REQUIREMENTS, DESIGN AND IMPLEMENTATION OF AN E-VOTING SYSTEM

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ABSTRACT
The rapid advancement in database, web and wireless technologies have given rise to new applications that were impossible just a few years ago. One of these applications is e-Voting. The term “e-Voting” is defined as the process of casting votes in an election using electronic means. This paper details the requirements, design and implementation of a generic and secure electronic voting system where voters can cast their votes anytime, any place and using a number of electronic devices including Web and mobile phones.

KEYWORDS
 e-Voting, web technology, mobile phones, system requirements, databases, software development.

1. INTRODUCTION
Voting and elections are essential ingredients of modern democratic societies. Unlike any other transactional event, the result of elections can have many effects on societies and their economic and financial wellbeing. Recent elections have seen a gradual decline in the overall percentage of the electorate exercising their right to vote. This is worrying from a democratic point of view in that, if the reasons of the decline are left unchecked, the mandate of those elected to hold the positions might eventually be questionable. Moreover, it is interesting to note here that traditional/manual voting systems are slow, complex, inaccurate and inefficient.

To counter these drawbacks, Governments have proposed a number of possible methods for re-engaging the electorate in the voting process. One of these methods is the modernization of the way in which the elections are being conducted. These methods include the use of electronic voting (e-Voting) as a new and modernized way to carry out the election process. e-Voting extends polling hours (anytime voting) and enables casting of votes from any place (anywhere voting) using different electronic means (any device voting) such as mobile devices and Internet-based voting.

In this technological age, it is imperative to explore and encourage greater use of information technology (IT) in most forms of service delivery. The ability to cast a vote through a multitude of choices such as web and mobile technologies is instantly attractive. Such facilities should also overcome constraints associated with the current voting process and engage more young voters. There is no doubt that remote electronic voting offers a convenience that would be appreciated by many people. E-voting enables citizens to participate electronically in democracy and provides them with more information about candidates and the election they are being asked to participate in.

This paper details the requirements, design and implementation of a generic e-Voting System, where voters can cast their votes anytime, anywhere and using a number of electronic devices including Web and mobile phones. Section 2 details a high-level set of requirements that an e-Voting system must satisfy. The architecture of an e-voting system that satisfies the stated requirements is presented in section 3. Section 4 outlines the implementation of a prototype for the e-Voting system. Finally, section 5 presents some concluding remarks.
2. REQUIREMENTS FOR THE E-VOTING SYSTEM

Prior to e-Voting System design, a comprehensive and detailed set of requirements have been developed. These requirements are divided into two groups, namely, generic and system-specific. The generic requirements are those requirements that apply to any voting system [1]. The generic requirements, as shown in Figure 1, include:

- **Privacy**: after casting a vote, no one should be able to link the voter to this vote;
- **Authenticity**: only eligible voters can cast their votes;
- **Integrity/accuracy**: once a voter cast a vote, no alteration to this vote is permitted. Moreover, all valid votes must be counted, whereas all invalid votes must not be counted;
- **Security**: throughout the voting process, a vote can’t be tampered with;
- **Democracy**: all eligible voters must be able to vote, one person - one vote and no one can vote more than once or vote for others.

The system-specific requirements, on the other hand, are those requirements that are specific to the electronic-voting systems. The system-specific requirements include:

- **Multi-user**: a number of voters can vote simultaneously;
- **Multi-campaign**: a number of elections can be running simultaneously;
- **Accessibility**: the system can be accessed by voters from any location using secure Internet and/or mobile devices;
- **Availability**: the system must have high-availability during an election campaign.

3. E-VOTING SYSTEM ARCHITECTURE

To accommodate these requirements, an architecture, presented in Figure 2, for the e-Voting system has been developed. The main elements of this architecture include:

- **The databases**: two databases have been developed for the e-Voting system, namely the election and Meta databases. The election database keeps track of campaigns, candidates and voters. The Meta database, on the other hand contains information about the structure and format of the different types of election campaigns as well as the applicable voting rules;
- **The database management system (DBMS)**: the DBMS [2] manages the election and Meta databases;
- **The web server**: the web sever interfaces the e-Voting system to web voters. In addition, it stores the different web pages containing the code required to interact with the user as well as the database system;
- **The SMS (Short Message Service) server**: the SMS sever, as shown in Figure 2, interacts with voters that use their mobile telephone set and the SMS messaging service to access the e-Voting system. At the lowest level, the SMS server interfaces to a number of GSM (Global System for Mobile Communications) modems that receive voters’ SMS messages through an SMS service.
provider (mobile operator). Once an SMS message is received by a modem, the SMS server grasp this message, perform, on its content, the required checks and then respond to the voter accordingly, by either placing a vote in the database or informing the voter about the occurrence of an error (e.g. invalid user name and/or password or multiple voting). After the voting campaign is completed, the SMS server sends all registered mobile voters (whether they have actually cast a vote or not) a message with the election results.

4. E-VOTING SYSTEM IMPLEMENTATION

Following the architecture presented in section 3, a prototype for an e-Voting system has been developed. The developed prototype makes use of two hardware (Pentium) servers, the database and the e-Voting ones. Both of these servers run Windows NT as an operating system. The details of these servers are presented next.

4.1 The database Server Implementation

The database server runs Oracle 9i [3] as a DBMS. In addition, the database server runs a newly implemented software tool, namely, the database creator. This tool, as shown in Figure 3, creates the election and Meta databases, according to the proper schema, and populates them with the initially needed information. In addition to database creation, the tool is used to clear the database tables and/or dropping the databases. The database creator tool makes use of Microsoft (MS) Visual Basic (VB.Net) framework to implement its interface to users. In addition, this tool uses ADO.NET technology to connect to Oracle to perform the different database creation/deletion activities.

Figure 2. An architecture for the e-Voting system.

Figure 3. The database creator.
4.2 The e-Voting Server Implementation

The e-Voting server, on the other hand, runs the following components, namely:

- **Microsoft Internet Information Server (IIS)**, as a web server. It stores and manages the web pages that implement the Graphical User Interface (GUI) for the Internet voters;
- **The Web Voters Graphical User Interface (GUI)** and the associated web pages. These pages are implemented using Java Server Pages (JSP) technology and connect to the database system using Java Database Connectivity (JDBC) library;
- **The GSM modems**: these modems connect mobile voters to the e-Voting system;
- **The SMS service/process**: this is an NT software process/service that monitors the GSM modems, process the received SMS messages and interact with the database server accordingly. In implementing this process, MS ADO.Net technology is used to connect the SMS process to the Oracle 9i database;
- **The administrative utility**: this tool, as shown in Figure 4, permits the administrator of the e-Voting system to carry out a number of activities, such as election campaign configuration and candidates, voters and the SMS service administration. The Graphical User Interface (GUI) of the administrative utility is implemented using Visual Basic (VB) technology. The different components of the administrative utility are presented next.
  - **The campaign configurator**: this tool, as presented in Figures 5, is used to create, delete and/or edit election campaigns. The creation of a campaign is carried out using the form presented in Figure 6, whereas, the form presented in Figure 7 adds a new candidate to an election. Figure 8 presents a form that is used to add a voter to the system;
  - **The SMS administrative tool**: this tool, as shown in Figure 9, is used to configure, run and stop the SMS service and initialize the GSM modem.
5. CONCLUSION

This paper details the requirements, design and implementation of a generic e-Voting System, where voters can cast their votes anytime, anywhere and using a number of electronic devices including Web and mobile phones.

REFERENCES

