

eVACS® and ACT Legislative Assembly Elections

Introduction

eVACS®, developed by Software Improvements, is the electronic voting and counting system used for the Australian Capital Territory (ACT) Legislative Assembly Elections of 2001 and 2004, and for a Casual Vacancy in 2003.

Initially incorporating a voting system, a data entry system for paper ballots, and a counting system with scrutiny sheet outputs, eVACS® is modular and therefore easily extendable to fit with other election system requirements. Specifically as a result of the ACT Electoral Commission Review of the 2001 election (<http://www.elections.act.gov.au/Elecvote.html>) a set-up election module was incorporated into the eVACS®- 2004 version, further increasing the security of the system as well as enabling automatic detection and configuration of hardware.

The following descriptions of eVACS® - 2001 and then eVACS® - 2004, detail the initial development and subsequent enhancements.

eVACS® - 2001

Modular

To provide for both electronic and traditional paper ballot voting, eVACS® in 2001 included:

- a voting system,
- a data entry system for ballot papers, and
- a counting system.

Assistance for voters

Special features of eVACS® are the provision of audio for visually impaired voters and poor readers, the availability of voting instructions in different languages, and the use of a keypad also assists a range of people with disabilities. For the 2001 Election, 12 languages were provided.

eVACS® operates on standard hardware.

For the voting system:

- at each Polling Centre standard PCs each with a keypad and barcode reader connected to an isolated LAN with one operating as a server

- one PC also with a larger screen plus disposable headphones as an aid to visually impaired voters
- a server with two hard disk drives and a removable media drive

A demonstration of the voting system was provided on a standalone machine at each Polling Centre, since this was the first time electronic voting had been provided.

For the data entry system:

- standard PCs connected to an isolated LAN with one operating as a server.

For the counting system:

- standard PC as server with a removable media drive

Counting

For the ACT Election, the eVACS® counting program handles multiple seat electorates in accordance with the Hare-Clark electoral system, a preferential method of proportional representation in which each voter has a single transferable vote.

The Hare-Clark system is the most complex election system.

Requirements of election systems

Key features of the parliamentary election systems in Australia that needed to be retained in eVACS® are:

- Authenticity of voter - process of being marked off the electoral roll to receive appropriate ballot papers
- Privacy - separate polling booths
- Avoidance of coercion - anonymity in the polling booth
- Empty ballot box – officials and scrutineers check that ballot box is empty at the start of polling
- Security of ballot papers - placement in the ballot box and then after counting of first preferences secure, transfer to the central scrutiny centre
- One vote per person – with at least the same level of control as the paper ballot system

In 2001 the electronic voting booths were two standard cardboard voting booths slotted together. The computer screen was set horizontally in the booth to maintain privacy when voting.

Voting booth arrangement in 2001



Copyright: Software improvements

The Development

There were 27 weeks from the signing of the contract with Software Improvements to Election Day on 20 October 2001.

A structured approach was followed for the development of the eVACS® software. IEEE Software Engineering Standards were used as the framework for the documentation produced. However, the standards were adapted as necessary to reflect the complexity and detail required for understanding how all the developmental artifacts went together.

A prototype system based on initial requirements from the tender documents demonstrated:

- the feasibility of using bar codes to ensure one vote per person
- the ability to legibly display all the candidates for a particular electorate on screen without scrolling (the display had to cater for up to 12 groups of seven candidates),
- the display of instructions in a number of languages
- the ability to store electronic votes, and
- have votes counted according to the Hare-Clark rules.

The final set of requirements was not met by the prototype and, although based on the same system design, the eVACS® software is somewhat different to the prototype.

Software requirements were specified using a real time functional decompositional approach in the Software Requirements Specification. All code was written from module specifications described in the Detailed Design. Unit testing of each module was based on its specification. Integrated testing of related modules then followed and continued until the whole system could be tested. The ACT Electoral Commission undertook acceptance testing, based on the Software Requirements Specification.

eVACS® is written in C and sits on a cut-down Debian GNU Linux operating System.

Integrity of eVACS®

eVACS® was extensively tested and audited against the detailed design specification and acceptance test cases and procedures developed in accordance with IEEE Standards.

Testing methods employed:

- Structured test cases in controlled situations, used to ensure individual modules perform as expected;
- Scrutinies in parallel, using eVACS® and manual counting of known sets of ballot papers, using a variety of test election outcomes to test specific cases;
- “Real user” testing, whereby large numbers of users cast electronic votes in a mock polling place and data entry operators entered the results from paper ballots, used to test useability and to simulate realistic loads on the system;
- Load testing, where large quantities of ballot data was simulated and loaded into the counting system; and
- Whole-of-life testing; in which the entire process was simulated, taking test electronic votes from a polling place, loading it into the counting server, adding data-entered results from paper ballots, and using the counting system to generate a Hare-Clark result.

