Appendix 2J

Experience of Electronic Voting Overseas

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1   Executive summary

Ireland is planning to use a fully electronic implementation of vote tabulation and counting for the local and national elections scheduled for June 2004. This report provides an overview of the experiences of other countries in using electronic voting and draws from these experiences any relevant lessons for Ireland. The comparative focus is on the adoption of electronic voting systems adopted at the national level. The survey excludes Germany and the Netherlands, since these countries are being reported on in-depth for the TCD research team by P&D Analytics (see TCD report 1.d.). For reasons described more fully in section 4.10, the report also does not cover the variety of decentralised (non-national level) electronic voting systems used in parts of the United States.

The use of electronic voting worldwide remains a relatively uncommon practice, although this is rapidly changing as countries experiment with various electronic methods or expand their existing use of electronic voting. Furthermore, electronic voting is not limited to Europe or North America, as countries such as Brazil and India have embraced electronic voting far more completely than Europe, the United States, or Canada.

The electronic voting systems reviewed here differed widely in terms of technology and implementation. Some involved paper audit trails, while others did not. Others have introduced electronic voting concurrently with a paper-based system, while others have chosen to phase in electronic voting without this option. Finally, different systems treat differently the ability of voters to spoil their vote or to cast blank ballots. This report reviews the different ways that countries using electronic voting have dealt with these choices and evaluates their experiences.

No system is free from problems or controversy, but what is fairly remarkable is that where electronic voting has been applied on a national scale, there has been neither widespread public backlash nor evidence of significant errors or system failures. Indeed, many electoral commissions charged with making the decision to use electronic voting cite errors and inaccuracies in the manual counting process as a compelling reason to adopt electronic voting and computerised vote counting methods. Furthermore, these arguments for the adoption of electronic voting are strongest in the two electoral contexts reviewed here that have the most complex voting rules namely Belgium, with its open list proportional representation system, and the Australian Central Territory (ACT) which uses a Single-Transferable Vote similar to Ireland's.

Another argument for the use of electronic voting is that it may increase turnout and therefore, the democratic quality of the election outcome. There remains no systematic evidence for this, except from remote electronic voting trials that are not covered in this report. On the contrary, a report following the UK trials with electronic voting in 2002 local elections found no support for the assumption that electronic voting methods would increase participation rates, particularly among younger voters.

2   Methodology

The method of researching other countries' experience was primarily through press reports, governmental web sites, academic studies, and documentary review of similar commission reports from other countries.

The coverage of countries examined here is designed to be comprehensive rather than focusing in detail on any particular system. In each case, the emphasis was on:

- Identifying the nature of the election for which electronic voting was used;

- Identifying the type of system, including the hardware and software used;

- Characterising the electoral rules governing the election; and

- Reporting on the overall experience with the use of the system.

Because of the widely differing contexts in which electronic voting systems are used, it is difficult in practice to objectively evaluate electronic voting system performance. Despite a vigorous debate over the potential problems and advantages of electronic voting systems, "many of the general claims in favour and against e-voting are not yet substantiated by thorough empirical research. They generally depend on local circumstances and particular beliefs, interests, and institutions" (Svensson and Leenes 2003, 14).

This report does not offer systematic empirical research, but rather surveys the main experiences of other countries using electronic voting systems, identifying the general quality of the experience. In looking at the quality of the experience in each case, the following criteria were examined in particular:

- Accessibility;

- Secrecy of the vote;

- Accuracy;

- Deliberation;

- Security;

- Authentication;

- Timeliness and availability of results; and

- Verifiability.

Whenever possible, public opinion regarding the system is also reported.

2.1 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 survey, 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. This is the system examined in this report.

(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. This sort of system is not surveyed in this report.

(iii)   Remote electronic voting

Numerous countries are currently experimenting with remote electronic voting systems, which allow voters to cast their votes through remote methods by using telephones, mobile telephone SMS text facilities, interactive digital television, Internet Web pages, or e-mail. A number of experiments have been conducted worldwide for example, trials conducted in the British 2002 local elections experimented with a variety of these methods; on-line and phone voting was tried in Canada in 2003; and also in 2003, web-based voting was used in a Swiss referendum. These methods raise many different issues not directly relevant to the Irish experience, and are therefore not covered in detail here.

3   International experience: full elections

3.1   Brazil

Brazil, the largest nation in South America, has been at the comparative forefront of electronic voting worldwide. Currently, all votes are cast by electronic voting machines in Brazil.

