Appendix 2D

Reliability and Accuracy of Data Inputs and Outputs

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1 Summary

The objective of this strand was to verify that the data coming out from the voting machine in the modules accurately captured the votes cast on the machine. While there has been extensive testing done on individual components of the Nedap/Powervote system by PTB [1,2,3,4], Zerflow [5,6], TNO [7,8,9,10,11], KEMA [12], Nathean [13,14] and ERS [15], there is no evidence of end-to-end testing of the system as a whole. An end-to-end test will confirm the accuracy of the individual components of the system as well as their interconnectivity with each other. This will confirm the integrity of each vote from the point at which it is cast at a voting machine to the point where it is counted at the count station. The ideal end-to-end test would be to perform a full-scale election simulation. Since this approach is impractical it was decided to simulate a miniature election.

The miniature election comprised three polls, a European election, a Local election and a Town Council election. These polls had 6, 7 and 12 candidates respectively. A list of 43 votes were prepared on a spreadsheet, these votes were then entered manually under the supervision of an observer to confirm that the correct votes were cast. Once all the votes were entered, the modules were loaded into the Integrated Election Software (IES) system. The votes were then copied onto three CD's for each of the count centres (European, Local and Town Council). The votes were then transferred to the individual count centres where the counts were performed. The votes used in counting were verified against the 43 cast votes and were found to be correct. The result of the election was also confirmed against a hand count.

As well as the end-to-end tests, we also ran tests on a voting machine and several ballot modules that verified that the buttons correspond to the correct candidate details and verified that the printouts produced by the voting machines are correct. These printouts are an audit of the number of votes cast on each machine. In further tests, we were unable to add votes to a module after close of poll. Finally, we checked that votes stored on a voting module could not be erased using an intense magnetic field. **These tests demonstrated that the voting machines and ballot modules behaved as expected.**

The miniature election simulation endorses the reliability and validity of data input and output from the electronic voting machines including the consolidation of data plus the reliability of the computer software. However it must be remembered that a full-scale field test has never been performed on the Irish Nedap/Powervote System where up to three different elections occur in parallel.

1.1 Recommendations

- **We feel that a miniature election should be part of the manual procedures involved in setting up the voting machines and counting PCs (if it is not already).** A miniature election creates confidence in the operation of all the components of the system and such a *distributed* testing process will guard against the introduction of fraudulent components into the electronic voting system (see section on Miniature End-to-End Election below).

- There is an inconsistency around the issue of null votes. Null votes can be cast in a multiple poll but not in a single poll. In a multiple poll, provided a voter casts a vote in at least one of the polls, they can cast null votes in the other polls. **This inconsistency could be cleared up by allowing the casting of a null vote in a single poll by pressing the Cast Vote button twice as is possible in a multiple poll** (see section on Miscellaneous System & Usability Issues below).

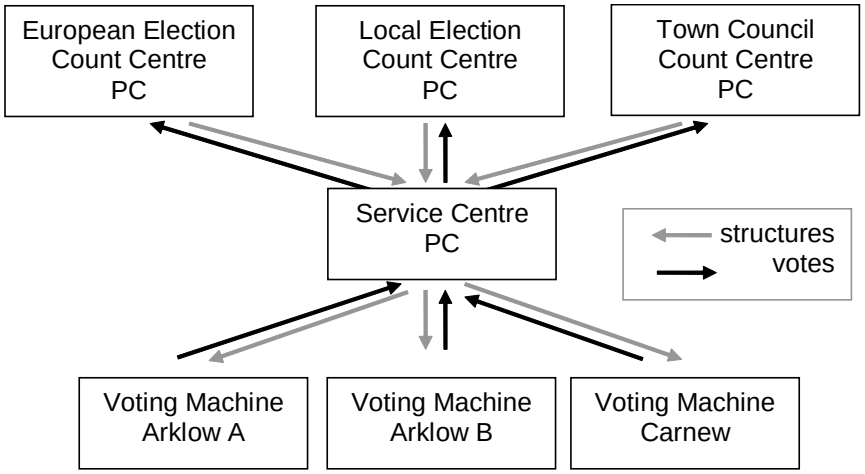
2 Input/output consistency

As part of the miniature election, 43 sets of votes were cast across 3 elections. The elections had 6, 7 and 12 candidates. The procedure was to prepare the votes in advance on a spreadsheet and then key-in the votes manually. The keying-in of the votes was watched by an observer to confirm that the correct votes were cast. This process was done in three episodes as votes were written onto 3 modules. The votes were downloaded from the modules onto the Service Centre PC and checked. The check showed that all the votes were correctly stored for counting.

3 Miniature end-to-end election

The layout of the election is shown in Figure 1 below.

