of multimedia and intelligent systems. Basic model of the system, its architecture and technology of implementation is described. This system has been tested as a part of Varaždin City Hall official web pages. Forum Virtualis has served as a facilitator of e-democracy processes where citizens of Varaždin are enabled with sophisticated technology to enhance their ability to solve common problems in this local community in interaction with themselves and municipal authorities. An example of a process where a problem has been solved with this system is described. Other potential fields of application of the system are described and the needs for future research noted.

Keywords: Group Decision Support System, virtual forum, e-democracy, discussion organization

1. Introduction

This article describes an attempt to integrate several information technologies to enhance an ability of mass-group of people to solve their common problem. While many type of groupware software and common trend of technology integration claim that they efficiently do the same [8, 10, 7], it will be shown that mentioned approaches have many shortages and further development of an inovative model will then be justified.

Initiation of Forum Virtualis project, has been motivated with a historical fact of uninterupted function of Varazdin City Hall in the same building since 1523. The City Hall has been situated in the main city square, that was called Forum Publicum in past. This square served as a place of public meeting and business making, the same as many similar places in Western culture since Ancient Grece and Roman Forum. As a consequence of modern life and technology clasical forum has wither away, a new *technologies* of public meetings are taking their place. Forum Virtualis has been developed as a part of Official City Hall Web site offering a new subsidiary way of local comunity governing.

Common problem solving processes, in general and especially political communities, are mainly unstructred and include a groups of people. This work is based mainly on Mintberg's decision making model, that is widely accepted in the theory of management [9]. According to the Mintzberg's Model, decision making is a process consisted from three phases: *identification*, *development*, and *selection*, described in terms of seven central routines: *recognition*, *diagnosis*, *search*, *design*, *selection*, *evaluation-choice* and *authorization*. Additionally, there are three supporting routines: *control*, *communication* and *political activities*.

Still, existing groupware softwares are covering these decision making phases only partially. Present groupware has many disadvantages. Table 1 is describing some disadvantages of examples of groupware focusing to the new features in Forum Virtualis.

Table 1. Disadvantages of groupware software and classical group work.

Type	Example	Disadvantages
GDSS	Group Systems	Intranet and LAN-based mainly, expensive, too formal, too complex and unwieldy, no multimedia.
Video conferences	WhitePine Enhanced CU-SeeMe Microsoft NetMeeting	Technology based focus to the communication function.
Forums	Jcorporate's IN Java eForum	Simple text based information exchange and idea generation, with no direct influence to process convergence and structure.
Discussion groups, chat	ICQ IRC software	Information exchange without any commitment to solve the problem and apply the solution.
Survey	Apian SurveyPro Poll Pro	Attitudes collection only, no formal results inclusion to the decision making process.
Multiple Choice	Analytical Hierachy Process AHP	Modelling of well-structured simple linear problems only.
Information organizer	Lotus Notes BSCW	Common well-structured information sources collection, suitable for highly formal organization only.
Parliament decision making	Classical parliament and business meetings	Old fashioned, expensive, slow, too formal, mainly disconnected from the real-time information sources and from people able to solve the problems.

2. Decision making model in Forum Virtualis

Forum Virtualis project is focused to the obtaining an Internet technology-based system that enhance ordinal forum system with (among others) following features:

1. Structure and discipline to support all phases of decision making process,
2. Management of decision making process,
3. Inclusion of hypermedia (XML documents),
4. Upgradability with new tools.

(The same name is used for both the project and the system that is developed as a goal – Forum Virtualis or FV.)

