AN ELECTRONIC POLLING SERVICE TO SUPPORT PUBLIC AWARENESS USING WEB TECHNOLOGIES

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ABSTRACT

This paper presents a Web-based, database-oriented application called "Electronic Polling", a smart way to support voting on common subjects in which all people of a Local Authority are interested. The systems services were planned and implemented to be easily expandable. The application is based on state-of-the-art software platform, integrating WWW and database. The system aims to become a pilot in future efforts relative with "on line Democracy". The system provides the capability to create a poll, view the subject and participate to the voting procedure. Only authorised users can participate to use the system to vote or create a poll but all users can view results from previous voting procedures.

1. INTRODUCTION

The explosion in popularity of Internet and the existence of tools, such as the World Wide Web – WWW, and various Internet applications, like web browsers, make the Internet readily accessible even to novice compute users. Moreover, the WWW has proven itself to be a cost effective means to provide information sharing and exchange.

Democracy based on citizen's participation in the procedure of decision making will always be a main priority for social units, like local societies, whole states or even communities of nations. Nowadays the reality of "Information Society" and the flyer globalisation of it will potentially affect the way of taking decisions with citizen interaction, permitting the public to take place in the political procedures.

Every new information and communication technology seems to garner proposals for application in politics and governance. Rapid worldwide growth in Internet and Web use has stimulated many initiatives aimed at applying information and communication innovations to create what has been called a "digital" or "electronic democracy".

The introduction of information technology has been set as a major goal for the Governments of Europe under the eEurope initiative and action plan. The aim of eEurope is to introduce in every day life Information technology applications in Public Administration, Yealth Transrort and Environment. in order to achieve better services.

Proponents of electronic democracy, who include increasing numbers of public interest groups, argue that a wide range of technological capabilities could be applied to facilitate closer links among citizens, as well as between citizens and local authorities. They also point to an array of new opportunities, such as the electronic delivery of many public services to people's homes or conveniently located multimedia kiosks, more access to a wider variety of public information, the creation of electronic forums for large-scale debates; and direct democratic participation through online voting and interactive polling (Bouras et.al 1998, Hague et.al 1999).

An *Internet or Electronic Voting System* is defined as an election system that uses electronic ballots that would allow voters to transmit their voted ballot to election officials over the Internet. *Internet Voting* means the casting of a secure and secret electronic ballot that is transmitted to election officials using the Internet.An *Internet Voting Machine* is defined as the computer hardware that allows an electronic ballot to be cast over the Internet

The provision of electronic voting via Internet may still be some way of, but the various pieces of the technology puzzle needed to make it a reality are now close to being in place. Internet voting is already widespread in a variety of forms, some serious, most not. It is technologically possible to utilise the Internet to develop an additional method of voting that would be at least as secure as the current ballot system in use.

The term "Electronic Polling" corresponds for a voting procedure, which is used only for getting public opinion thinking and can be used by the Local Administration as a tool for planning and development. The main difference from a voting procedure is that the voting procedure needs strong authentication and verification mechanisms, is addressed more to transfer the real voting situation through the Internet and there is always a predefined set of voters.

 "Electronic Polling" was developed in order to improve everyday's contact between citizens and local authorities and amplify active citizens' participation in the reception of decisions. The need for such applications came up due to the increased requirements to encourage even more citizens' participation in the reception of decisions.

The knowledge of public opinion in certain subjects (environment, culture, etc) is important for every local government for designing and planning actions related to the people. Public opinion should be taken account in every action planned by local authorities and especially the ones that affect a major part of the community. The ability of collecting the different opinions can save the administration from acting against people will and to discover the acceptance of each planned action.

 "Electronic Polling" can be used to collect citizens' opinion on common matters. All citizens can participate in the procedure by adding their ballot on the specified voting subject. After ensuring results validity system extracts the final results and the local authorities can determine their politics according to public trends on each subject. The system should be easy enough to be used by non experienced users and allow the procedure to be set up at any geographically dispersed area.

