

Mobile cum web based voting system

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Abstract—Elections allow the populace to choose their representatives and express their preferences for how they will be governed. Naturally, the integrity of the election process is fundamental to the integrity of democracy itself. The election system must be sufficiently robust to withstand a variety of fraudulent behaviors and must be sufficiently transparent and comprehensible that voters and candidates can accept the results of an election. Unsurprisingly, history is littered with examples of elections being manipulated in order to influence their outcome.

The design of a “good” voting system, whether electronic or using traditional paper ballots or mechanical devices must satisfy a number of sometimes competing criteria. The anonymity of a voter’s ballot must be preserved, both to guarantee the voter’s safety when voting against a malevolent candidate, and to guarantee that voters have no evidence that proves which candidates received their votes. The existence of such evidence would allow votes to be purchased by a candidate.

The voting system must also be tamper-resistant to thwart a wide range of attacks, including ballot stuffing by voters and incorrect tallying by insiders. Another factor is the importance of human factors. A voting system must be comprehensible to and usable by the entire voting population, regardless of age, infirmity, or disability. Providing accessibility to such a diverse population is an important engineering problem and one where, if other security is done well, electronic voting could be a great improvement over current paper systems. Flaws in any of these aspects of a voting system, however, can lead to indecisive or incorrect election results. There have been several studies on using computer technologies to improve elections. These studies caution against the risks of moving too quickly to adopt electronic voting machines because of the software engineering challenges, insider threats, network vulnerabilities, and the challenges of auditing.

Keywords- Database Systems; Electronic voting; Mobile devices; Web-based application; Wireless network interfacing; XML data representation

1. INTRODUCTION

Voting and elections are essential ingredients of modern communities. Unlike any other transactional event, the result of elections can have many positive and/or negative effects on these communities and their wellbeing. For many

years, elections, in general, have suffered from declining participation rates due to the inconvenience of manual voting. Manual voting has several other drawbacks among which are inaccuracy in ballot counting and the delayed announcement of election results. To overcome these drawbacks, the Electronic Voting (e-voting) technique, the use of computers or computerized equipment to cast votes in elections, has been proposed. E-voting automates and simplifies the election process, speeds it up, increases participation rates, reduces counting mistakes and minimizes the time it takes to announce results.

This paper details the requirements, design and implementation of a generic e-voting system capable of supporting a number of election campaigns simultaneously and permits voters to cast their votes in these elections at anytime (anytime voting), from any-location (anywhere voting) and using a variety of electronic devices (any-device voting) including Web browsers, WAP-enabled [3,4] devices (Smart Phones) and SMS-based [5,6] mobile phones (Regular phones). To avoid web content replication for each of the connecting devices, the implemented system separates the data content from its presentation form. To achieve such a separation, the Extensible Markup Language (XML) is used to represent the web data content, whereas, the Extensible Style Language Transformation (XSLT) style sheets are used to customize the presentation of such a content on different connecting devices, thus, achieving true “author once, publish to any device” design and implementation. To validate this concept, this paper presents the implementation of a prototype for the e-voting system in support of democratic elections within a sector.

The rest of this paper presents some background material on e-voting systems. The relevance of the research reported in this paper to the general area of computer interfaces and standards is also presented. Further, the set of high-level requirements that an e-voting system must satisfy are presented. The technologies and standards needed to support the development and implementation of e-voting systems are presented.

2. EXISTING E-VOTING SYSTEM

Elections, in general, can be divided into two main types, namely, political (e.g. legislative and municipal types of elections) and non-political (e.g. election of student governing body within a university, election of trade associations). Both of these election types have different security requirements. While high security is needed by political elections, a substantially less amount of security is needed

by the non-political ones. Different electronic systems have been proposed in support of elections and voting, namely:

2.1. Computer Counting

This type of systems requires the voters to mark their votes on a paper with a pencil or marker or remove divots from a perforated card [9]. The ballot cards are then scanned and tallied at a central computer site or at each polling station.

2.2. Direct-recoding electronic voting machine (DRE)

This system requires voters to use a keyboard or touch screen to mark their votes on a computer terminal, directly connected to a stand-alone, polling-station-located computer. The votes are immediately added to a running tally stored in the computer's storage system. The final DRE[2] tally is then moved to a central location where it is added to the tallies obtained from other DRE machines. A comparison between DRE and paper-based voting systems is presented in ref.[7].

