ANALYSIS OF ELECTRONIC VOTING SYSTEM IN VARIOUS COUNTRIES

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Abstract— India is the world's largest democracy with a population of more than 1 billion; India has an electorate of more than 668 million and covers 543 parliamentary constituencies. Voting is the bridge between the governed and government. The last few years have brought a renewed focus on to the technology used in the voting process. The current voting system has many security holes, and it is difficult to prove even simple security properties about them. A voting system that can be proven correct has many concerns. There are some reasons for a government to use electronic systems are to increase elections activities and to reduce the elections expenses. Still there is some scope of work in electronic voting system because there is no way of identification by the electronic voting system whether the user is authentic or not and securing electronic voting machine from miscreants.
This paper provides an overview of the experiences of other countries using electronic voting machine. The comparative focus is on the adoption of electronic voting systems adopted at the international level.
Keywords-Electronic Voting Machine, Invalid votes, Audit traits

I.   Introduction

Electronic Voting Machine is a simple electronic device used to record votes in place of ballot papers and boxes which were used earlier in conventional voting system. It is a simple machine that can be operated easily by both the polling personnel and the voters. Being a stand alone machine without any network connectivity, nobody can interfere with its programming and manipulate the result. Keeping the erratic power supply position in many places in the country, the machines have been made to run on batteries. It has mainly two units: Control unit and Ballot unit. The Control Unit is the main unit which stores all data and controls the functioning of EVM. The program which controls the functioning of the control unit is burnt into a micro chip on a "one time programmable basis". Once burnt it cannot be read, copied out or altered. The EVMs use dynamic coding to enhance security of data transmitted from ballot unit to control unit. The new EVMs have also got real time clock and date-time stamping facility which enables them to record the exact time and date whenever a key is pressed. After the voting is completed and the close button is pressed, the machine does not accept any data or record any vote. Through the press of "total" button, the control unit can display the number of votes recorded till that time which can be cross checked with the register of voters. The display system of the control unit shows the total number of votes polled in a polling station and the candidate-wise votes polled in the machine when the 'result' button is pressed by the counting staff in the presence of counting agents at the counting centre. The control unit can also detect any physical tampering made with the connecting cable and indicate the same in the display unit.

In previous manual elections in India, a nationwide ballot could consume around 8,000 tonnes of paper and 400,000 phials of indelible ink and require some 2.5 million strongboxes to store them under heavy security until the votes were counted. In the past, it took up to three – four days to count the votes, with hired personnel spending day and night in secured areas manually counting each ballot. Sometimes demanding for recounting resulting for the low margin of difference of votes between the top two candidates coupled with large number of invalid and doubtful votes.

The electronic voting machines are intended both to reduce errors and to speed the counting process. Advantages of EVM over the traditional ballot paper/ballot box system are

   i. It eliminates the possibility of invalid and doubtful votes which, in many cases, are the root causes of controversies and election petitions.

   ii. It makes the process of counting of votes much faster than the conventional system.

iii.   It reduces to a great extent the quantity of paper used thus saving a large number of trees making the process eco-friendly.

iv.   It reduces cost of printing almost nil as only one sheet of ballot paper required for each Polling.

II.   DEFINITIONS

The category "electronic voting" is potentially broad, referring to several distinct possible stages of electronic usage during the course of an election. For the purposes of this paper, distinctions are made between the following terms:

(i) Electronic voting:
Electronic voting refers to any system where a voter casts his or her ballot using an electronic system, rather than a paper ballot (or mechanical machine to punch a paper ballot). Once recorded, an electronic vote is stored digitally and transferred from each electronic voting machine to a counting system [2].

(ii) Electronic vote counting:
Electronic vote counting refers to the system that is used to tabulate ballots and award seats. It would be possible to vote using a non-electronic medium and then convert these votes to an electronic system and award seats through an electronic vote counting system [2].