Main requirements set on the system are following:

- a) **Content access and content kind.** All content stored in FV system and all of its functions must be accessible by Internet. Content should be hypermedia as a key factor to user acceptance.
- b) **User management.** The system should cover several combinations of access rights to a discussion process. Therefore, in order to monitor access to a discussion or its activities (if the decision process requires it), users must have accounts in the system and through those accounts and user groups to which they belong, they get access rights to particular activities. Activities do not necessarily require such registration of users. However, registration of users enables connecting posted materials with their authors (if it is not an anonymous activity). This can also help in knowledge discovery, data mining etc. since registered users can enter their specialization, demographic, and sociographic etc. data. Benefit to users is ability of

customisation or personalization of FV system and availability of its functions that cannot be implemented if the user is unknown (like event notification or message broadcasting).

- c) **Knowledge management** includes finding materials or solutions to problems in previous discussions, finding discussions concerned with an interested category of problems, organization of all of these materials/content in such way that it can be used by knowledge discovery or data mining software and that it enables sophisticated content export/extraction [5]. Also, connected to user management, human resources management is the part of the knowledge management since, based on the information about expertise of users and their previous participations, they can be asked to participate in certain experts' discussions.
- d) **Participation in discussion and discussion management.** A user must be given tools to review and participate in a discussion in one or more of its activities based on his access rights. Discussion moderators must be given tools to organize discussions, set their properties such as access rights, agenda, description, related documents etc. Further, each discussion activity kind has its own management tool (brainstorming, pools, threaded discussions etc.) and if it is a moderated activity, moderators must be given tools for moderation of posted materials.
- e) **Supporting FV functions.** There are several supporting processes that should be implemented: broadcasting messages, events informing, help system, management of moderators, editors and administrators, glossary management etc.
- f) **Integration requirements.** There are many diverse applications of this system, which require integration of the system in some existing web site or adaptation of design or functionality of the system's GUI. The FV system must allow configuration of such components.

Applying Mintzberg's model of decision making, the group of people willing to solve their common problems, e.g. citizens of Varazdin, are scanning their virtual (Internet) and real information sources. They are recognizing the situation like problems, crises and opportunities that need some problem solving process. The triggers are reported to the City Hall representatives (*Ask the City Hall*) or to all citizens (*State Your Opinion*) in the form of a multimedia document. In a case of simple problem (structured problem with a ready made solution), the City Hall officer diagnoses the problem, searches the ready made solution (some document containing regulation or City Hall act, or some previous case) and writes an answer to the question (problem solution) in the form of the hypermedia report. Report contains links to the information sources where the solution is. In less structured problems, where the solution is not ready made, the process of problem solving is started. The moderator of the process is defined, who is making a starting document (description of the problem) in the form of hypermedia document. He is defining the parameters of the process with the aid of wizards and he is selecting the starting group of participants (according to their speciality and interest). Different tools are selected and are offered to the participants, allowing them to reach final solution at last. The moderator is finally making a solution and he is reporting it to the participants.

Decision making processes that are performed in the community are listed for the insight. Every decision making process is consisted from several tasks, some of them performed parallelly.

The wizards are helping to start the process of decision making. Some rules that are starting and stopping the process follows:

IF There exists clear public demand for problem solution THEN Start decision making process.

IF The problem becomes meaningless OR The problem becomes irrelevant OR There are no activities in the problem solution AND The problem is not solved THEN Mark the problem solving process «STOPPED» AND put it to the archive.

IF There exists clear demand for problem solution AND Similar process is interrupted THEN Get the «STOPPED» process from archive AND start it.

Decision making processes and tasks, as well, could be public and limited by insight and participation. Public insight and participation means that everybody in the database of participants

could participate to the process respectively, while limited insight and participation means that only specific group of participants from database is allowed to have an insight or participate in the process. The table 2 describes the four insight/participation models.

Table 2. Insight and contribution to the decision making processes tasks

Model	Insight	Contribution	Example
A	Public	Public	Like ordinary forum where all citizens can see the comments and write their contribution.
B	Public	Limited	Group of experts are solving some problems while the citizens can see the process without ability of public contribution; it is exclusively reserved for experts.
C	Limited	Limited	Group of experts is solving problem without public included in the process; confidential problem.
D	Limited	Public	Delphi-like method, citizens can contribute to the process, but they cannot see it; solving the problem of corruption in the local community – citizens are discussing cases, while the group of experts are able to see the comments.