The Brazilian Supreme Electoral Court authorised the use of Electronic voting technology in the 1996 Brazilian municipal elections. This use was further extended in 1998 when over 60 million voters (57% of the electorate) used electronic voting. By 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. Powered by National's Geode™ technology, the voting machines feature an integrated screen and keyboard in a small (30x40x20 cm) form factor. 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.

Concerns regarding the accuracy of the self-auditing systems caused the legislature to mandate a retrofit of 3% (some 12,000 machines) 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 October

6, 2002 election. Following that demonstration of the reliability of the machines, use of the paper trail was abandoned for subsequent elections. Following a lengthy debate over the advantages and disadvantages of the paper trail option, the government concluded that eliminating the use of printers within the system would save Brazil about $100 million. In addition, moving to all printerless machines would make voting much faster.

The evolution of electronic elections in Brazil:

- March 1995: The Electoral High Court ordered work begun on an electronic ballot box after ascertaining no suitable example is available worldwide.
- November 1995: Government tenders issued for hardware and software manufacturers.
- October 1996: First electronic municipal elections held using electronic voting. 33% of population vote on 77,000 electronic boxes in 57 cities. (Manufacturer: Unisys).
- October 1998: 58% of population voter for president and other candidates electronically in 537 cities using 167,000 ballot boxes. (Manufacturer: Procomp)
- October 2000: 110 million voters, including indigenous reserve residents, used 354,000 ballot boxes for municipal elections nationally. (Manufacturer: Diebold Procomp)
- October 6, 2002: 406,000 electronic voting machines were used exclusively for the first time to register 115 million voters' preferences on 18,882 candidates for 1655 posts in all government levels. (Manufacturer: Unisys)
- October 27, 2002: Second round of voting for president. The same technology and logistics applied as from the first round.

3.2   India

India's first-ever election using electronic voting is scheduled to take place from April 20 through May 10, 2004. As 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).

Following legal approval in 1989 to allow the use of EVMs, they have been used in many state elections but never in an entire general election. In the 1999 parliamentary poll, the machines, prepared by Electronics Corp of India and Bharat Electronics, were used in 45 constituencies. EVMs were also used on an experimental basis in five state elections in November 2003.

Slightly bigger than a laptop, 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 a minute, or nearly 3,000 votes in a polling day.

Stages in India's EVM system:

1. Control unit: polling station staff press a button to release a ballot for each voter entering the booth. There is also a "close" button, which, once pressed, prevents any more votes being cast.
2. Balloting unit: this is the equivalent of a ballot paper.
3. The voter presses the button next to a candidate's name and the control unit records the vote.

At the count, it says how many votes were cast and for whom.

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 days to count the votes, with hired personnel spending day and night in secured areas manually counting each ballot. Vulnerable as the procedure was to human error, a recount was frequent. The electronic voting machines are intended both to reduce errors and to speed the counting process.

3.3   Belgium

Belgium has been experimenting with electronic voting since 1991, when it began trials to address a number of specific complexities and constraints of the Belgian electoral system (mandatory vote, 1 to 5 simultaneous elections, 3 different languages, and up to 87 candidates for each list and election). In the manual system, these complexities made counting a long and difficult process, often subject to error. Electronic voting was approved by law in 1994, and widely used in the 1999 and 2000 general and municipal elections. Belgian authorities have progressively extended the constituencies which use electronic voting, with the system expected to be in place everywhere by 2006. In the general elections of May 18, 2003, 3.2 million Belgian citizens (or about 44% of the electorate) were able to vote electronically.

Belgium's approach has been similar to Ireland's in that it does not modify the voting process (by permitting remote electronic voting for instance), but rather replaces the ballot paper with a machine at the polling station, and then uses an electronic counting system to tally the results.

The security of the e-voting systems in use was criticised in the past by both citizen's groups and some political parties. To address these criticisms, the law now imposes an independent audit of the systems prior to election. 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. To increase public confidence in the system, the federal government also decided to publish the source code of the three e-voting software systems used (Digivote provided by Steria, Jites provided by Philips and Stesud, and Favor) and to run a simulation of the electronic voting operation on its e-government portal http://Belgium.be.

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.

According to early reports, causes for the delays were:

* The limited number of computer booths available in polling stations equipped for e-voting;
* The complexity of the e-voting systems and the lack of information and knowledge of most voters on the way to use them. To ensure maximum reliability and security, the e-voting process comprises several additional steps compared with the manual process; and
* A series of computer or power failures, with more than 500 maintenance and repair interventions in comparison to 463 such interventions during the local elections in 2000.

