

IES Counting Software

**The Counting Program of the Electronic Voting System
to be used in June 2004 for Local and European Elections**

**An Incomplete System
An Unproven System**

Report

by

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The opinions are mine.

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Introduction

The purpose of this document is to provide a review of the IES counting software in so far as that can be done by an informed citizen.

- The IES software proposed for use in Ireland is a modification of the system used in Holland.
- The process used for modifying and testing the software has not been done in accordance with best practice.
- There is a medium to high risk that the system will fail if put into service in June 2004.
- Many aspects of the project give cause for concern including:
 - Serious delays in developing the software
 - A very small team of experts
 - No public scrutiny of the implementation of the statutory counting rules
 - No pilot has been done of the latest counting software with 3 ballots

In the next 9 pages I report on my research, finding and conclusions.

My recommendation is that the full rollout of this system be postponed until all the concerns have been resolved.

Background

I became involved in politics in 1985 when Des O'Malley asked the Irish people to respond to his call for a new style of politics. I had not previously been a member of any political party but I soon became very active. In short order I was elected chairman of the local branch, branch organiser and eventually constituency organiser.

For Dáil and local elections I was appointed sub-agent or Election Agent and I have tallied at every count since 1987.

I am no longer directly involved in party politics and I am not a member of any political party. I do however retain a keen interest in election management and in tallying the count.

I have a detailed knowledge of the counting rules and I am aware of their complexity. At one election the candidate I represented, who had tied for the last seat after the final sub-parcel was transferred, won the seat by 4 votes after two recounts.

As a computer professional of 30 years standing I am very wary of computer systems. I know how they should be programmed and I know how they do wrong.

I support the move to electronic voting in Ireland but only if it is implemented safely and properly. The design of the system should be a matter for public debate and the implementation should be done in open manner. All the internal workings should be

visible to the candidates and their election agents. The public need the reassurance that their preferences are accurately recorded and counted.

In June 2000, the Department of Environment and Local Government invited tenders for the supply of an electronic voting and vote counting system. After a detailed evaluation of the proposals received, the Powervote / Nedap solution was selected, subject to satisfactory testing.

The solution, called Election Management System, includes the use of voting machines and dedicated Integrated Election Software (IES).

The IES software is written by Powervote / Groenendaal Bureau, a Dutch company and their lead programmer is Jan Janson.

In October 2002, I set about finding out how the count was to be done in this new Electronic Voting system.

There are in fact two different computer systems in use here – one is the Nedap Voting Machine with its software and the second is the Powervote Counting System with its own software called IES which runs on a PC.

These two machines and their software are so complex that I had not enough time to complete a detailed report on both of them. In this report I have concentrated on the Counting System and the PC on which it runs.

My research and findings on the IES counting system are documented here but please note that I have further serious professional concerns about the Voting Machine and its software. I plan to write a report on this after Christmas.

The Counting System

The vote counting is done by the Integrated Election Software (IES) as part of the Electronic Voting system.

There is an Information Paper available publicly on the Department's website. This paper was written by Nathean Technologies, the Irish company which reviewed the software on behalf of the Department.

I made a series of requests under the Freedom of Information Act and I received a quantity of information. I have listed these reports in the Appendix. My report is based on the material released by the Department up to 13th November 2003. Later developments may alter my findings.

There are several reports on the Nedap Voting Machine from TNO and PTB. TNO is based in Holland and they carried out tests on the Voting Machine itself while PTB in Germany tested the software which runs on the Voting Machine. These companies did not examine the Counting Software.

It should be noted that there is no information available from Powervote to explain how the counting software carries out the job of mixing and counting the ballots.

My assessment of the counting software is based on:

- the four code reviews written by Nathean

- a report from Electoral Reform Services who tested the system by running different sets of votes through the counting process
- a 14 page response from Powervote to Nathean's comments
- several minutes from meetings in the Department with Powervote.

The Department has refused to release one further report:

Draft Nathean Report of IES for DoEHLG (Build 0111)

"Report is not finalised and release of the record would unduly interfere with the ongoing deliberative process. The public interest would not be served by granting the request. Section 20(1)."