The wizards that can help moderator to define the process can be built by following patterns. An example of insight/participation rules:

IF The problem is of the kind that public could give the information THEN Set PARTICIPATION = PUBLIC.

IF The problem is of the kind that public should see the information THEN Set INSIGHT = PUBLIC.

The tools are developing and implementing:

- a) Reports (XML documents).
- b) Discussion (ordinary Forum). Initial description of the goal of the activity and then the tree structure of the answers.
- c) Survey: contributions are hypermedia files (text, picture, sound, video, hyperlinks, structure, etc.), limited, open questions and closed questions type (*yes/no, m of n, scores, bullets*)
- d) Analysis tools: Excell, SPSS, Attar XpertRule Miner and IBM DB2 Intelligent Miner for Data and Text. (Classical statistical methods and data mining tools for the analysis of survey and activities of the process.)
- e) Management tool for moderators (wizards).

3. Forum Virtualis Architecture Skeleton

It is common knowledge that user acceptance is key factor in success of an IS project. Thus, it is important to find simple technological solutions for a complex problem or process. The architecture is based on requirements that all of the FV functionality is accessible over Internet through a browser and that as much work as possible can be automated and simplified. Such work includes administering the database, user accounts, managing discussions, communications, managing content (created, uploaded or stored) in the FV system. Figure 1 holds main FV system components groups.

Page templates are parameterized HTML pages and XML documents. When the FV user's browser requests a page, the request is sent to a FV component, which takes specific page template and data in the database, it generates a page which is sent back to the browser. If the request was such, the component also updates data in the database.

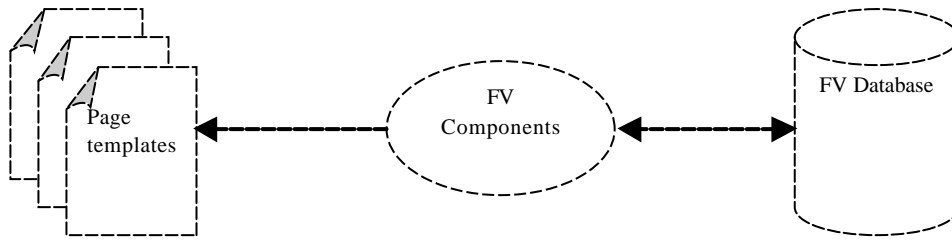


Figure 1. FV system components groups

It is possible to divide the set of FV components in two groups. One group of components generates FV web site pages or is tightly connected with the web site functionality (like search engine or user identification). The second group are 'background' components which do some background work like broadcasting messages to users, data mining etc.

Pages of FV web site are modular. Each FV system function of a web page is generated by its corresponding component. That means that page templates are composed of HTML or XML source which references these components (with some parameters if necessary). When a FV component for generation of a complete web page takes the template, it changes any *parameterized* parameters to their values (parameters), calls any other components referenced in the template page to generate their part of the page and sends the page to the browser. This is illustrated in the figure 2.

