Appendix 2M

Feasibility of Audit

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1 Summary of conclusions

The conclusions are:

1. The NEDAP/Powervote system does not provide a full audit trail;

2. The system is not feasibly capable of modification to provide a full audit trail without unrealistic cost;

3. Consequently, there is no *post facto* method of validating that the votes stored in the data cartridge are the same as those entered at the keyboard by the voters;

4. It is possible to independently verify that the votes recorded on cartridges are those uploaded to the count centre PC; and

5. There are electronic voting systems available which offer a full audit trail.

2 Capabilities of proposed NEDAP system

The NEDAP/Powervote system does not provide any meaningful audit trail. There is a small printer in the machine, which produces summary and machine status information. Details of the contents of these printouts are given in the Functional Specification provided by NEDAP. The only 'audit trail' data on the printout is:

- Information to identify the polling station;
- Information to identify the poll;
- The number of activations;
- The number of votes cast (including in the case of multiple elections the number of null votes); and
- Number of deactivations.

3 Audit trail principles

The concept of an audit trail comes from accounting, but the meaning of the term in electronic voting is different in one critical respect, which changes the meaning of the term 'audit trail' entirely.

The purpose of an audit trail in an accounting system is to enable an auditor or authorised party to trace a transaction from source to destination. With a proper audit trail, it must be possible not only to explain or reconstruct each figure in key statements such as balance sheets, profit and loss accounts or cash flow statements, but to follow individual transactions as they progress through the system. A key feature of the design of such systems is that anonymity is not normally a requirement. This is not the case in voting where the secrecy of the ballot must be maintained. For this reason, comparisons that have been made by some commentators equating voting machines with automatic teller machines (ATMs) are not meaningful as there are several ways that a user of an ATM can check that a transaction has been accurately recorded and processed (and it will soon be clear if it has not). This type of audit trail is not, therefore, suitable for a voting machine.

Where secrecy of individual transactions is required, the only method of providing an audit trail is at the aggregate level. Since an individual vote cannot be tracked (indeed, must not be traceable), the only option is to check the overall result. This can only be done by a mechanism that is:

- Visible to the voter;
- Durable;
- Impossible to alter without it being obvious that a change has been made;
- Independently countable; and
- Anonymous.

The only practical medium, which meets these criteria, is paper and the only mechanism by which an independent audit trail can be established is by voter verification of a paper printout of the ballot before it is cast and retention of that paper ballot until after the count is complete. There is strong academic support for this from leading experts in this field. It is a view also endorsed by the Irish Computer Society in its submission to the Commission as well as by a number of other computer experts who made submissions.

4 Voter verifiable audit trails

Conceptually, there are four basic ways of providing a paper audit trail. A voting machine could:

1. Scan a conventional ballot paper;
2. Scan a specifically designed machine readable (e.g. a 'lotto' type) ballot paper;
3. Show the voter the completed ballot behind a glass screen before it is cast; and
4. Produce a pre-printed ballot, which is machine read by a device similar to that in a national lottery machine.

The first of these can work well for a single, first past the post voting system, but is problematic for a STV system because of potential errors in scanning handwritten numbers.

The second class of machine overcomes some of the problems with the first, but is still liable to problems with the machine reader if the voter does not fill in the form correctly or, for example, seeks, by overwriting, to correct an error that they have made.

Both the third and fourth options are good solutions to the problem of audit trail. They enable the electronic capture of votes and provide a separate and parallel paper ballot, which can be counted manually or by a separate machine at a later time if necessary. Bar coding can also be used to reduce errors.

5 Concerns about paper systems

All of these options are more vulnerable to mechanical failure than a purely solid state/electronic system such as the NEDAP/Powervote system. Specifically, either the printer or scanner can fail. While these problems are not insurmountable, a system with moving parts is more prone to failure and more problems can be expected during a poll than with a solid state system such as the proposed system.

Some commentators have expressed concerns about the use of printing in electronic systems. These concerns can be summarised as:

- A matter of principle. Why introduce electronic systems if you are simply going to rely on paper?
- Problems for voters with disabilities.