While there's been a lot of research on electronic voting systems, there isn't much software available that you can purchase or download and use to run an election immediately. A number of systems have been developed and are used run an election for a non-governmental organization. FREE (Free Referenda & Elections Electronically (see http://www.thecouch.org/free/) is designed to make an easy and secure job to run an election or referendum and it is an open source system for conducting electronic votes. VoteBot (see http://www.votebot.com/) is a system which offers decision-support for distributed communities. It allows starting a poll, survey or election for free. The basic service is free, the technology is easy to use and the service is flexible, trustworthy and secure enough to be useful

EVote (see http://www.ozemail.com.au/~jjjacq/evote) is a system that allows members of an email list to poll themselves. Any list member can initiate a poll, vote and receive a receipt for his/her vote, change or remove the vote while the poll remains open, Find the polls in progress, the statistics in a particular list, find out how someone voted and carry on a discussion with other list members as usual.

The Italian Academic Community (Bonetti et.al. 2000) voting system is a simple voting system to support voting in common matters for the Academic Community. There are also many Services Vendors that offer voting equipment, which is designed for special purposes and has very small capabilities.

On the hand a number of experimental Voting Systems have been developed to support real voting procedures. Vivarto Voting System (see http://www.vivarto.com/o2/eng/index2.html) is a system which aims to combine efficiency, democracy and expertise in governing large organizations with the help of modern information and communication technology. The primary innovations are the so-called Vivarto Representative System (a very advanced proxy voting system), and the Vivarto NetConference Modules (a new, powerful, easy to use, communication structure based upon the adoption of different rating scales, multi-level conferences, statistical analysis and intelligent display of results). Sensus (Cranor et.al 1997) employs a three-stage protocol in order that the vote gets tallied and presumes the use of a public key system for all voters. The system was developed in C and Perl and makes use of CGI scripts. E-Vox is a secure electronic voting system developed by the MIT Laboratory for Computer Science and Cryptography and Information Security research group. This research is supported by DARPA contract DABT63-96-C-0018, "Security for Distributed Computer Systems" and by NTT and is based on the work of (Fujioka et.al. 1992). A second version of the EVOX system (Durette 1999) has been created which uses multiple administrators for vote signing aiming at improving the security by preventing the administrator from forging votes. In (Davenport et.al 1995, Hersberg 1997) secure web-based systems developed to undergraduate student elections are presented.

This paper is organized as follows: in section 2 follows a general overview in which we present the main characteristics that apply to a "good" voting schema in general and the special characteristics of our system. In section 3 there is a short description of the project context of the architecture of the application. Section 3 contains the system analysis, where the general rules of the procedure are presented, the system design where we present the system architecture and specific implementation issues. Finally we describe in detail the main functionalities offered by the system. The last section summarizes conclusions inferred from our work and presents future work issues.

GENERAL OVERVIEW

Nowadays citizens have the need to obtain general information, submit questions and remarks get in contact with the right administration and services as far as local authorities concern, quickly and easily. Internet has provided an efficient infrastructure to be used for information dispersal and Local Authorities have discovered that WWW are favourable tools for information exchange (Bouras et.al. 2000). Such environments and mechanisms for efficient information exchange when needed can make an organisation more efficient and competitive. In order to increase participation of citizens in the local affairs evoting is a tool for this reason. Actually the system is developed as a part of Telematics services incorporated in the Web Site of the Municipality of Patras.

The characteristics of a good electronic voting system depend on the purpose that this system is going to serve. Nevertheless there are some similarities among most systems that allow us to determine a set of general characteristics that are essential to most cases (Cranor et.al 1997, Riera 1997). These characteristics are:

Accuracy. A system is accurate if (1) it is not possible for a vote to be altered, (2) it is not possible for a validated vote to be eliminated from the final tally, and (3) it is not possible for an invalid vote to be counted in the final tally.

Democracy. A system is democratic if (1) it permits only eligible voters to vote and, (2) it ensures that each eligible voter can vote only once.