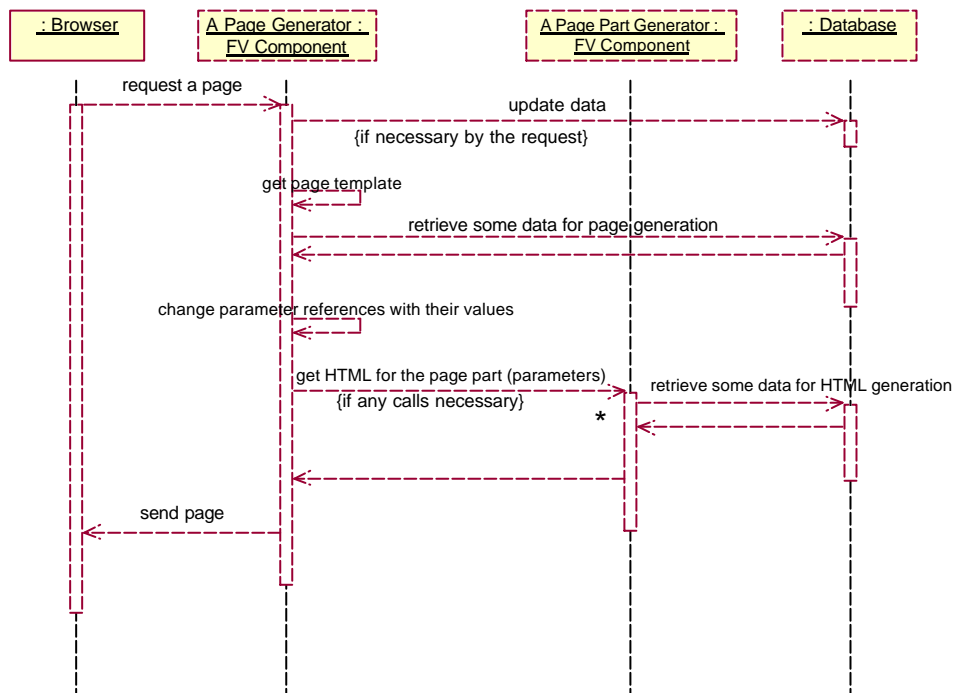


Figure 2. FV web page generation process (UML Sequence Diagram)

There are several default models of access to data and discussions in Forum Virtualis system. This is necessary because of many different applications of Forum Virtualis and different models of discussion processes (decision processes, negotiation processes etc.). Access rights are organized around *user groups*. FV system recognizes following default user groups:

- *basic users* - registered users with basic status
- *moderators* - registered users with moderator status

- *editors* - registered users with editor status
- *administrators* - registered users which are administrators
- *registered* - all registered users.
- *all* - all users, including unregistered.

Unregistered user has no FV account; *registered user* has a FV account, *moderator* is a registered user with moderator status and can be selected to moderate a discussion. *Editor* is a registered user with rights to start a discussion, set its moderators and do several other “editorial” jobs. *Administrator* administers FV configuration, functionality, user accounts and similar. Moderators, editors and administrators can add and manage unlimited number of additional user groups. Thus, a discussion or only some of its activities can have restricted access and other rights for privileged groups. Thus, depending on the user groups a user belongs to, one has visibility, read, append and change rights on particular FV system.

All users have all FV capabilities over an Internet browser (due to the requirement for global access to FV over Internet) including administrators, who can administer FV, moderators, who can moderate and organize discussions and editors, who can do all of their tasks over the Net. Among other benefits from this solution (like simplifications of FV architecture) this enables working at home or teleworking for persons who’s jobs are to be editors, moderators or administrators. Also, this enables to such a person to work for/in many FV instalations around the Globe which can be more efficient for FV installations whith small number of open discussions.

UI design aspect of FV. FV system would have to be integrated in existing web site which means: its design must match the overall design. FV system model has a set of UI properties that are customizable. They range from the selection of styles (cascading style sheets) for displaying page elements to management of all (parameterized) texts that are automatically generated by FV system (for messages, page titles, ...). FV has built-in multilingual support which means that user can select a language from a list of available languages in which all FV texts will be displayed to him/her. This does not include materials that are posted by users (mainly discussion process products). This brings international forums one step further in their applicability. When powerfull and high quality translation systems come to life, they will enable autotranslation of a discussion material (stored in a default language) to a desired language for the user. Such system would enable a user to write, read and search for textual content using any supported language no matter in which supported language given content was created.