The following comment comes from an open letter opposing paper systems signed by representatives Robert W. Ney and Steny Hoyer of the US House of Representatives and Senators Mitch McConnell and Christopher J. Dodd of the US Senate summarises the case:

> "*The proposals mandating a voter-verified paper record would essentially take the most advanced generations of election technologies and systems available and reduce them to little more than ballot printers. While such an approach may be one way to address DRE*[1] *security issues, it would, if adopted, likely give rise to numerous adverse unintended consequences. Most importantly, the proposals requiring a voter-verified paper record would force voters with disabilities to go back to using ballots that provide neither privacy nor independence, thereby subverting a hallmark of the HAVA legislation. There must be voter confidence in the accuracy of an electronic tally. However, the current proposals would do nothing to ensure greater trust in vote tabulations but would be guaranteed to impose steep costs on States and localities and introduce new complications into the voting process*."[2]

In practice, neither of these concerns are difficult to address. In particular, where paper is only used as a back up system and proper facilities for disabled voters are in place, these are not important issues.

However, there is an important difference between the United States, where most of the discussion of voter verified audit trails takes place, and Ireland and that is the complexity of the voting system. A voter verified audit trail works well in a first-past-the-post election system where there is one count and every vote is counted. A single transferable voting system using sampling for distribution of surpluses is quite different. Because of randomisation, a parallel paper count will almost never give the same result as a machine count due to a mixture of sampling error and the almost inevitable human errors that occur in any manual system. If, on recounting manually, the difference between the manual result and the machine result were within the sampling error, what would this prove? Furthermore, which would now be the definitive result?

Another potential complication is that paper verification assumes that paper votes will be counted in some, possibly several, constituencies. What or who determines whether such a count should be held? Proper infrastructure for such a count might have to be put in place in anticipation of a call or calls for a manual count. If manual re-counts were to become common, the benefits of the electronic voting system would be largely negated and the costs would increase enormously.

The case for voter verified audit trail is a powerful one. In particular, it eliminates many of the risks of electronic voting at a stroke. On the other hand such an approach is not without drawbacks and is likely to lead to significant difficulties during a complex ballot.

[1] Direct Recording Electronic
[2] Source: http://www.jfanow.org/cgi/getli.pl?1963

6 Verified voting machines

The following are machines that claim to offer a form of voter verified voting.

a) *Accupoll*

This system uses touch screen technology and a printed-paper "Proof of Vote". Ballots are not pre-printed. Voters verify that the printed ballot reflects their choice of candidates. This is then deposited in a separate ballot box. If required, paper ballots can be independently checked (Source: www.accupoll.com).

b) *Vote Trakker*

This system produces a paper print out *after* the vote has been cast. According to their own material:

> "*After the voter makes their selections on the touch screen, they press the "Cast Ballot" button. A printout of their choices appears under a protective viewing window. The voter then can review the paper. They will see their selections for each contest. Also on the top they will see a header that contains a randomly generated number that does not tie the vote to their identity. Once the voter leaves the voting machine, a presence sensor sends a signal to the printer to retract the paper record into the voting machine. There is no intervention required by a poll worker*."

It is not clear what happens if the vote print is not the same as what the voter thought that he/she had cast (Source: www.aitechnology.com/votetrakker2/).

c) *Populex*

While this system uses touch screen technology, a ballot card is printed with readable details and a bar code. This card is then the official ballot (not the electronic version). According to their web site:

> "*…. in contrast to most other touch screen voting systems that collect and store the votes electronically in computers, the Populex™ system prints a tangible paper ballot card. This ballot card is the official ballot. Each ballot contains a bar code that is scanned to reliably record and count the votes on election day. The same ballot card is the permanent paper record that must be available for manual audits…"* (Source: www.populex.com/dfb.htm)

d) *Truvote*

It is not exactly clear from the material available how this system works in practice. It does produce a voter verifiable printout, but does not say what is done with this. A noteworthy feature of this machine is that it enables voters to write in candidates using a touch screen keyboard (Source: www.truvote.com).

6.1 Some other technologies of interest

a) *Automark*

This system uses scanning technology to fill in a pre-printed ballot paper, which is then cast in a normal ballot box. It is designed to help voters with disabilities
(Source: www.vogueelection.com/products_automark.html).

b) *VH-VHTi*

This is a sophisticated system that uses cryptographic techniques to guarantee privacy in the ballot. It includes a facility not only to use a paper verified ballot but also, later to check on-line that the vote was recorded correctly. This seems unnecessarily complex for Irish elections (Source: www.votehere.net/vhti/documentation/VH_VHTi_Overview.pdf).

c) *Vreceipt Technology*

This is currently a concept rather than a product. It uses ideas from cryptography to produce a highly verifiable system where not only is there a paper ballot kept, but the voter also gets a receipt. While this system looks interesting, the degree of complexity involved seems out of proportion to the need.