Privacy. A system is private if (1) neither election authorities nor anyone else can link any ballot to the voter who cast it and (2) no voter can prove that he or she voted in the particular way.

Verifiability. A system is verifiable if anyone can independently verify that all votes have been counted correctly.

Convenience. A system is convenient if it allows voters to cast their votes quickly, in one session, and with minimal equipment or special skills.

Flexibility. A system is flexible if it allows a variety of ballot question formats including open ended questions.

Mobility. A system is mobile if there are no restrictions on the location from which a voter can cast a vote.

Local Authorities lack the possibility for consulting efficiently and quickly public opinion in matters that are of interest to people of the whole community. The traditional way to measure public opinion is using polls to contact surveys. A survey is a systematic, scientific and unprejudiced way to collect data. You can survey a group or sample of people about their feelings, plans, opinions, beliefs and personal, educational of financial background. Surveys are used by many different kinds of organisations and the data collected by surveys can be used to enhance communication, improve attitudes, and increase involvement, determine and social and other needs (see InfoPoll, http://www.infopoll.com.). Local Authorities realize that an electronic polling service can be used as a tool for planning and acting based on the needs of the citizens rather than on the needs of the authority. Based on these needs the Municipality Authorities of Patras set the objectives of the system.

The electronic polling service we developed had to comprise with the following objectives:

- Reporting of public opinion on common matters and record of public trends through an efficient, easy to use and up to date Internet based mechanism.

- Provision of directives, through the expression of public trends, towards local authorities in order to ensure valid and irreproachable results taken from voting. The final results will help in taking future decisions.

- Best possible familiarisation of the citizens with modern technology.

- Employment of a pioneer way of holding a poll/questionnaire with the participation of a representative percentage of people in the bounds of a local society.

- Procedure should be able to ensure the privacy and uniqueness as in real world voting. A strict electronic voting system to support the voting process is something considered very extreme just for the purpose of surveying people for their opinion.

- The authorisation procedure to be applied must be simple and give the citizens the sense that no vote can be related to a voter and to provide a mechanism for verification of the citizens vote.

- Polling announcement service will inform the voter for common subjects and encourage the citizens to exercise their right to vote.

- Offer the citizens a forum where they can set up their own voting procedure for a specific matter. Thus the citizens will be able to gather opinions for specific subjects and argue with the decisions of local authorities.

In order to confront the above issues in the whole a Web based, database oriented, information system has been designed and implemented. This system is based on Internet technologies and offers a set of interesting new features. It includes:

- Dynamic generation of polls. No need for form designing or programming.

- User administration for poll creation. Any (authorised) user can create polls with questions having multiple answer choices.

- Any number of polls can be created and the last poll created will be enabled automatically.

- The polling period is defined by the user and the system is responsible to maintain the poll and gather the results.

- Authentication control avoids multiple poll entries. Facility to restrict the user from taking the poll more than once.

- After a poll is over users can see the poll results in a graphical form. Results of preview polls are also available for further examination.

- DSN connection to the database.

- Select the subject of interest and select an answer from a potential set.

- A predefined set of voters (voters database) can be plugged in to facilitate statistical concrete results.