However, e-voting systems do not appear to be the only cause of organisation problems encountered: delays were also experienced in polling stations using traditional voting methods, due to problems such as a shortage of bulletins, lack of voting inspectors, or insufficient number of polling stations. Furthermore, use of electronic voting has steadily spread in Belgium, with 100% adoption scheduled by 2006. The reason for the gradual replacement of manual with electronic voting is primarily motivated by the associated financial costs.

4   International experiences: trials

4.1   Australia

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 revealed 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. Similar to numerous election authorities in the United States, the ACT Electoral Commission decided to investigate electronic voting methods as a remedy for errors and inaccuracies.

Ultimately, the ACT Electoral Commission adopted a system known as eVACS, or Electronic Voting and Counting System. The system was created (by a company called Software Improvements) to run on Linux, which is a widely used, freely available open-source operating system. The Commission posted drafts as well as the finished software code of eVACS on the Internet for the public to review. No serious functional or security flaws were exposed, although some bugs were discovered following public and academic reviews of the code. The public reaction to this open source approach was also quite positive.

The 2001 election was used to provide a trial for the new system. A total of 80 machines were tested in the election, distributed among eight polling places throughout the capital Canberra. A total of 16,559 electronic votes were recorded at 4 pre-poll voting centres and at 8 polling places on polling day. A comparative manual count after the election showed that the system operated accurately.

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. Once a selection is made and reviewed, the voter swipes the bar code again to cast the vote. The bar code does not identify the voter; it simply authorises the voter to cast one ballot.

The terminals link to a server in each polling place through a secure local-area network - no votes

are transmitted over the Internet or via phone lines. The server writes two copies of the votes onto separate discs that are digitally signed and delivered independently to a central counting place. The digital signature is a 128-bit unique identifier generated from the voting data. If the data were changed in transit, the identifier would change too, raising red flags that something went wrong.

The machine does not provide a paper audit trail or a voter-verifiable printed receipt. Similar to the Irish decision, the Electoral Commission rejected the printout feature in order to keep expenses down and to reduce possible mechanical faults that might have resulted from a printout system.

In its summary of the electronic voting system from the 2001 trial, the ACT Electoral Commission reported that the use of electronic voting and electronic vote counting was a success as well as "a valuable improvement on democratic processes in the ACT." The ACT Electoral Commission's report states that the electronic voting system:

- Eliminated the need for manual counting of electronic votes, thereby reducing the possibility of counting error and speeding the transmission of results;
- Was reliable and secure;
- Effectively eliminated unintentional voter errors;
- Reduced the number of informal votes;
- Allowed blind and sight-impaired people to vote entirely without assistance and in secret through use of headphones and recorded voice instructions; and
- Provided on-screen voting instructions in 12 different languages.

The electronic counting system also had significant benefits. Preferences shown on paper ballots were data-entered by two independent operators, electronically checked for errors, and manually corrected if needed. This data was then combined with the results of the electronic voting, and a computer program was used to distribute preferences under the ACT's Hare-Clark electoral system.

The electronic counting system:

- Effectively eliminated errors such as incorrectly sorting or counting ballot papers;
- Increased the accuracy of the election count;
- Reduced the time needed to accurately count the votes and announce the election result; and
- Increased the amount of information available about errors made on paper ballots by electors.

While the electronic voting and counting system experienced some problems, such as difficult-to-use barcode readers and minor delays in displaying results on and after election night, it was well received by voters. The Commission considered that these minor problems were relatively easy to resolve, and strongly urged that an improved system be made available for the 2004 Legislative Assembly election.

4.2   Italy[1]

The Italian Department for Innovation and Technologies and the Ministry of the Interior announced on February 20, 2004 that a large-scale electronic vote count experiment will be carried out during

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[1] The summaries for sections 4.2, 4.3, and 4.5-4.7 are paraphrased from the Spanish Interior Ministry's website at http://www.euskadi.net/botoelek/otros_paises/sim1_i.htm.

the 2004 elections for the European Parliament.

The initiative, dubbed "Electronic Scrutiny", will take place alongside the traditional manual vote count during the June 12-13 European elections in Italy but will not have any legal value. Approximately 2,500 electoral sections will participate in the electronic scrutiny pilot, which could pave the way for legally binding electronic vote counts in the future. 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.

Interior Minister Giuseppe Pisanu has stressed that this experiment will allow the country to kick-off electoral modernisation without disturbing the voting habits of the citizens in the more delicate moment of voting itself. Instead, he added, the government has decided to start with modernising the vote count process and the transmission of election results. The Italian government has not yet released detailed technical specifications of the planned electronic vote counting system.

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.

4.3   Argentina

In 2003, Argentina piloted an electronic voting system in Buenos Aires Province, the most populated province in Argentina. Citizens were able to try the electronic systems piloted in 11 towns in a mock ballot with a slate composed of Argentinean historical figures.