2.3. On-line Voting

This type of systems involves the use of a computer and the Internet or a private network in support of the voting process. On-line voting can be conducted in a variety of ways, namely :

- “Poll site” e-voting system: this type of voting systems requires voters to go to staffed polling sites and use computers to cast their votes. A network (Internet or private) is used to transfer ballots from each polling place to a centralized site, where votes are tallied and election results are published.
- “Kiosk” e-voting system: this type of systems allows voters to vote from computers/ATM-like machines situated within kiosks. The kiosks are setup by the voting authority in suitable locations such as post offices or shopping malls and connected to a central location via the Internet (or a private network). A vote casted at the kiosk will immediately be forwarded across the network to the centralized tallying site. The kiosks are not monitored by poll workers at all time and may allow voting over a period of several days or weeks. Once the voting period for a given election is up, the associated tallying site publishes the result of that election.

“Remote” e-voting system: This type of systems allows voters to cast their votes from any computer or digital device connected to the Internet or to a private network; typically from home or at work. Devices such as personal digital assistance, mobile phones and even game machines may access these systems.

Several studies exist on using computer technologies in support of political remote e-voting systems. Most of these studies have focused on assessing the vulnerability of this type of systems to vote-tampering and illegal access. Other studies have concentrated on developing techniques to insure the security, privacy and integrity of this type of voting systems. The use of remote e-voting systems in supporting of nonpolitical elections have been investigate by many projects [6,7]. Little work has been reported on the integration of different technology components and protocols to implement this type of systems. This paper concentrates on this aspect of the remote e-voting systems taking the implementation of an e-voting system for a legislative election as a case study.

3. PROPOSED E-VOTING SYSTEM

The objective of Online voting system is to help the organization in automating the whole manual processing of the existing system. The existing system is manual so members of the unit generally face a lot of embarrassing situations many times. Now they need to automate the whole process so as to make it more easy and accurate.

The main objective to develop the system is to make the accurate & efficient decisions in different tasks at different time at different situations.

System supports multi-user environment.

System is fully automated.

System is providing concrete security features like creating users and assigning privileges to users of the system.

System will be capable to keep track of all the detailed descriptions of the voters and the candidates, also whole details of services offered.

Various outputs (reports) shall be available online any time.

System will be able to handle extremely large volumes of data (Large database support).

3.1 Relevance to computer standard and interfaces

This paper examines the notion of remote e-voting, and investigates the software components, standards and technologies needed to support its implementation. It also details the requirements, design and implementation of an e-voting system suitable for Democratic Approach where people can elect their governing counsel by casting their votes anytime, anywhere and using fixed and mobile electronic devices including personal computers and smart and regular phones.

The work presented in this paper is relevant, in many aspects, to the general area of computer standards and interfaces. First, this paper discusses and make use of Wireless and Internet communication protocols/standards including the Wireless Application Protocol (WAP) [3,4], Short Message Service (SMS) [5,6] and Hyper Text Transport Protocol (HTTP). These standards enable different electronic devices to connect to computer systems through wired, wireless and GSM networks. Second, this paper uses programming standards such as the Extensible Hyper Text Markup Language (XHTML), Wireless Markup Language (WML), Extensible Markup Language (XML), and the Extensible Style Language Transformation (XSLT) style sheets, to represent data content and data form.

These standards are instrumental in developing modern interfaces customized to fit the need of the different types of users and connecting devices. It is important to note here that the study of these standards and their use in developing modern electronic systems and interfaces are of great interest to a wide segment of "Computer Standards and Interfaces Journal" readers.

4. REQUIREMENT FOR E-VOTING SYSTEM

Prior to e-voting system design, a comprehensive and detailed set of requirements must be developed. These requirements include three main types, namely, generic, system specific and election-specific requirements. Samples of these types are presented next.

4.1. Generic Requirements:

The generic requirements are those requirements that apply to any voting system. These requirements, as shown in Fig. 1, include:

1. Authenticity: only eligible voters can cast their votes;
2. Integrity/accuracy: once a voter cast a vote, no alternation to this vote is permitted. Moreover, all valid votes must be counted, whereas all invalid ones must not be counted;

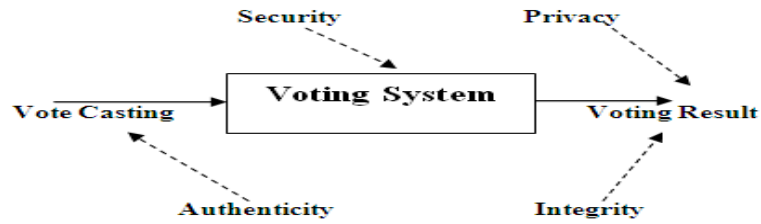


Fig. 1. A generic set of requirements

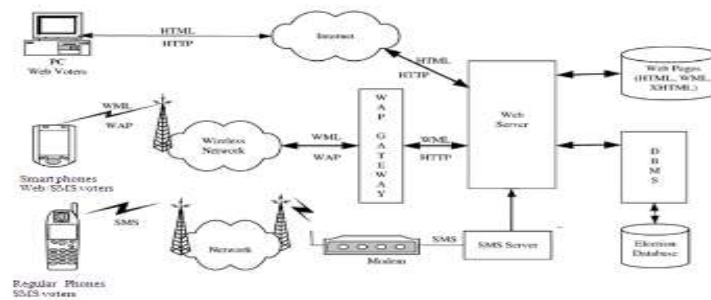


Fig 2.The organization of Generic voting system

3. Privacy: after casting a vote, no one should be able to link the voter to this vote;
4. Security: throughout the voting process, a vote can't be tampered with or viewed by anyone;

5. 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.