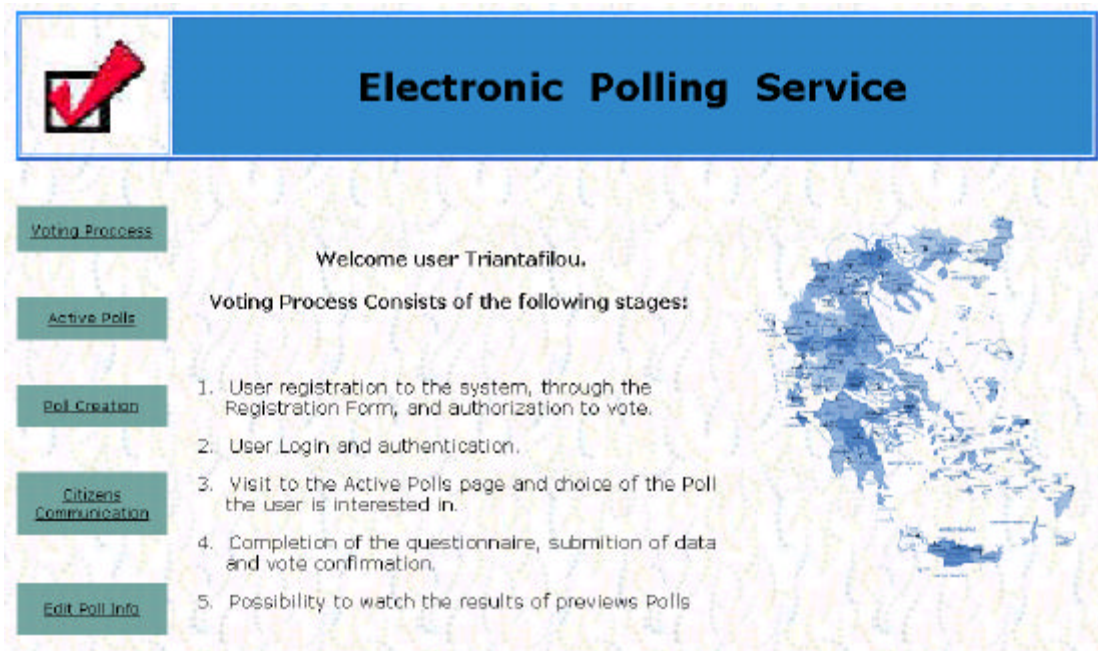## ARCHITECTURE OF THE APPLICATION

System analysis

Figure 1. Presentation of the application

The system functional specifications where derived from a extensive process of discussions with the responsible people of Municipality of Patras. The main objective was to obtain the basic requirements of such a system (Cranor 1996, Larsen 1999). In Fiigure 1 the layout of the specific application is presented.

Only authorized persons can use the system. Although each user has the possibility to access the main page of the voting application, only authorised users are allowed to participate in the voting procedure. A user is authorized to participate in the procedure if he registers giving his personal data and a Username and password. The mechanism must always inform the user (citizen) for a successful or unsuccessful attempt when he/she tries to use the provided services. Unauthorised users are able to see information about the voting procedure and relevant polls running but they have to register first in order to vote. This interaction helps the user to get easily familiar with the application and not to be bored and feels embarrassed.

A Data Base Management System (DBMS) is used that works behind the Web Server and provides the whole system with an efficient way of manipulation. The DBMS keeps all data about previous and on line polls, user profiles, votes, access authorities etc. The whole system is supported by a user-friendly interface. Classical browsers are used to access the application and an easy mechanism for localization of partial facilities of the application, e.g. by one mouse selection.

The use of the application must be possible from all citizens who have access to Internet through a personal computer (home, work etc) or an info-kiosk, without (necessarily) having an email account. The presentation of the results of an electronic voting snapshot should come true after the expiration day of the voting period and not during the holding of the procedure, in order not to affect citizen's opinion on a specific common matter. Additionally there are some non-functional specifications that are met in order to ensure the quality of the system application and that fall into the following categories:

Performance. The system should be available 24 hours a day. When the system data change, the updated data will be immediately available to the users. Users must be aware of the last changes (for instance via an electronic message). The system can collect statistical data, to allow the study citizen's correspondence and interesting for the services. A questionnaire form is maintained to ask citizens to evaluate the functionality of the system.

Safety. No information is to be lost if the system fails and a backup mechanism ensures data integrity.

Security. Data consistency is ensured. The system is protected against inappropriate users' behaviour and unauthorised access. An option for encryption of data transferred is provided.

Maintenance. The system is designed to be open in terms of smooth integration with new projects or new services or enhancement of existent application.

Environment. Inexperienced users can use the system within a short period of time. The user can interact with the whole system to submit remarks, comments to improve functionality and facilities.

System Design

The application is based on the provided services and functionality of the World Wide Web – WWW. The services have been developed on a WWW Server that provides the central node of communication, processing and reference. In Figure 2. there are the three layers of the system.