I have asked for an internal review of this refusal and a decision is expected by 5th December. I have just been informed that this document will eventually be released.

As far as the public knows, these are the only documents available to the officials in the Department which allow them to judge if the Irish count rules have been implemented properly.

Findings

Having made a detailed assessment of these six documents released to me under FoI, I list my findings below:

1. The IES computer program, which will be used to count the votes, is still in a state of flux. It has been changed over 30 times from Version 83 in January 2002 to Version 115 in September 2003.

This indicates that the Department, the developers and the testers are still changing requirements and finding bugs on a regular basis.

2. The last version tested by the English company Electoral Reform Services (ERS) was Version 93 in April 2002. They have not tested any of the recent versions so it is likely that there are further bugs still in the software.
3. The main comment from ERS, was *"It is clear that the risk of the IES software failing to conform to the Irish STV counting rules is very low indeed - as an order of magnitude, we would say probably less than 1 in 1,000 elections."*

This statement by ERS shows a finite risk that at least one person will be deprived of his / her rightful seat over the next twenty years as a result of a failure of the IES to conform with the count rules.

4. ERS testing was based on a version of the software with just one ballot. The new software is significantly more complex because it has up to three ballots in use at the same time.
5. The code reviews from Nathean are not yet finished so we do not have a complete review of the counting software. We do not know if the Irish reviewer has arrived at an opinion that the counting system is safe and secure.

6. The developer, Powervote, is in direct contact from time to time with the reviewer, Nathean. There should be a formal separation of these two roles in order to ensure the integrity of the review. It should not only be independent, it should be seen to be independent.
7. The computer program has not been tested to ensure that it complies with changes resulting from High Court challenges. This means that any close result produced by the system in a real election could result in a long and complicated judicial review.
8. The opinion expressed by Nathean in the first review was: "*In general the source code has been well written and with a few exceptions seems to implement the count rules correctly.*" This opinion gives us no confidence that the Counting System will count the votes properly.
9. Nathean commented in their fourth review: "*To date no responses to the documents supplied to Powervote during the last review have been received. The reviewer would like to request from Powervote and update on when responses could be expected.*" This shows that Nathean have not yet finished reviewing the Counting software.
10. The Powervote computer program which counts the votes "*consists of approximately 200,000 lines of code in 150 / 180 source code units*". If printed out, this would cover four thousand pages of A4 paper – that is 8 reams - about a box and half of copier paper.

Eight days were spent by Nathean reviewing this large amount of information. This means that only a small amount of time could have been spent reviewing each unit of code. In my opinion, it is not possible to review such complex code so quickly.

11. The Department does not have the source code for either the Voting Machine or the Counting Software.

12. Two crucial code units have the following comment:

"The code in this unit is mostly written using the Dutch language, which obviously makes it very difficult to work out all of the functionality contained in the unit."

Nathean's summary of this issue is:

"The source relating to the transfer of data between the memory modules and the database have been written prior to the Irish extensions and thus are written containing Dutch language comments and variable/function names.

Thus we concentrated on the more abstract coding structures".

The code units concerned do all the writing to and reading from the blue Ballot Modules. Each module carries details of the candidates and all of the votes from the Voting Machine to the Count Centre.

The code units do the electronic equivalent of the opening the ballot box and initially checking the ballots before the mixing and counting starts.

13. There is a report that one Ballot Module has had a failure in Dublin South West.

It is Ballot Module, number 367 of Dublin South West – used at St Paul's Senior and Junior Primary Schools, Limekiln. It had a *"blocked - checksum not in order"* failure and was sent *"to Nedap for a report"*.

This failure shows that computer systems do fail sometimes. This is one part of the Irish Electronic Voting system that has failed.

14. The contract with Powervote had not been signed as of 13th November 2003.

15. A set of important records not released as of 13th November are concerned with Security and Audit features of the Election Management System.

This is the most important issue that concerns me as a computer professional. I have seen a description of the detailed methods used to protect the integrity of the vote in the Nedap machine and in the blue Ballot Module. However, I have not seen any similar precaution to protect each ballot being taken in the Microsoft Access database used by the Counting software.