The Argentine system is based on machines already used in Brazil. The electronic voting machines (EVMs) resemble ATMs. 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.

The screen of the EVM shows the first office that the voter will vote for (e.g. Governor, in 2003) and 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.

4.4   United Kingdom

In May 2002, thirty local governments in England tested various technological improvements to voting or vote counting. Some jurisdictions used new technologies for the polling place, such as touch-screen voting machines while others tested techniques for voting remotely. Nine 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

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(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[2] 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.

4.5   France

Pilot schemes were staged involving 4000 voters in Strasbourg during the 1994 European election and in Issy-Les-Moulineaux during the presidential election in 1995. In 2000, the city of Lyon staged a trial electronic ballot. France has also experimented with the SVI integrated voting system provided by Nedap (the same system as used in Ireland, Germany, and the Netherlands). However, widespread use of electronic voting is not currently envisaged in France.

4.6   Costa Rica

The Electoral High Court (TSE) of Costa Rica provides a description of an electronic voting system currently under study. The 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, numbered from 1 onwards corresponding to the mayoral election. 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.

4.7   Panama

In Panama, the first experiment with electronic voting took place in a referendum held on 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. For the 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.

4.8   Japan

A pilot scheme was carried out in the municipality of Kawaguchi in 1999. There were 362,743

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[2] "The Implementation of Electronic Voting in the UK", available from http://www.dtlr.gov.uk.

people on the electoral roll, distributed into 78 polling stations, of which eleven (with a total of 54,953 potential voters) took part in the electronic voting trial. Voting occurred using a touch-screen system, with voter identity verified using a magnetic strip card system. Reports suggest the system worked satisfactorily and that the verdict of the electorate was positive.

Another pilot was used in June 2002, in the western Japanese city of Niimi. More than 15,000 people from 43 polling stations voted using a touch-screen system. Officials reported that the electronic voting went smoothly except for an initial machine trouble that delayed the issuing of voting cards for some 15 people.

4.9   Spain

While it has not yet employed electronic voting on a national scale, 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 in five municipalities coupled with an electronic counting system (developed by Demotek). Despite relatively low participation levels (less than 20% of targeted voters), Government sources said that public reaction to the pilot tests was "excellent" and that the tests were "successful". None of the tests had legal value however, so citizens participating in the tests also had to vote via traditional methods. Legal use of such e-voting systems in Catalonia would require the Parliament to pass a new election law.

4.10   Experiences with electronic voting in the United States

The US experience poses a number of problems for discussion in parallel with national experiences, since the US voting systems and election technology is:

a) Highly decentralised, generally decided at the county level;
b) May involve numerous different technologies even for elections to the same office; and
c) Has taken place in a politically charged environment among a background of controversy from previous failures attributed to non-electronic voting machines.

While it is possible to summarise the information from many localities, counties, and states where electronic voting systems have been used, these systems are not included in this report, which is based on comparisons of national systems only.

5   Comparing features

This final section compares the features of different systems with reference to a number of the dimensions deemed most important as highlighted in the public debates over the introduction of electronic voting systems in Ireland. These four dimensions, depicted for the three national systems surveyed in Section 3 of this report, are:

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1) Whether a country's system uses a paper audit trail;
2) Whether the system was introduced first in a pilot fashion;
3) Whether the system permits an anonymous, blank or spoiled ballot; and
4) Whether the software is open source or proprietary.

The findings of this section are also summarised in Appendix B.

5.1   Paper audit trails

Of the three countries surveyed in Section 3, only Brazil used paper audit trails on any significant scope. Following a lengthy and vigorous debate as to whether the paper audit trail was needed, 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. As a control, the Commission also checked 3% of all ballot boxes against paper printouts. However, due largely to the costs associated with their use and also because of physical problems with the paper systems in Brazil's tropical climate, the paper audit trails are to be phased out by October 2004.

5.2   Basis by which system was introduced

In all three countries surveyed in Section 3, 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 Dáil elections, would also fall under this category. Furthermore, the numerous examples from Section 4 document 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.

5.3   Treatment of blank or invalid votes

Two of the systems surveyed in Sections 3 and 4 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 (for "none of the above") 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.

5.4   Open-source versus proprietary software

Two of the countries surveyed in Sections 3 and 4 (namely, 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.