The browser is placed at the first layer. Citizens uses this browser to access the system (e.g., MS Internet Explorer or Netscape Communicator).

At the second layer there is the Web Server, which operates as an interface between the two other layers. In particular, the Web Server using ASP scripts provides the interface with the user, defining the data that will de presented each time to the browser as well as the connection with the real data stored in database and file system.
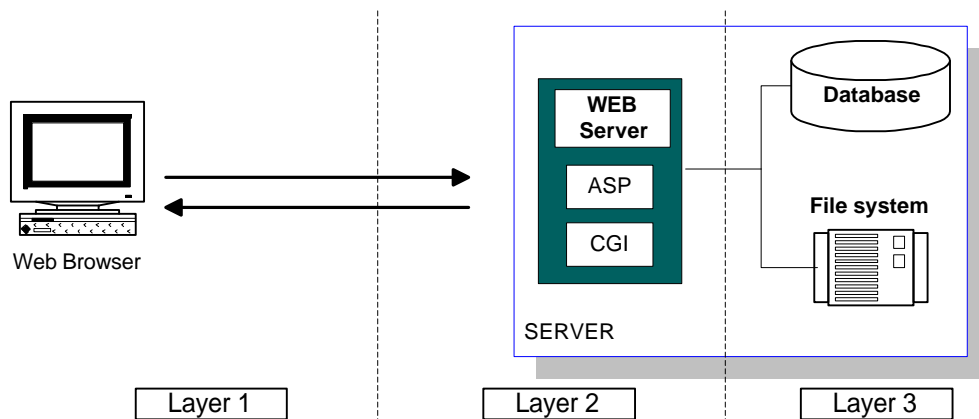
Figure 2. The three tiered architecture

Finally, at the third layer there is the file system of the server, where all the available electronic material is stored (messages, responses, several snapshots of the voting process, results etc) and the database Server which stores all the relative information for the material.

The Database contains all the necessary information about the users (personal and identification information), messages (questions, remarks, comments and the respective answers) the polling material (subject, potential answers), intermediate results (ballots in each category), final results (of the current and past snapshots of voting procedures) and useful statistical data for future study and processing.

The above information is distributed to the tables described below:

User_Voter: Contains information about the citizens that are registered in the system (personal data). The table also contains a field that corresponds to the status of a user (allowed to create a poll or not).

User_Login: Contains the authentication information of the registered users Login – Password.

Poll_Info: Contains information about the subject, the description, the number of questions and the expiration date of a poll.

Quest_Info: Contains information about the ID and the subject of each question as well as a foreign key to the poll that it belongs.

Answer_Info: Contains information about the multiple answers that each question has. It includes the text of the answer, the Question (Question_ID) and the Poll (Poll_ID) the specific answer belongs to and the number of voters that have voted for this answer.

Citizen_Contact: Contains information about the citizen that sends a message to the authorities. This table keeps information for the whole message too.

Citizen_Reply: Contains the answer to a citizen's message.

Implementation Issues

As mentioned before "Electronic Polling" is an interactive application where citizens send some kind of information (a ballot, user profile) and expect to view a set results. For the exchange of this information the HyperText Transfer Protocol (HTTP) is used.

The majority of the HTML (HyperText Markup Language) document responses are produced "on the fly". HTML is a markup language, which consists of tags embedded in the text of the document. The

browser reading the document interprets these markup tags to help format the document for subsequent display to a reader (user). We tried to limit the cases where many of the decisions about layout are made by the browser.

HTTP is a protocol with the lightness and speed necessary for a distributed collaborative hypermedia information system. It is a generic stateless object-oriented protocol, which may be used for many similar tasks such as name servers, and distributed object-oriented systems, by extending the commands, or "methods", used. A feature if HTTP is the negotiation of data representation, allowing systems to be built independently of the development of new advanced representations.

The communication takes place over a TCP/IP connection. The transaction consists of the establishment of a connection by the client to the server, the request that corresponds to the sending, by the client, of a request message to the server and the response that is the sending, by the server, of a response to the client. Finally the closing of the connection by either both parties commences.