4.2. System-specific requirements[1]

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

1. Multi-user: a number of voters can vote simultaneously;
2. Multi-elections: a number of elections can be running simultaneously;
3. Accessibility: the system can be accessed by voters at any time, from any-location using the Internet/Intranet, PDAs, and/or mobile phones;
4. Availability: the system must have high-availability during an election campaign.

4.3. Election-specific requirements

The election-specific requirements are those requirements that are specific to a given election. For example, the election specific requirements for student council election include the following items:

1. The age of voter must be 18 or above;
2. The age of candidate as per particular specifications;
3. A voter/candidate must hold citizenship of India;
4. The candidate
5. The fundamental rights of voter/candidate should not be violated;
6. A candidate must not serve more than two consecutive elections;
7. A candidate is also a voter;
8. An election winner must be one of the candidates for that election;

9. The voter name should be included in voting list.

5. E-VOTING SYSTEM ORGANIZATION

A generic e-voting system, as shown in Fig. 2, consists of a number of components, each of which will be presented next.

5.1 The election database and the database management system

The election database stores the data elements representing elections, candidates and voters as well as the schema that describes these data elements and the associated constraints. These constraints implement some of the election-specific requirements presented above. The election database is managed by a modern database management system (DBMS) such as Oracle, Sybase or MS-SQL.

5.2 The web server and the associated web pages

The web server connects, as shown in Fig. 2, the e-voting system with the Web and WAP [3,4] voters. In addition, it stores the different web pages and the code / intelligence required to interact with the user as well as the database system. The web pages are of two types, namely, static and dynamic. The data content of a static web page does not change throughout its existence, whereas, the content of a dynamic page changes based on the client input. To create dynamic web pages, a number of technologies can be used, namely, Common Gateway Interface (CGI) scripting [8], Java Server Pages (JSP) and Java Servlets.

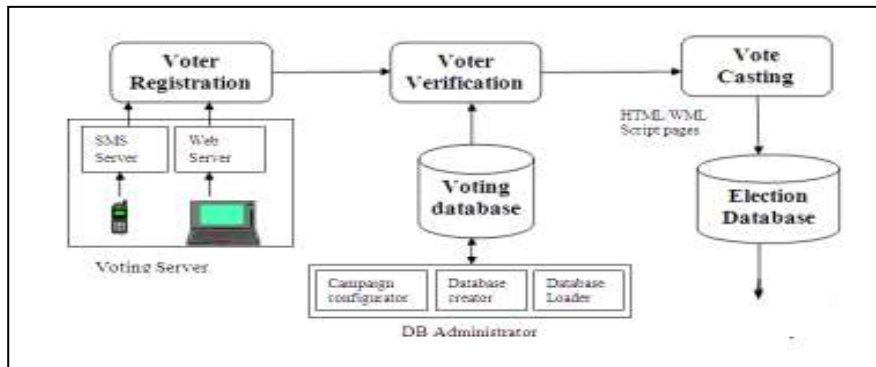


Fig 3. The component of implemented E- voting system

5.3 The SMS server

The SMS server, as shown in Fig. 2, interacts with voters that use their regular mobile telephone sets and the SMS (Short Message Service) [5,6] messaging service to access the e-voting system. At the lowest level, the SMS server interfaces a number/bank of GSM (Global System for Mobile Communications) modems that receive voter's SMS messages through an SMS service provider (GSM operator). Once an SMS message is received by a modem, the SMS server grabs this message, performs, on its content, the required checks and then respond to the voter by either placing a vote in the database, rendering a service to the voter or informing the voter about the occurrence of an error (e.g. invalid user name and/or session password). 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 containing the election results.

5.4 The access devices

Table1.Voter types and corresponding protocols

Voter type	Access Device	Presentation Engine	Communication Protocol	User interface specification
Web voters	PCs, laptops	Web browser	HTTP	HTML, XHTML
Web/SMS voters	Smart phones	Micro browser	WAP	WML
SMS voters	Regular phone(text editor only)	Text Editor	SMS	none

Different devices, as shown in Table 1 and Fig. 2, are used to access an e-voting system, namely, regular PCs or laptops, WAP-enabled hand-held devices (Personal Digital Assistant (PDA), smart phone) and/or regular cell phones. The interface technologies and protocols available for each type of these devices are outlined next.