III.   INTERNATIONAL STATUS OF ELECTRONIC VOTING:

A.   Brazil

In Brazil, the largest nation in South America, currently, all votes are cast by electronic voting machines. The Brazilian Supreme Electoral Court authorized the use of Electronic voting technology in the 1996 Brazilian municipal elections. In 2000, the Brazilian government had converted to fully electronic voting and deployed over 400,000 kiosk-style machines in elections that year. Voters in Brazil use an electronic voting device that, for each office, displays the choices and prompts the voter for his or her vote. The voting machines feature an integrated screen and keyboard .To vote for a candidate, voters only need to press on the keyboard the number designated for a particular candidate. The candidate's picture then appears on the screen. Voters can confirm, reject, choose another candidate or start the selection process again. The Brazilian electronic voting technology is unusual in that the voting machine itself tallies the votes once voting finishes, producing both digital and printed reports of the number of votes given to each candidate. 12,000 machines used to produce a paper ballot that the voter could peruse and deposit in a box for recount. These paper-trail machines were successfully used during the election [2].

B.   India

In India first election using electronic voting is scheduled to hold from April 20 to May 10, 2004. India is the world's largest democracy with a population of more than 1 billion, India has an electorate of more than 668 million and covers 543 parliamentary constituencies, and will require more than one million electronic voting machines (EVMs). The legal approval in 1989 to allow the use of EVMs, they have been used in many state elections but never used an entire general election. Electronic Voting Machines prepared by Electronics Corp of India and Bharat Electronics. The EVM comprises two units, one for control by the polling staff and the other for the use of voters. The balloting unit requires voters to press the button next to the candidate's name and symbol and the control unit records the vote. A light next to the button glows, and a short beep sound follows indicating the vote has been cast. The polling officer then presses a switch to clear the machine for the next voter. The EVM comes in a reusable carry pack, and can operate on a battery power source in remote areas. According to Election Commission officials, each EVM can record five votes minute or nearly 3,000 votes in a polling day [4, 10].

C.   Belgium

In Belgium Electronic voting was approved by law in 1994, and widely used in the 1999 and 2000 general and municipal elections. In the general elections of May 18, 2003, 3.2 million Belgian citizens were able to vote electronically. Belgium's apply similar approach as Ireland's in that it does not modify the voting process, but rather replaces the ballot paper with a machine at the polling station, and then uses an electronic counting system to tally the results. In 2003, an audit report released by the Federal Public Service of the Interior approved the systems after a simulation based on around 1 million votes [3].

Some difficulties were recorded during the 2003 voting (May 18) in the Belgian communes where electronic polling booths were in use for the general elections, which renewed both federal assemblies of the country. Delays occurred in voting operations in some localities, causing some polling stations to have to remain open well after the official closure time of 3 p.m. Voters therefore had to wait for a long time to cast their vote in some

areas. Most did wait, due to Belgium's compulsory voting system and fines for failing to do so, but it was reported that an estimated 10% of voters abstained from the ballot in certain areas [12].

D. Australia

In Australia EVM started in a close election in 1998. The Australian Capital Territory (ACT) is one of eight states and territories in Australia. Members of the ACT Legislative Assembly are elected using a proportional representation electoral system known as the Hare-Clark system. Hare-Clark is a variant of the single transferable vote method used in Ireland. Electors vote by showing preferences for individual candidates. To be elected, a candidate needs to receive a quota of votes. Each elector has a single vote, which can be transferred from candidate to candidate according to the preferences shown until all the vacancies are filled. In the ACT, the Hare-Clark system is used to elect 17 members from 3 multi-member electorates. The electorates of Brindabella and Ginninderra each elect 5 members, and the electorate of Molonglo elects 7 members.

A close election in 1998 in the ACT found numerous problems in the state's hand-counting system, when two candidates were separated by only three or four votes. After recounting, officials discovered that out of 80,000 ballots, they had made about 100 mistakes. Ultimately, the ACT Electoral Commission adopted a new system known as eVACS, or Electronic Voting and Counting System. The system was created (by a company called Softwar Improvements) to run on Linux, which is a widely used, freely available open-source operating system[1].