So, each time a web client sends citizens' requests and receives answers via HTTP. Since the contents of various information change, the HTML page has to be generated from the second layer – as shown in the above figure – every time the user makes the request. Thus the web server scripting is essential in building systems such as ours. The second layer, namely Web Server, is responsible for the execution of the scripts. It is really easy to create web based applications and dynamic content. For the development of our information system the Microsoft Internet Information Server 5.0 (IIS 5.0) for Windows 2000 was used.

But why is web server scripting so essential? First of all web server-scripting enables the "backend" for the web application. HTML and HTTP do not by themselves provide a way to access databases or carry information about users from page to page. Server-side scripting accesses programs on the server that provides this necessary functionality behind the scenes to deliver web applications and customized HTML for each user. Second web server scripting separates the content from the presentation for easier design and data management. Server scripting allows the user of templates for creating HTML documents "on the fly". The contents of a page can come from anywhere – databases, plain text files, searches, calculations – and be dynamically inserted before it is sent to the user. Information can be managed in the most appropriate manner, and does not have to be stored in HTML pages that must be changed by hand whenever the data changes.

Active Server Pages (ASP) is a powerful server-based technology from Microsoft, designed to create dynamic and interactive HTML pages for World Wide Web sites, or cooperative intranets. The technology of Active Sever Pages (ASP 3.0) allows the use of programs, which are executed in the environment of MS-IIS 5.0. ASP pages are files that contain HTML headers, text and script commands. Moreover, ASP pages call ActiveX components for the execution of functions, like connection with a database or computations.

The power of ASP lies in two facts: first, the HTML is not created until the user wants to see the web page, and second, it does not care what web browser is being used. While ASP must be executed on a computer that supports it, we can view ASP-driven web pages from any computer, and with any modern browser. ASP pages are responsible for the administration of information stored in the system database. For ASP pages speaking the connection with the database is achieved by ActiveX Data Objects (ADO), through OLE DB and ODBC.

Finally, the part of the third level, namely Database, is responsible to enforce the authentication and security. All citizen information is stored in the database and are crossed each time the citizen desires to use the application of "Electronic Polling". Authentication involves prompting citizens for unique user Login and Password information, which must be correspond to a valid "user account", as it represented in the database records.

The system supports user-vote anonymity. A vote cannot be assigned to a specific user. This is done using a Secure Hash Standard. This Standard specifies a Secure Hash Algorithm, for computing a condensed representation of a message or a data file. When a message of variable-size m bits is input,

the Hash Algorithm produces an output called a message digest. The message digest can then be input to the Digital Signature Algorithm (SA) which generates or verifies the signature for the message. Signing the message digest rather than the message often improves the efficiency of the process because the message digest is usually much smaller in size than the message. The same hash algorithm must be used by the verifier of a digital signature as was used by the creator of the digital signature. The Hash Algorithm is called secure because it is computationally infeasible to find a message which corresponds to a given message digest, or to find two different messages which produce the same message digest.

After the publication of the results of a vote, each user that has participated in that specific vote has the ability to verify his own ballot. This way the voter can check if his ballot has been fraud or has been miscounted and certify the integrity of the voting. During the voting procedure the voter submits the ballot decryption key. The system uses the key to decrypt the ballot which is then stored in the database. After the election, the system publishes a list of encrypted ballots, decryption keys, and decrypted ballots, allowing for independent verification of election results

System Functionality

A set of functionalities where defined during the requirement analysis leading to a minimum set of parameters should be satisfied in order to have an efficient polling system (http://deimos/E-Voting/). These parameters may ensure the quality of the application [3] and ensure the validation process.

Registration Request. The citizen first fills and submits a registration form. The registration form includes the personal data (first name, last name, personal ID number, address etc.) as well as the coded access data (login, password) that he/she wishes to use each time, in order to make use of the application. The above data must be unique for every user. In a different case the authentication system will reject the request.