Appendix One   Table of comparative experience with electronic voting systems

Country	E-voting electorate	Company	Type of elections	Electoral system	Year introduced	Year used	Software used	Hardware	Problems
India	668 million	Bharat Electronics Limited & Electronics Corporation of India	State elections	FPP	2001	2004*/2003/2001 by-election	Software using EPROM (erasable programe read-only memory)	EVM (Electronic Voting Machine)	None
Belgium	3.2 million	Steria	general & municipal	Open PR-List	1994	1999	Digivote provided by Steria, Jites provided by Philips and Stesud by Favor	Digivote electronic voting system	2003: 500 power & computer failures
Brazil	66 million	UniSys & Diebold	All government levels		1996	1996/1998/2000/2002	Diebold Accuvote using GEMS(global election management system), using Windows CE	National's Geode GX-1 integrated processor (Urna Eletronica 2002)	None
	66 million		Local, state, national			1998		BULL	None
Australia	218,000	Software Improvement	ACT federal	PR-STV (Hare-Clark)	2001	2001	eVACS operating on Debian/GNU Linux system	standard PCs connected to an isolated LAN	None
UK	1.5 million	Sequoia Voting Systems	Local govt (pilots)	FPP	2000	2000/2003	AVC Edge® and the AVC Advantage®	Various forms. DRE (Direct Recording Electronic) used AVC Edge	Only with mobile e-voting, e.g. SMS text and internet. None related to stand-alone e-voting
Switzerland	1,150	Hewlett Packard & Wisekey	Pilot (Geneva suburb)	Jan & Nov 2003	Jan & Nov 2003		PKI operates on Linux	PKI System (internet)	None
Spain	130,000	Election Systems & Software	Mallorca local assembly	PR-List	2002	2003	ES&S Profile	iVotronic Touchscreen Voting Machine	None
Spain	3,000	Indra & Demotek	pilot municipal	PR-List	2002	2003	SIRE	SIRE system	None
Canada	98,000	CanVote	Ontario municipal	FPP	2002	2003	Canvote operates on Linux	CanVote internet & telephone	None
Romania	1600 military	Romanian Government	referendum	PR-List	2003	2003	N/a	N/a	None
Japan	15,000	Association of Electronic Voting System	municipal(Niimi)	Mixed Member System	2001	2002	N/a	VT25	None
Paraguay	34,000	UniSys & Diebold	Presidential	PR-List	2002	2003	Diebold Accuvote using GEMS	Diebold Accuvote T-S machines	None
Argentina	500,000	UniSys & Diebold	Gubernatorial pilot	PR-List	2003	2003	Diebold Accuvote using GEMS	Diebold Accuvote T-S machines	None
Venezuela	11 million	Election Systems & Software	All government levels	PR-List	2000	2000	ES&S Profile	iVotronic Touchscreen Voting Machine	Supreme Court had to postpone elections following problems with e-voting, e.g. difficulties

Appendix Two   Summary of main decisions made in other countries regarding electronic voting properties

Country	Paper Audit Trail	Pilot Fashion	Blank/Invalid Vote	Software-Open/closed source
Brazil	Initally planned, but later rejected. Used on trail basis Oct. 2002 on 12% of all machines. Voters could see printout of their vote. Commission also checked 3% of all ballot boxes against paper print-outs. All VVPAT due to be phased out Oct 2004.	Limited basis:Tested in large cities for municipal elections Oct. 1996. 33% of population tested	Yes; vote for 'none of the above' option which is included in total valid votes. Kept secret.	Only part of software code open to inspection by political parties and electoral commission, and only over short time period
Australia	None-to keep expenses down	Limited fashion:Trial run in state election 2001. 8 machines tested on 16,559 votes.Voters had choice of written or e-vote.Also parallel fashion:officials entered written votes into computer and compared sample (4560 votes) of results	Yes; can register blank votes as 'informal'. These votes are not included as part of total valid (i.e.'formal') votes. Kept secret	Open: available online
India	None, and no plans to have one	Limited basis: EVMs manufactured in 1989-90 were used on experimental basis for the first time in 16 Assembly Constituencies in the States of Madhya Pradesh (5), Rajasthan (5) and NCT of Delhi (6) at the General Elections to the respective Legislative Assemblies held in November, 1998	No scope for invalid votes; because in a number of constituencies in every General Election, the number of invalid votes is more than the winning margin between the winning candidate and the second candidate.	Closed
Belgium	None. Was tested in small precinct election but later dropped.	1991-1994 pilots. First test 1991 in Canton Verlaine.Pilots run on limited basis, but voters had a choice betweeen paper or e-vote.Gradually extended to all cantons in limited fashion, and by 2000 it was possible to vote electronically in all cantons	Not possible anymore to cast invalid vote.	Open. Initially not released but done so 1999 to increase public confidence in system

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