16. With regard to the Voting Machine, I have found reference to the consequences of a power failure occurring just as the voter finishes voting.

A very intricate analysis is needed to decide where the vote is moving in the electronics between the time the "Cast Vote" button is pressed and the voter's preferences being recorded safely in the blue Ballot Module a few hundred milliseconds later. This is still an open issue.

Software Bugs as reported by the reviewers

1. In every review to date, the reviewers have found bugs in the Powervote software.
2. The most recent review lists twenty-four open issues with the counting software.
3. Nathean are not happy with the Developer's responses to three architectural issues. The Department has requested Powervote to address these issues and has made it a condition of the contract that these issues be fixed.
4. Several other software bugs were caused by external factors such as:
 - the use of Microsoft Word version 2000
 - the need for a particular Service Pack of fixes for Windows 2000
 - The use of Microsoft Access 2000 instead of Microsoft Access 97.

Departmental Concerns

In mid-January 2003, the Franchise section in the Department recommended that the Electronic Voting system be used only in Dublin and Leinster for the June 2004 elections. This recommendation was not accepted and in February the Department established a dedicated project team to implement the Electronic Voting system. A summary of the Work Programme listed aggressive dates for finishing various tasks.

The most critical task was to develop software for multiple ballots and have it fully completed and tested by July 2003. Testing of the Count software was to be completed by the Department, by returning officers and by Electoral Reform Services (UK).

The software is still clearly in development and is not yet stable.

There are no records to indicate that the testing has been completed. When this testing takes place it is likely that further bugs will be found necessitating changes to the software.

From the records released under FoI we know:

- that the software is not complete.
- that it has not been tested recently by ERS.
- that the Nathean review of Version 111 is still in draft format

Conclusions

From these findings, I draw the following conclusions:

1. The Nathean review is not yet finished.
2. The current Version 115 of the count software has never been piloted. The earlier Version 93 had 3 pilots where transfer of surpluses and elimination of candidates took place. This pilot had only a single ballot paper. The next election will have three ballot papers.
3. The petitions functionality has not been thoroughly tested by the Department.
4. There is no formal separation of the "third-party" reviewer from the developer.
5. Only a few people have knowledge of the Counting software and how it works. The lead programmer is in Powervote in Holland and 2 people in Ireland have reviewed the software. This is a very small group of experts to guarantee that the Irish democratic process is being carried out in accordance with Statute. There is a serious risk to the development and maintenance of the counting software if these experts become unavailable.
6. Two important modules are written in Dutch.
7. The operating system environment is open to bugs – the Microsoft Windows operating system and the MS Access database should not be used in mission critical systems. The proof is to be found in the various bugs already found during testing of the IES system.
8. The Counting Software had just one suite of tests in Spring 2002 where actual votes were run through the Counting process. Since then there have been at least 23 further releases of the Counting Software. Note that the Nathean code reviews do not actually test the software.
9. In the absence of design documentation from Powervote, it is unclear, when dealing with three different ballots, whether the results are being recorded in one database or in multiple databases. The new software to handle these multiple ballots is significantly more complex than the software used in the three pilot constituencies in June 2002 where only one ballot was used.
10. Three standalone tests have been carried on the System:
 - a) Tests by TNO and PTB on the Nedap Voting Machine
 - b) Tests by ERS on the Counting Software
 - c) Code reviews by Nathean of the Counting Software

There is no report of an end-to-end test where one full set of votes are entered into several Nedap Voting Machines, with the blue Ballot Modules being transferred to the Count PC and a full count being completed by the Counting software.

11. Given the above, it would be foolhardy to proceed with this complex Electronic Voting system in June 2004.

Summary

In my experience of large projects, six months is insufficient time to correct the flaws which were evident in November 2003.

In my professional opinion:

- Development of this Electronic Voting system is not complete.
- The schedule for development and testing has slipped significantly.
- This system is unsafe to use nation-wide in June 2004.

A full end-to-end test of this system is urgently needed, not just to allay public concern, but to verify that the system works as required by the Electoral Acts.