Figure 3. Registration Form

Citizens data used for this application are stored in the database of the system and are always available to the system administrator. In addition, administrator can delete a user in the case inappropriate or

unreasonable use is notified. This information could be used to ensure that the physical person behind the username and password is the same. All we have to do is announce a registration period before the poll begins.

All users are allowed to see results of old polls and to send to the administrator questions and remarks about the whole procedure.

Electronic Polling. After the registration process is completed the user is free to make use of the application and participate in a vote. The user visits the page with the active polls and picks a subject. By following the link the questionnaire is presented to him/her. The questionnaire includes questions of "closed type". In such a questionnaire the citizen can answer by selecting an answer from a set of possible answers.

This type of questionnaire was chosen because it offers more efficient statistical processing of the final results, which come up after the termination of voting process.

There are two ways to access the system: 1) from distance, using a computer that has access to the Internet. 2) From an info-kiosk established in a central area.

The execution of the voting procedure is based on the following steps: The user selects the desired answers and then submits his answer to the system. A confirmation mechanism is engaged to present to the user the specific choices he voted for before sending them to be stored and tallied. The confirmation of his vote results into counting his vote and storing the results into the database.

Based on the registration data given by the user in order to be allowed to use the voting service the citizen can send a message (question, remark, and comment) to the administrator of the electronic voting service. The user gives the username and password, writes down a short subject (description) of the main message, at the appropriate field and fills in his/her message and sends it. The response of the message can be retrieved when the user gives again the username and password and there is a response available for the specific user.

System Administration The system administrator is responsible for the creation and deletion of a poll. The user can dynamically generate a poll without the need for form designing or programming. Any number of polls can be created and the last poll created will be enabled automatically. The system administrator can assign privileges to users for creating a poll after they have send an application requesting such privileges.

The administration application offers a menu where the administration can create a new poll. The administrator is prompted for a title of the poll, a description and the questions/answers. The question/answer mechanism supports the insertion of a text for each question and the corresponding answers (questions having multiple answer choices). The administrator also defines the polling period and the system is responsible to maintain the poll and gather the results. After a poll is over users can see the poll results in a graphical form. Results of preview polls are also available for further examination.
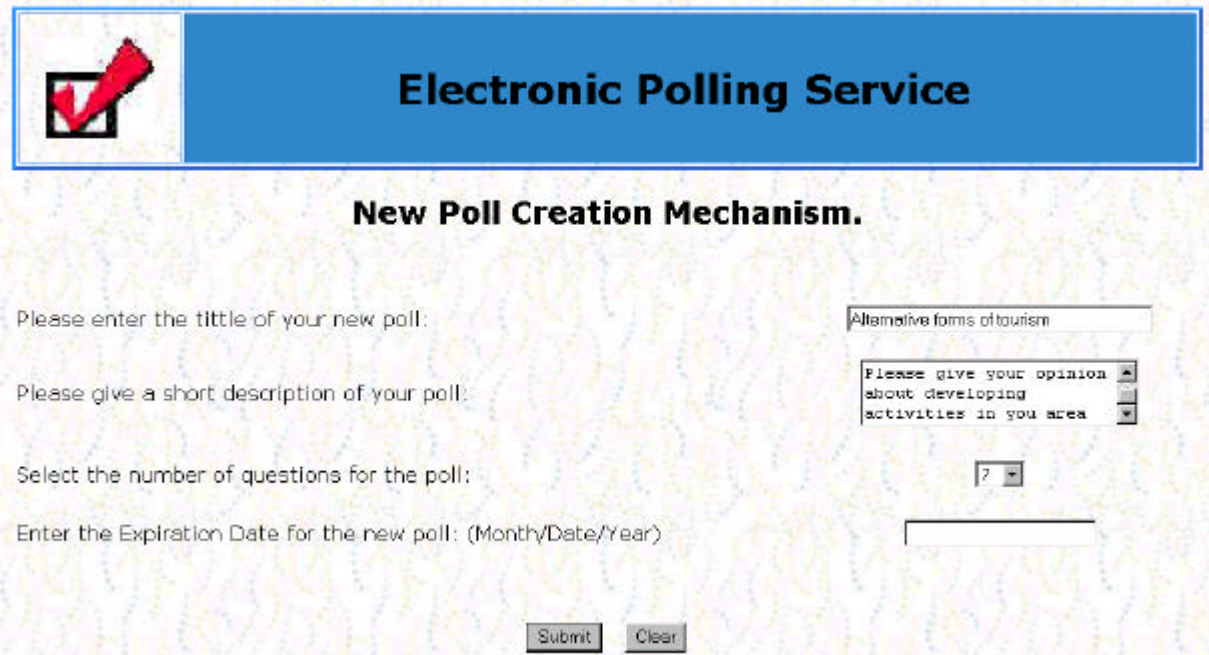
Figure 3 presents the first page of the poll creation schema. The fields are filled with the following information: Title of the poll, Description of the poll, how many answers will the poll contains and when does the poll expires. When the above data are completed (the system checks if anything is missing) then the system produces a predefined form to be used for question structure.