One of very important functions is **message broadcasting and events notification**. Registered users can subscribe to FV events and how to be informed about them (e-mail, phone, fax, ...). Messages are broadcasted by moderators, editors and administrators. FV model has a gateway to an unified messaging system which takes care of broadcasting content using a user preferred communication channel. Examples of unified messaging systems are Canbox® [1], XIAM Information Ruter [4] and partially o3sis services [2]. This also can include advanced technologies like TTS (Text To Speech) for voice channels of broadcasting. It is to early to say which third party UMS will be used or more of them will be suported or a simple one will be developed.

FV web site’s pages are component based. This means that functionaliy or functions of a page are defined through use or referencing components in the page’s source. So FV has a quite **open architecture** for extensions of functionality of FV web site. Components can be added from completely different systems by purpose, without affecting previous components (and thus, FV functionality).

Since most of the FV users are not *power users*, a **help system** is provided. For each FV function available on a page, there is link to the help page(s) for that function. Users, based on their status (registered user, moderator, editor or administrator) receive a manual providing all necessary help. A great deal of time and effort was spent in FV design for documentation, including documenting and

modeling user's help system. Let's just mention that even the help system adheres to general UI changes and is integrated in overall multilingual support.

4. Discussion organization and methodology

Let's say for this paper that *a discussion methodology for a particular kind of discussion consists of a model of discussion process and (expressed or formalized) knowledge how to use that model*, where *kind of discussion* is like: decision process, voting, problem solving, negotiation etc.

One of the most difficult problems in design of this system was how to support all methodologies or more precise their models [7, 8, 9, 10]. The *knowledge how to use that model* is easy to integrate, for instance, as a well organized help. There is a very large number of such models and even larger number of their variations (using different techniques for the same phases etc.) and we haven't mentioned all *ad hoc* organizations of discussions. Each of this model has its own set of phases and rules for phase transitions and other rules. This drags the need for different data models as well; this need is a huge task for:

- overall database scheme development
- search engine applicability,
- complexity of software for discussion's web page generation etc.

This simply wasn't the solution and it required a completely new approach.

The idea came from the obvious fact that these methodologies all consist of one or more activities with defined rules of transitions from one activity to another. Some of possible activities are: chat, pool, voting, collecting initial information, brainstorming and Delphi method. The other obvious fact is that those activities are more or less 're-used' with no or little changes across the methodologies. Thus, we can say that there is a **set of activities of which any known discussion model consists**. Instead of supporting models, FV can support the activities and organization of those activities into models. With this view of the problem, it is exponentially reduced. There are additional benefits to this approach: discussion moderators can **use predefined model templates** (methodology's models packed with FV installation), they can **customize** them, they can **create new models**, and **store and share** the models for later reuse in other discussions. With this, FV can be a testbed for new methodologies.

Discussion model is selected or built in preparation of a discussion. Then, discussion is managed based on the model. Discussion management includes management of its activities, their synchronization, if applicable - moderating activities etc. It would be good if there was a way to manage discussions by all models similarly, if not the same way, no matter the methodology used. This is important because of the learning curve of discussions' participants and managers (moderators, editors), the simplicity of use and system maintainance and lower overall system complexity. This technique should be *visual* as much as possible. This is where we introduce the *discussion diagram*, a diagramming technique for modeling discussions which is also very appropriate for discussion management. The technique is not completely formalized and tuned-up at the time of writing of this paper, but it is enough clear and defined to be used in this system. In this paper the technique will be presented only in a few words.

5. Discussion Diagram

The diagramming technique (its language – syntax and semantics) is described using Unified Modelling Language (UML). To understand it, some basic knowledge of UML constructs Class and Class Diagrams is needed. The diagram elements' *look* is based on UML Activity Diagram [Object

The diagram consists of diagram elements. The elements are defined in the figure 3.