Auditing undertaken:

- Software code was independently audited and certified:
 - to neither gain nor lose votes;
 - to faithfully implement the algorithm for vote counting; and
 - is written in a consistent, structured and maintainable style.
- The independent auditor also checked the version of the code containing actual candidate information after the close of nominations that was used in the ACT election.

The independent audit of the code ensured that no extraneous code had been inserted that could sabotage the votes by amendment, inclusion of additional votes or exclusion of existing votes.

Commission Review

In the Review of the 2001 election the Commission(<http://www.elections.act.gov.au/Elecvote.html>) recommended the following enhancements to eVACS®:

- i) extending the range of statistics that can be published electronically during the count;
- ii) improving the set-up process to automate the loading of election details, particularly candidate names and sound files; and
- iii) enhance the usability of the error-control reports used in the data-entry process.

eVACS® - 2004

There were a number of changes incorporated into eVACS® for the 2004 election:

- i) inclusion of a set-up election module,
- ii) cursor on the electronic ballot paper opened at the top if a party column randomly (rather than always starting in the top left-hand corner)
- iii) first preference results were available in polling places after the polls closed;
- iv) a variety of reports was available from the system;
- v) the size of printed barcodes was changed enabling better detection and reading by the barcode readers;
- vi) use of CD-Rs (write once, read many CDs) instead of zip disks;
- vii) the automatic detection and configuration of the hardware being used; and
- viii) the use of a cut-down Red Hat Linux operating system.

Automated Set-up

The set-up election module allows for specific election data (date, candidates, parties etc) exported from the Commission's existing information technology systems to be loaded directly into eVACS®. The enhancement to automate the set-up of eVACS® has the following benefits as identified by the Commission

(<http://www.elections.act.gov.au/Elecvote.html>)

- i) the setting of the ballot papers and sound files for the system was simplified;

- reduced the risk of errors occurring in the setting and proofing of ballot information;
- reduced the time taken and cost of set-up;
- allowed for the early printing of barcodes for the system; and
- enhanced the security of eVACS® by ensuring that Commission staff were able to load candidate and other details into the system without outside assistance and that the eVACS® program certified for the election was locked and could only be opened for changes using a password held only by the Commission.

Barcode Changes

Changing the size and font of the barcode printed by eVACS® for greater compatibility with the barcode readers used by the Commission, resulted in quicker voting as the system responded faster when the barcode reader was able to read the barcode on the first swipe, compared to having to swipe the barcode several times in 2001.

Reports

Enhancements to the reporting features ensured the scrutiny sheets were able to be exported electronically for publication on the internet and for use in other IT systems used by the Commission.

Reports produced during the data entry process were reformatted for ease of use by supervisors.

Hardware

Automatic detection and configuration of the hardware meant different PCs were used.

In addition, one polling centre was fitted with a portable voting "tablet" as an alternative form of hardware. The voting tablet contained standard PC electronics, contained in a shockproof, waterproof, dustproof, tamperproof, solid-state casing with no internal moving parts. The tablets used removable flash memory cards rather than CD drives. The casing incorporated a computer screen on its top face, enabling the tablet to sit on top of the normal shelf in the Commission's standard cardboard voting screens. The tablets used the standard barcode readers and keypads.

Voting booth internal arrangement with new voting tablet



Copyright: ACT Electoral Commission

In 2004 special cardboard inserts allowed each voting computer or tablet to be easily installed in a single standard cardboard voting screen.

Voting booth internal arrangement in 2004 with standard computer



Copyright: ACT Electoral Commission

Voting booth arrangement in 2004 with standard computer



Copyright: ACT Electoral Commission

Continuing Integrity of eVACS®

The enhanced 2004 version of eVACS® was extensively tested (using the same testing methods as for the 2001) and audited before use at the election.

As well as auditing the code to establish no extraneous code had been inserted that could sabotage the votes by amendment, inclusion of additional votes or exclusion of existing votes, the independent auditor also indicated that the Hare-Clerk algorithm used to distribute preferences was correctly implemented in the code.

Commission Review

In the Review of the 2004 election the Commission

(<http://www.elections.act.gov.au/Elevote.html>) recommended enhancements to eVACS® to ensure that:

- i) the volume of the spoken word instructions can be varied to make them easier to hear in noisy environments;
- ii) the screen display of the ballot paper can be set with difference fonts for the party names and the candidates for ease of reading by voters;
- iii) the data-entry error-correction process needed to correct entries where papers are missed or duplicated by simplified; and
- iv) the data entry module is modified to require a second operator to validate changes made by supervisors, where a change is made to both original data entry records of a ballot.

The Commission has also recommended:

- electronic counting using eVACS® continue to be standard practice at ACT elections, and
- electronic voting using eVACS® be offered again at the 2008 election.