Personal computers /laptop

Personal/Laptop computers, as shown in Fig. 2,

Internet, the web browser and the web server make use of the standard Internet communication Protocol, namely, Hyper Text Transport Protocol (HTTP).

5.4.1 Smart Phones

As shown in Fig. 2, the Smart phones are connected to the e-voting system through a wireless network. Because of the network's limited bandwidth, these devices utilize the Wireless Application Protocol (WAP) [3,4] framework and, as shown in Fig. 2, a gateway to connect to the Web server. The role of the gateway is to translate WAP into the standard Internet communication protocol HTTP and vice versa. In addition, smart phones are characterized by smaller memory sizes and limited processing power and therefore they run a limited version of the standard Internet browser, referred to as WAP micro-browser. This browser utilizes the Wireless Markup Language (WML) as a specification for user interfaces. WML is based on the Extensible Markup Language (XML) [10] and therefore has no resemblance to the classical HTML language.. As a matter of fact, WML is a small subset of XHTML that requires less processing power and therefore it is more suitable for the handheld devices. WML can support tables and simple scripting through WML Script.

5.4.2 Regular cell phones

Regular cell phones, as shown in Table 1 and Fig. 2, utilize Short Message Service (SMS) [5,6] technology to connect users to the e-voting system. SMS is very popular among users because of its low cost and ease to use. The low cost stems from two factors, namely, the low cost of sending and/or receiving a message and the low cost of the mobile phone supporting this service since all that is needed is a simple textual editor for message composition and display. One disadvantage of SMS is its difficulty to construct a highly interactive dialog between the mobile device and the e-voting system.

6. E-VOTING SYSTEM IMPLEMENTATION

Following the requirements of Section 3 and the architecture of Section 4, a prototype for an e-voting system has been implemented. The developed prototype, as shown in Fig. 3, uses two hardware servers, the database and the voting ones. The functionality and software components developed for these servers are presented next.

6.1 The database server

The database server, as shown in Fig. 3, runs a modern Database Management System (DBMS). In addition, it supports a number of software tools, the implementation of which is presented below.

6.1.1 The election database implementation.

The design and implementation of the election database starts with analyzing the election process and its data requirements, the election data is organized as a set of entities (Voter, Election, candidate, Winner) interlinked by a number of relationships. The Voter entity and its attributes, for example, capture the data associated with voters (their IDs, names, Date of Birth (DOB)... etc.), whereas, the Election entity capture the data associated with elections (election-IDs, tiles, start-date, end-date... etc.). The Candidate and Voter entities are interlinked by a specialization relationship since a candidate is indeed a voter with some extra attributes. Then database schema expressed using the Structured Query Language (SQL). The database is then created by the DBMS according to this schema. Once created, the database will be ready to receive the election data. The design and implementation of the Election database incorporates some of the Election-specific requirements as constraints. For example, election-specific requirements are implemented by constructing specialization relationships between Voter, Candidate and Winner and therefore insuring that a person can't be a Winner unless he/she is a candidate and a voter.

6.1.2 The implementation of the database administrator

The database administrator tool assists the system administrator in managing the election database. The Administrator tool is a GUI-based tool implemented using Java framework and connects to the database using JDBC/ODBC technology. JDBC provides a uniform way for a Java program to connect to a variety of database management systems without having to use DBMS-specific features. The different components of the administrator utility are presented next.

- The database creator: the database creator tool creates the election database, according to the associated schema. In addition, this tool is used to clear out the database tables and/or dropping the database.

- The database loader: The database loader tool enables the system administrator to load, from a file, qualified voters into the Voter table. To do so, the database

loader implements some of the election-specific requirements as constraints and apply these constraints to the file to select those individuals that are eligible for voting and, then, load these individuals into the Voter Table. Users may also register for voting through the Internet (Web and WAP users) and/or SMS messages.

- The campaign configurator: This tool is used to create, delete and/or modify election campaigns. The creation of a campaign/election is carried out that may add a new candidate to an election and may add a new voter to the system.

6.2 The voting server

WML document. The resulting document is then sent to the connecting client for display, this document is rendered by the Web and WAP browsers, respectively. Pressing the Candidates link on the menu page that transfers the control to another ASP document, namely, candidates.aspx which first creates and sets up an ODBC object, through which it connects to the Candidates database table. The processing continues by retrieving the list of candidates for the specified election and generating an XML document that represents the candidates' retrieved list. candidates.aspx continues by applying the appropriate XSLT sheet (xhtmlCandidates.xsl or wmlCandidates.xsl depending on the type of the connecting client) to generate candidates.html, an XHTML document, or candidates.wml, a WML document. The resulting document is then sent to the connecting client for display

7. REFERENCES

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