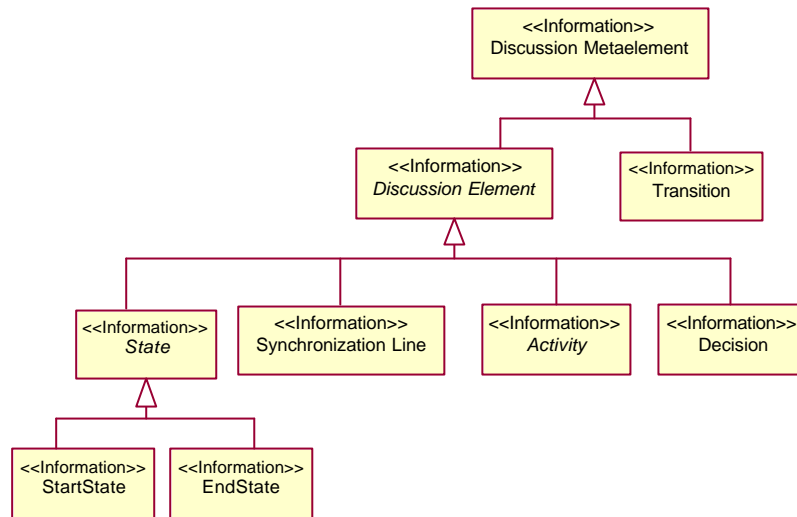


Figure 3. Diagram elements (UML Class Diagram)

Transition connects two other non-transition elements. Figure 4 shows how elements must be connected through transitions:

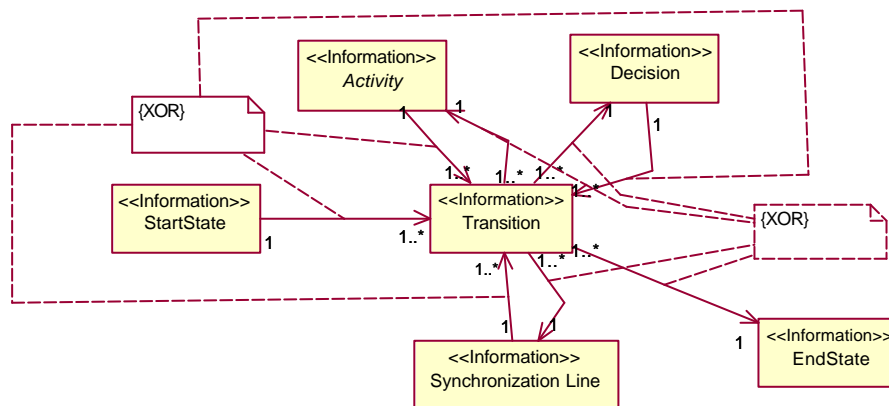


Figure 4. Diagram elements connection (UML Class Diagram)

We can express which elements a discussion diagram consist of with the following UML Class diagram.

We'll not go any further into well-formedness of the diagramm, recommendations etc., since this is not a paper about discussion diagrams. This technique enabled design of a tool in FV that lets discussion moderators select or make a discussion model and manage discussion flow and discussion elements (mostly activities).

Please note that previous figures (2, 3 and 4) *define* diagram's rules or language and discussion management is inseparable part of them. Users don't see the diagramm like this (they see it more like UML Activity Diagram with iconized stereotyped activities).

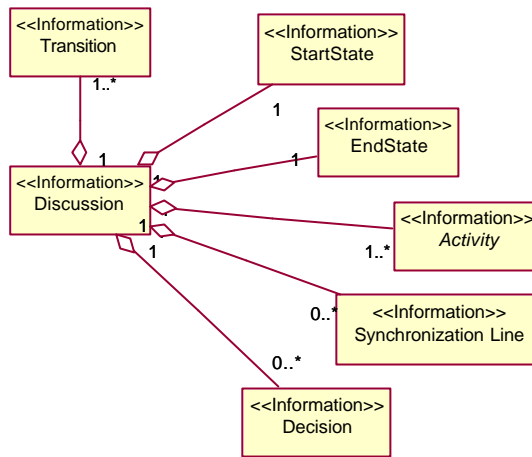


Figure 5. Composition of a discussion (UML Class Diagram)