The eVACS-based voting terminal consists of a PC and offers ballots in 12 languages, including Serbian and Farsi. The system includes English audio for vision-impaired and illiterate voters. The voter swipes a bar code over a reader that resets the machine for a new vote and calls up a ballot.

The eVACS- baesd voting system find problems, such as difficult-touse barcode readers and minor delays in displaying results on and after election night, it was well received by voters.

E. Italy

In Italian electronic scrutiny system involved in the large scale election in 2004. According to the Italian Government, the main advantages of an electronic scrutiny system would be easier and faster operations, more accurate vote counting, faster and secure transmission of results and an increase in overall election efficiency.

The Italian government has not yet released detailed technical specifications of the planned electronic vote counting system [2].

A national ad-hoc Commission will assess the pilot, with particular reference to the efficiency of the system, and address any problems it may encounter. The Commission will then make any necessary recommendations in order to prepare the system for wider testing in future elections.[5]

F. Argentina

Argentina started an electronic voting system in 2003. This system is based on machines already used in Brazil. The electronic voting machines (EVMs) resemble ATMs. At the time of voting each citizen shows identity documentation at the voting place, and the registrar enters the voter's identity number at a keyboard with a display. If it appears OK on the display, the person is approved to vote and goes behind a partition where the EVM is located [7].

The screen of the EVM shows the first office that the voter will vote for all the political parties that presented candidates, each paired with a number. The voter chooses his or her favourite by punching a key with the number of the chosen party. The next screen shows the name and photo of the chosen candidate. To confirm the selection, the voter punches a green key. If the voter wants to change the selection, he or she punches a red key. Once the selection has been made, the voter pushes a white key and then the green key to confirm. The system also permits voters to cast "blank" votes, which in Argentina are counted in order to calculate the percentage of votes obtained by each party. After completing a vote for a particular office, another screen appears with the following office to choose and continues until the ballot is completed. At this point the EVM disables, preventing a second vote [8].

G. United Kingdom

United Kingdom started EVM in May 2002, tested various technological improvements to voting or vote counting, such as touch-screen voting machines while others tested techniques for voting remotely. Some jurisdictions allowed voters to cast their ballots using electronic methods, such as interactive voice response (IVR) technology, PC-based systems and handheld mobile devices via short message service (SMS). Some of these jurisdictions allowed voters to cast ballots from PCs or kiosks in public places such as shopping centres. In the Electoral Commission's report to reviewing the e-voting trials, it found that the hardware and software

performed successfully and without any significant problems. It also identified no evidence of fraud during the pilots, although it did express concerns about potential security and privacy violations [5, 6, 7, 9].

H. Costa Rica

The EVM system was tried out in elections for mayors, district councillors, municipal district councils and aldermen on December 1, 2002. Electors who choose to vote electronically are given a blank receipt signed on the back by the members of the panel presiding over the polling station. The electors' choice at each election is indicated on this receipt either by the electors themselves or with the aid of an assistant using a printer provided for that purpose. The chairperson of the Receiving Board activates the system so that each elector can vote. Electors are then presented with a monitor screen showing a ballot paper with the list of parties. Electors vote for the number of the party of their choice, they are then shown the ballot paper for district councillors, and must follow the same procedure. When each elector has finished voting, he or she must take the receipt and fold it so that the signatures of the members of the panel are visible, then drop it into the relevant ballot box. Once the paper is in the box, the elector's ID card is returned and he/she must leave the polling station [13].

I. Panama

In Panama, the first experiment with electronic voting in 15th November 1992. The system consisted of a mechanical element in which electors used bulb type switches to vote, and then pull a lever to record their vote via perforations in a paper. The experiment involved six voting machines in the metropolitan area of Panama City and San Miguelito, in the districts of Bella Vista, Parque Lefevre, Juan Díaz, San Francisco, Bethania and Belisario Porras. In 1999 elections, an electronic voting system was tested at several points in the Republic of Panama, though in the end it was not used due to a lack of consensus between political parties as to its use [13].