The Minister extended an invitation to experts to meet with his experts. I would like to take up this invitation as soon as possible.

The system needs a full peer review by Irish citizens who are both expert in computer software and expert in the Irish electoral system.

The courts have ruled¹ in matters relating to the conduct of elections in Ireland that:

"Constitutional rights are declared not alone because of bitter memories of the past but no less because of the improbable, but not to be overlooked, perils of the future."

We should not overlook the peril we face in putting our trust prematurely in this Electronic Voting System. The improbable future may arrive in June 2004.

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Friday, 5th December 2003

¹ McMahon v. Attorney General [1972] IR 69, Chief Justice O Dálaigh.

Appendix A - List of Reports

The Department has released the following documents on the IES software.

	Title	Author	Date
1	Code Review Of the Powervote Electronic Voting System	PMI Software Ltd. John Pugh, Robert Doherty	14 th December 2001
2	Code Review Of the Powervote Electronic Voting System (Additional Input/Output Units)	PMI Software Ltd. John Pugh	1 st March 2002
3	Report on Irish STV Software Testing	Electoral Reform Services Joe Wadsworth and Brian Wichmann	29 th May 2002
4	Code Review Of the Powervote Integrated Election Software Build 2001-0094	PMI Software Ltd. John Pugh	6 th June 2002
5	IES Database Validation Technical Design Specification	Nathean Technologies Ronan Wisdom	5 th September 2002
6	Code Review Of IES Build 2002-0096 And Build 2002-0099 For The Department Of The Environment And Local Government (Referendum Units)	Nathean Technologies John Pugh	7 th October 2002
7	Powervote Responses to Code Review	Powervote Roy Loudon	1 st December 2002
8	Analysis of Developer Comments	Nathean Technologies John Pugh	6 th December 2002

Statistics

Number of IES software releases		At least 33.
	Version 83	16 th January 2002
	V 93	30 th April 2002
	V 108	May 2003
	V 111	June 2003
	V 1.14	9 September 2003
	V 115	11 th September 2003
	Later	September 2003
Number of test reports	1	by ERS in May 2002 with 393 cases
Number of major reviews	3	2 published, 1 currently withheld December 2001 June 2002 Mid 2003
Number of modules or code units	150 / 180	Source: DoEHLG paper
Lines of code	200,000	Source: DoEHLG paper
Number of pages at 50 lines per page	4,000	
Time taken to review the code	8 days	
Pages of code reviewed per day	500	

Appendix B - IES Software Testing History

This table is included in Appendix C of the ERS report dated May 2002.

Version	Date received	No. Cases tested	Reason for failure
Pre-V83	various	10	The first test file was run through the IES software on 15/11/2002. Formal testing did not commence as Powervote were still working on other changes requested by Ireland. Jumbled figures on some result sheets were noticed (see V87 below). Problems were encountered trying to load the software onto different PCs including a laptop and an iMac with a PC platform (also see V88 and V89 below)
V83	16/01/2002	21	M002: Numerous errors including wrongly drawing lots and distributing surplus votes to an excluded candidate. C001: appears to apply shortcut too early when an excluded candidates papers must be distributed.
V84	31/01/2002	36	R003, R008, R014: appears to “lose” a vote after a transfer; after this point the total number of votes is one less than at the start M002: still fails as above
V85	19/02/2002	14	R056: reports tie when it should do a multiple exclusion of three candidates R051: error screen after drawing lots R048, 049, 050: Jumbled figures (see V87 below)
V86	15/03/2002	40	R009, 011, 017: Jumbled figures (see V87 below) ASC output format (number of carriage returns in the non-transferable line) had been inadvertently changed from previous versions; Powervote agreed to revise.
V87	19/03/2002	61	Powervote finally solved the problems with jumbled figures in result sheets: Office 2000 apparently handles indexes differently to Office 97 and XP. R036: declares result a stage too early. R049, R059: wrongly puts all of one candidate’s surplus votes into non-transferable. Formatting problems with Word—columns not lining up
V88	03/04/2002	10	“DAO No current Record” errors after trying loading IES onto additional PCs. M101: error screen saying “total vote differs from total vote at first stage”. Discovered that the larger tests take a long time to run!
V89	11/04/2002	270	Problems with “DAO No current Record” errors during import/numbering/counting were fixed by ERS, by upgrading to Office 2000 SP2 M108, M110, M116, M118, M147: these and several other cases were found which showed an anomaly with the count rules in cases where there is a surplus and candidates have zero votes. Ireland issued a clarification to the rules.
V90	Not received	0	N/a
V91	25/04/2002 (am)	5	Excludes candidate in M001c5 then declares him elected!
V92	25/04/2002 (pm)	71	Failed to complete S009 and R005
V93	30/04/2002	393	All tests compare except C007, T084, T089 (see Comparison Failures). IES certification complete!
<i>Total tests run</i>		<i>931</i>	