Each element has its attributes and operations (they are *UML classes*). The attributes and operations are just exposed in the following figure 6:

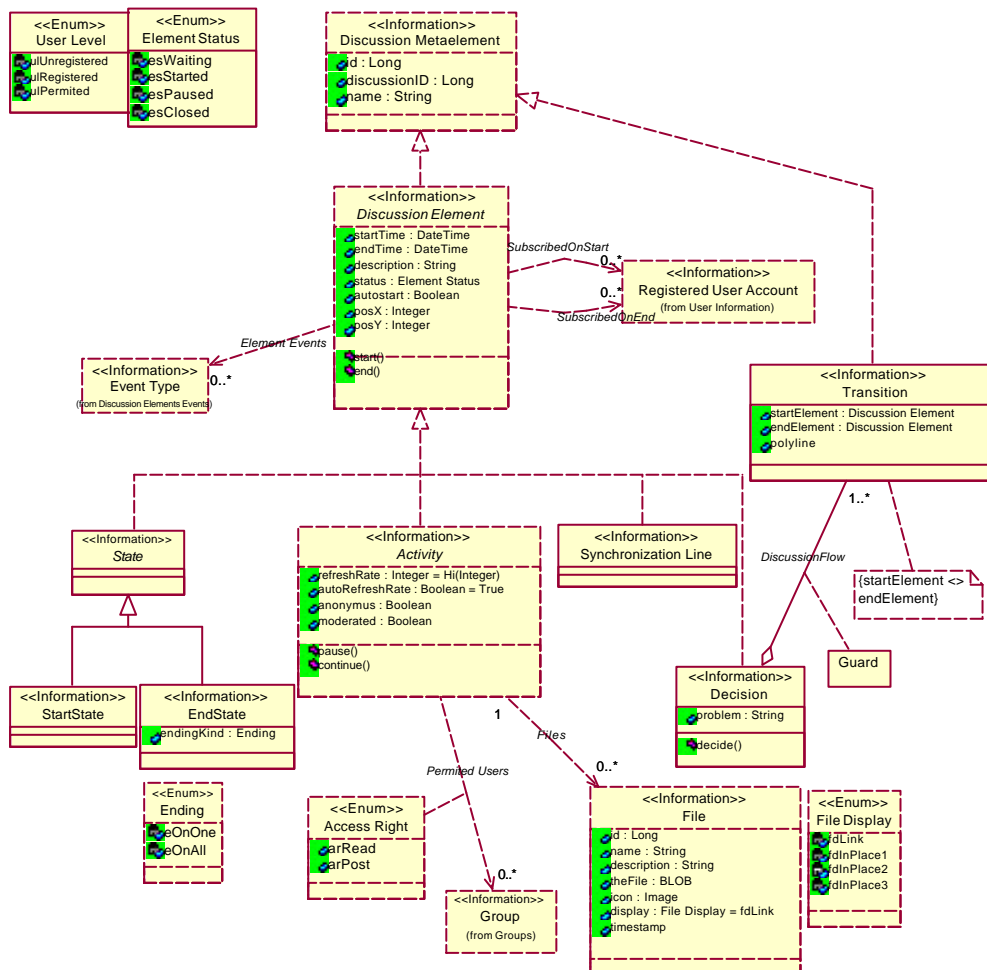


Figure 6. Discussion Elements' attributes and operations and other related information

Additionally, each discussion activity is implemented in FV system as an add-in or plug-in. Thus, it is possible to extend FV systems' discussion support. Installation of add-ins can be done on a *live* FV

system, which means, while it is running. The feature is very important for real-time, currently opened discussions on a given FV installation.

6. An Example

This is an example how government local authorities can solve a problem which concerns all local community members. Community members participate actively in the problem solving process. The example is a user interface working demo.