Figure 1. A schematic representation of the components in the miniature election



The organisation is as follows. There are three Count Centres, at European, Local and Town Council level, which were represented by three separate installations of IES on a single PC (henceforth the Count Centre PC). The Service Centre is represented by the hardened PC provided by the Commission. Although we were only provided with one physical Voting Machine, by configuring three modules we were able to represent three different Voting Machines (Arklow A, Arklow B and Carnew).

The process was as follows:

- The election details for the three elections were prepared on the Count Centre PC.
- The details were transferred to Service Centre PC on CD ROM.
- The modules for the three Voting Machines were prepared ('programmed' in the IES terminology) on the Service Centre PC.
- The procedure for setting up a poll was followed on each of the Voting Machines and the votes were input as described above.
- The polls were closed and the modules were transferred onto the Service Centre PC.
- The votes were grouped by election and consolidated on the Service Centre PC.

- The consolidated votes were transferred to the Count Centre PC on CD ROM.
- The counts were carried out on the Count Centre PC.

The votes counted were verified to be the votes cast and the counts were verified to be exactly correct.

We have found this test of the complete system to be a useful exercise in establishing confidence in the interconnectivity of the system. It should be noted that this is a small scale simulation and that a full election contains many more voters, Voting Machines and Service Centres.

4 Electromagnetic field test

We exposed the three modules used in the miniature election to an electromagnetic source of 7 Tesla. After exposure the contents were verified against the data stored prior to exposure. It was found that exposing the modules to an electromagnetic field of this intensity did not damage the data stored on the modules. It is extremely difficult to produce a field of this strength. The machine we used is approximately two metres high, costs in excess of €250,000 and requires a supply of liquid Helium. In Ireland there are approximately 10-15 machines capable of an electromagnetic field of this intensity. The majority of these are located in the universities, with a small proportion in industry.

5 Verification of open/close poll printouts

Verification of the open/close poll printouts was performed on a number of voting modules. These tests were as follows:

- A poll was opened and the open poll printouts were examined.
- A number of votes were cast, including null votes and deactivated votes in single poll and multiple poll elections.
- The poll was closed and the close-poll printouts were examined.

In every test the open-poll and close-poll printouts were accurate. We also confirmed that we were unable to cast votes after closing the poll. However, it should be noted that it was possible to cast votes before the open–poll printout process was performed. **Therefore it is essential that the Poll Clerk verify that there are no votes recorded on the open poll statement.**

6 Miscellaneous system and usability issues

This section summarises some issues that arose during this analysis.

- There is inconsistency around the question of casting a null vote, i.e. expressing no preference in a vote as opposed to not casting a vote. It is not possible to cast a null vote in a single poll. However, in multiple polls (e.g. a European and Local Election) it is possible to cast a null vote in some (not all) elections: i.e. it is mandatory to vote in at least one election. From a systems point of view, this is not good design as it is sometimes possible to cast a null vote and sometimes not. The potential to cast a null vote in a multiple poll is an artefact

of the way the interface is designed. This inconsistency could be addressed by allowing a null vote to be cast in a single poll by pressing the Cast Vote button twice as is the case in a multiple poll. This solution may prove to be easy to implement.

- There are two keys needed for the PRU; the red key is for the reading slot and the black key for the programming slot. Both keys must be turned on to either read or program. This could give rise to an accidental overwriting of a module at the service centre.

- We were issued with a "hardened" PC of the type that will be used at every point in the election process, i.e. in the Service Centres and Count Centres. "Hardened" in this context implies a high level of security; with restricted user privileges, secure logging-on and restrictions on the installation of new software. However, we found that we were able to change the build of the count software by overwriting the original build with an older build. **This raises concerns about the level of "hardness" of the PC we were provided with as it seems that it would be possible for Service Centre and Count Centre officials to replace the count software with an alternative piece of software**.

Appendix A Referenced documents

No.	Company	Title	Date
1	PTB	*Test Report*	20-03-2003
2		*Test Report 2*	17-09-2003
3		*Software Requirements for Voting Machines*	18-03-2003
4		*Test Report*	08-09-1998
5	Zerflow	*Electronic Voting Security Assessment*	27-03-2002
6		*Review*	04-07-2003
7	TNO	*Test Report: Program Reading Unit Model ESI 1*	28-10-2003
8		*Test Report: Voting Machine Type ESI 2 (Standards IEC 60839-1-2, etc)*	30-06-2003
9		*Test Report: Voting Machine Type ESI 2 (Standards IEC 60839-1-3)*	29-10-2003
10		*Test Report: Voting Machine Model PRU (Standards EN 50082-2, etc)*	06-08-2003
11		*Test Report: Voting Machine Model PRU (Standards IEC 60068-2, etc)*	08-08-2003
12	KEMA	*Certificate No. 2028725.01 issued to NEDAP*	20-06-2003
13	Nathean	*Architectural Assessment and Code Review of IES for use at June 2004 Elections*	23-12-2003
14		*Code Review of IES Build 0111*	23-12-2003
15	ERS	*Software Validation Report*	15-12-2003