Appendix C - Joe McCarthy CV

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Joe McCarthy is a consultant working in the network marketplace where he applies the latest technologies to the design and management of large-scale complex networks. He has substantial expertise in the telecommunications business - especially with regard to rapidly developing changes in technology and tariffs. His advice to clients enables them to achieve substantial cost reductions while improving overall service levels.

Joe has been working in the telecommunications and computer business in Ireland for over 30 years. His career in IBM Ireland gave him extensive experience in designing, marketing and implementing solutions for varied clients. These ranged from integrated re-engineering systems for Call Logging in Telecom Eireann's crossbar exchanges to the design of countrywide networks for large clients such as AIB and An Post.

He is a competent systems analyst and programmer. He is expert in programming languages including Fortran, Assembler, PL/1, Visual Basic and scripting languages. He is expert in database systems including Microsoft Access.

Joe spent a year as an Editor in IBM's International Systems Centre in London where he published 70 sets of books and manuals as part of the Large Systems Support Programme.

Joe was the Irish consultant for the Networking Practice of the IBM Consulting Group in his latter years with IBM, where he gained wide experience in network requirements analysis, technology selection, traffic & performance studies, and cost optimised design for large networks in Ireland and the UK. He left IBM in 1995 to set up his own consulting company.

Joe is now a consultant for Internet technologies, for data and voice integration systems and has provided advice on the regulatory position in the telecommunications market as it develops under the influence of EU directives. He has applied his skills and experience to reduce the cost and optimise the capacity of many nation-wide networks. Joe is a member of the Expert Group on Future Skills Needs which is producing recommendations for government policy on the provision of sufficient skills for Ireland's growing economy.

He is interpreting the impact of the new networking technologies on their businesses for such diverse clients as Cablelink, Baltimore Technologies, Lifetime Assurance,

the IMI, Údarás na Gaeltachta, the Department of Agriculture & Food, An Post and the National Lottery Company.

Projects completed by Arkaon include:

- Re-design and optimisation of a nation-wide network where technology change is facilitating dramatic reduction in cost while improving capacity and response. Technologies used include: IP, Dssnet, ATM, ISDN, PSTN, DWDM.
- Design, implementation and testing for a countrywide network of 3,500 POS terminals. Traffic measurement and reporting, transaction time optimisation, network cost management together with strategies to migrate legacy systems to an open standards platform.
- Design and implementation of a Public Key Infrastructure for a semi-state company. Disciplines addressed include IP planning, Firewall and resilience planning, development of PKI procedures for security and CPS.
- Design, coding and implementation of a network management platform based on Mapinfo which integrates SNMP, business data and trouble ticket reports for an office network of 1,000 nodes.
- System design and implementation of a medium scale scanning and database project with some 100,000 documents per month being scanned and analysed. This system was based on NT and SQL Server with VB object modules to link the components from scanning to interpretation to database load to reporting. MS Access queries for trend analysis and quarterly reporting were also implemented.
- An interactive support environment for the LEADER II National Networking unit in Ireland. It includes databases, newsletters, reference material and discussion groups all built on a Lotus Domino server. It can be seen at <http://www.leaderii.ie>.
- Strategic analysis of the cryptographic marketplace for a client who purchased Baltimore Technologies. Subsequently ran a European test market campaign for their encryption products. Also planned and implemented the first Baltimore Web site.