Figure 7. Forum Virtualis – user interface demo

The town council decided that the town should have its *modern version* of coat of arms and that it would be a good idea to include the citizens in this *creative work*. So, they opened a discussion in Forum Virtualis which is integrated in the town's web site (Figure 7). The discussion's moderator named the discussion *Modern version town's coat of arms* and described the problem and the agenda. The discussion is marketed on the town's web site, local massmedia and leaflets. Discussion is organized as in the following figure 8:

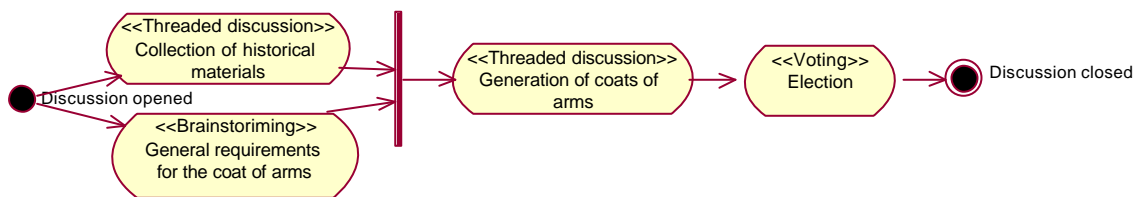


Figure 8. Discussion diagram (displayed as UML Activity Diagram)

1. Discussion's participants read the material posted by the moderator on the discussion's page (elaborated problem, agenda, related links).
2. Collection of historical materials and general requirements for the new modernized coat of arms are held simultaneously. The collection of historical materials for the coat of arms will be in the form of not moderated, threaded discussion where all users can view but only experts can post materials. General requirements collection is organized in the form of a moderated brainstorm in which requirements (such as colours, size, symbolism) for the coat of arms will be found based on historical materials and other.

- When both these activities are closed, the generation of coats of arms can begin. It is in the form of threaded discussion also, but moderated this time so that some ‘punks’ don’t post unrelated coats of arms such as from heavy metal groups etc. Users post their suggestions onto which other can replay and give *constructive* suggestions (the moderator takes care of this) and then the authors can update the look if they agree and post the new coat of arms (Figure 9). After several days or weeks, the FV system informs the moderator that no new posts are created or that the frequency of new posts has significantly dropped and that it is time to close this activity.



Figure 9. Forum Virtualis – discussion using hypermedia documents

- So the moderator closes the activity and opens election in the form of voting. Before opening, based on the previous activity, moderator has selected those coats of arms that received most replays and best responses. The voting is held for 3 days. Each user can vote only once. Voting is anonymous. User can vote for 3 of the offered coats of arms. The one with the largest number of points wins. Only registered users can vote. After voting, the discussion is closed and the coat of arms is send to the town council which obliged to authorize it with eventual small changes.
- Because the town council obliged, the monitoring of introduction of the coat of arms is not a part of the discussion. The moderator writes a report about the discussion, main conclusions and final solution. The report is published as the final document in the discussion and it is also sent to the town council.

Conclusion

The system Forum Virtualis has been designed and will be developed and tested in the next few months. We hope that the proposed model covers some key technologies and its functions should significantly surpass existing solutions. Our primary objective to obtain an open advanced experimental system is obtained. We also hope that it will reach the final goals that could help people to **really** solve some common problems on more efficient and natural way than still existed. It seems that our goal to enhance common problem solving will be reached then. However, our first area of

application seems to be idealistic in the nature, but in the background, there are many more commercial applications, for example in tourism and industry.

The main feature of any new invention in this area: simplicity and efficiency in problem solving, cannot avoid this **group support** solution: support by the *critical mass* of the users. It is necessary to obtain mature solution and a group of people willing to start many processes and intrigue other people to work with them. We learned it to be *conditio sine qua non* [6].

The main problem is how to initiate real serious processes with the serious participants. That means that the local forum must begin with many activities and obtain support of local intellectuals and highest local government bodies. It is planned that firsts such actions should be strategy development of economy and tourism.

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