The deletion mechanism presents to the administrator all polls (active or not) and he just selects the poll he wants to delete. There is no modification functionality for the administrator to perform because since a poll must be modified the assumption of quality between all voters has been violated thus leading to a false polling procedure. The administrator is responsible for user administration. User administration is very important since it deals with personal data protection and user identification.

The system administrator is offered a simple mechanism that allows simple statistical process of the results of each poll. This facility is provided to the administrator to organise and extract a set of conclusions based on samples of the personal data. Thus, the administrator can present answers per age, profession, and educational level thus enhancing the interpretation of the results. This facility was

left to the administrator since this kind of statistical process is assumed not to be essential for all polls conducted.

The appearance of the final result is made visually through graphical representation. These graphical representations are accompanied by preferable percentages in order to make results comprehensive to simple user of the application.

Figure 4. New Poll Creation

CONCLUSION AND FUTURE WORK

This work is an attempt towards the direction of research on relative issues and provides a good technological background for future work. The aim is to produce a tool that the public administration can use in order to collect public opinion on specific administrative, environmental, economic growth and social aspects. The system will serve the purpose of a pilot for the development and deployment of similar systems in Greek Authorities

The exchange of information through Internet requires a data security mechanism, since only authorised access at this information should be granted. Our system deals with only parts of the security issues considered and safety mechanisms should be applied to prevent the unauthorised access thus leading to a more robust system against hurtful attempts. There must be some more security and safety automated mechanisms in order to ensure the authorized access, tracking more controlling levels and the system must be robust against hurtful attempts.

The system was planned and implemented in order to be easily expandable. We intend to incorporate public-key cryptographic techniques in order to tampering tracking, user and vote authentication, verification of the voting procedure etc. Careful improvement to the electronic voting mechanism next years will increase public participation while preserving voting integrity.

We intend to support the electonic voting service with an automatic mechanism to check and select the representative (each time) human sample in an electronic voting procedure. At this time, the checking of an appropriate sample can be done manually offline, after the end of the voting procedure. An online automated mechanism would be preferable and could enhance the accuracy of the respective results (the voting procedure would be ended after the collection of an appropriate sample of voters).

The system will be enhanced to support voting procedures of predefined set of voters (the members of a specific club, or of a specific profession). The system as it has been developed can easily compare personal data against a specific set of individuals and can be used to support the voting procedure (not the actual procedure) when the set of eligible voters is specified (the case of the employees of a Prefecture or a organisation). When the set of voters is known the results of the voting procedure can be easily evaluated and processed statistically. Local authorities in order to support more accurate political procedures have the need to offer a forum for citizens to express themselves. These voting procedures will lead to the design and implement of more secure and trust worthy voting procedures allowing the easy set up of elections at a local level. These local elections must be more robust with more security mechanicms.

Finally we would say that the whole system has been developed to work using Internet structure and its main intention is to improve democratic capitulates or to find another way to express them. It is one of the many attempts which will lead to next century «on line democracy».

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