J. Spain

Spain has experimented with various forms of electronic voting. In the March 14, 2004 general elections, numerous small-scale, non-legally binding electronic voting trials were successfully conducted. These included diverse technologies in addition to strictly Irish-style electronic voting systems, such as Internet and SMS remote voting.

On November 16, 2003, three e-voting pilot tests were successfully conducted during the elections to the Parliament of Catalonia. This included remote voting via the Internet for eligible voters living abroad, and touch-screen voting coupled with an electronic counting system (developed by Demotek) [13].

IV. COMPARING FEATURES

This section provides the compares of the features of different systems with reference to a number of the dimensions most important over the introduction of electronic voting systems. These three dimensions, find out for the national systems surveyed in this paper.

   i.   Whether a country's system uses a paper audit trail.

   ii. Whether the system permits an anonymous, blank or spoiled ballot.

   iii. Whether the software is open source or proprietary.

A. Paper audit trails:

Out of the ten countries surveyed, only Brazil used paper audit trails on any significant scope. The Brazilian government introduced them on a limited basis for the October 2002 elections, where paper audit trails were used on 12% of all machines. The system allowed voters to see the printout of their vote, before both paper and electronic votes were recorded and saved. The paper audit trails are to be phased out by October 2004 in Brazil.

B. Basis by which system was introduced

In all ten countries surveyed, electronic voting was first introduced in either limited constituencies or for sub-national elections. Ireland, which introduced electronic voting first in the three constituencies in the 2002 elections, would also fall under this category. Furthermore, the trials in progress in a number of countries where national-level elections have not yet used fully electronic voting. In several cases (e.g. Brazil, Australia) the authorities audited the results from a subset of the machines to verify whether the results were accurate or not.

C. Treatment of blank or invalid votes

Two of the systems permitted blank votes to be cast (Brazil and Australia), and both of these preserved the anonymity of the voter casting such votes. In the Brazilian system, a blank vote is included in the count of total

valid votes, while in Australia it is not. India's system does not permit invalid votes to be cast, owing largely to substantive reasons and the fact that the level of invalid votes has traditionally been very high, and one of the key advantages for electronic voting was seen as the ability to reduce the high level of invalid voting. Belgium's system no longer permits the casting of blank or invalid votes.

D. Open-source versus proprietary software

Two of the countries surveyed (Australia and Belgium) post the source code of the electronic voting software used on the Internet for inspection. Australia initially posted its software source code, and Belgium chose this measure in 1999, in order to increase public confidence in the system. Brazil permits a partial inspection of its code for a short time before the election, and it is only available for inspection by political parties and by the electoral commission.

India has not announced any plans to make its software source code publicly available.

V. COMPARATIVE ANALYSIS WITH ELECTRONIC VOTING SYSTEMS

TABLE I. COMPARISON AMONG THE COUNTRIES OF ELECTRONIC VOTING SYSTEM

Country	E-Voting	Company	Election Type	Electoral System	Introduced Year	Year Used	Software Used	Hardware Used	Problems
India	668 million	BHEL	State	FPP	2001	2009 /2004 /2003 /2001	EPROM	EVM	None
Belgium	3.2 million	Steria	General & Municipal	Open PR-List	1994	1999	Digivote, Jites, Stesud	DEVS	2003: 500 power and computer failure
Brazil	66 million	UniSys & Diebold	All Govt. Level		1996	1996 /1998 /2000 /2002	GEMS	GX-1 integrated processor	None
Australia	218000	Software Improve	ACT federal	PR-STV	2001	2001	eVACS	PCs	None
UK	1.5 million	SVS	Local Govt	FPP	2000	2000 /2003	AVC	DRE	Mobile e voting
Spain	3000	Indra	Municipal	PR-List	2002	2003	SIRE	SIRE System	None
Canada	98000	CanVote	Municipal	FPP	2002	2003	CanVote on Linux	CanVote Internet	None

VI. CONCLUSION

This paper has presented the comparative study of voting techniques in various countries which highlights the scope of improvement in them.

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