United Nations Assistance Mission for Iraq (UNAMI)

IHEC Board of Commissioners Background Information: Technologies for Casting, Counting, Tabulating, Reporting Election Results*

Two of the greatest lessons learned from the January 31, 2009 Governorate Council Elections were the need for IHEC to improve the voter registry and to also find ways to accelerate the counting, tabulation and release of election results. IHEC is currently investigating different options relating to voter registration including a transition to "smart cards." The pros and cons of "smart cards" will be discussed separately in other papers. This paper seeks to provide IHEC with information regarding available technologies for counting, tabulating and reporting votes cast.

Technologies for casting, counting, tabulating and reporting votes can be broken into three primary systems: paper ballots; optical scanning and direct recording electronic systems.

A. Paper Ballots

This is the system that has been used to date in Iraq and which the voters and political entities are most familiar with. Paper ballots have served the election process well in Iraq. They are relatively easy to produce, easy to mark and easy to count, but they can be quite expensive to print and distribute, they can only be used once, and they are not a particularly good use of resources.

Depending on the type of paper ballots used, they may not be considered the best method to record a vote and can be prone to fraudulent use such vote buying.

Counting paper ballots manually, although relatively reliable can prove to be cumbersome and prone to errors which, in turn can result into the need for multiple counts of the same ballots. Counting and tabulation can also take weeks to complete raising suspicions of manipulation and increasing the risk that results may not be accepted. In the modern electronic era, the expectations of many Iraqis is that ballots should be counted much faster and results released sooner.

Mechanical voting machines were used widely in the United States, and to a lesser extent in a small number of other countries around the world, but they are being replaced by electronic voting machines. The controversy surrounding mechanical voting machines in Florida during the 2000 American election have led most countries to move away from this technology and few countries are adopting it.

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* These principles can be found in papers located on the excellent website of aceproject.org. 1998-2006 © ACE Electoral Knowledge Network

Electronic voting machines are used on a large scale in Belgium, Brazil, India, Venezuela and the United States among others. Although there is a trend for adopting this technology there are still many countries that prefer hand-marked and manually counted paper ballots.

While the efficiency of some of these electronic systems is not disputed they have suffered from different degrees of security problems as well as a perception that they are not reliable and that they can introduce substantial counting errors.

B. Optical Scanning

An optical scanning device combines specialized computer hardware and software. The hardware devices capture an image and software converts the image to computer-readable data.

Voters using machine-readable ballots are given a ballot paper with the names of parties or candidates printed on it. Next to each party/candidate a symbol is printed, such as a rectangle, circle or incomplete arrow. The voter indicates a choice for a candidate by filling in the appropriate rectangle or circle or by completing the arrow.

After voting the voter may (1) feed the card directly into a computer vote tabulating device at the polling place, or (2) the voter may place the card in a ballot box, which is later transported to a central location for tabulation.

The computer tabulating device identifies the marks made by voters on the cards and records votes accordingly. The individual votes are recorded in a database and aggregated to give total results. There are four main types of optical scanning technologies:

1. Optical Mark Reading (OMR)
2. Optical Character Recognition (OCR)
3. Intelligent Character Recognition (ICR)
4. Imaging technology

1. Optical Mark Reading (OMR) scanning systems

Most machine readable/optical scanning voting systems use OMR technology. OMR technology has been widely used since the 1970s for a variety of purposes, including school and university tests, censuses, surveys and lotteries, as well as for voting. It is also used in barcode readers, which are in widespread use in retailing, stock taking, libraries and schools.

OMR typically involves a scanner reading particular kinds of marks in a defined set of locations on a page. The computer software used by the OMR scanner is programmed to recognise the meaning of the various marks and to convert scanned images into computer-readable data using the location of those marks.

OMR systems are well suited to first-past-the-post and open/closed list electoral systems, where voters are asked to make simple choices when voting, easily represented by a simple mark. In more complex electoral systems, such as alternative voting systems and single transferable vote systems, where voters are asked to choose candidates by showing sequential preferences, it is more difficult to apply OMR technology. As a result, scanning technology has not been used widely for counting these kinds of ballots.

OMR technology is very useful for and efficient at gathering relatively simple, pre-determined data. However, it is not very good at gathering complex, variable data, such as large amounts of text. OCR and ICR systems are more suited to this purpose.

2. Optical Character Recognition (OCR) scanning systems

OCR scanning systems take scanned images and use computer software to recognize the shapes of printed or handwritten characters such as numbers and letters and store them as computer-readable data. OCR is typically used to convert printed text into computer-readable text.

This capability has many potential applications in the electoral field. For example, in the early 1980s, the Australian Electoral Commission produced an extensive set of procedures manuals. Some years later, when the manuals were due to be revised, the original computer files containing the manuals were not able to be used by the Commission's upgraded computer software. Rather than retype the original manuals, OCR software was used to convert the printed manuals into computer files suitable for editing and revision.

Another important use of OCR is for data capture of information printed on forms. Rather than manually typing information contained on forms, OCR can be used to automatically convert information from forms into computer-readable data.

OCR works by “training” the scanning software to recognize particular shapes as letters and numbers. Since different print fonts are different shapes, OCR systems have to be trained to recognize that a particular letter or number can take several different forms. Given the regularity of printed fonts, this is a relatively straight forward process. OCR systems can also be trained to recognize hand writing. However, given the infinite variety in hand writing styles, this is a much more difficult task.

Early OCR systems had a relatively high error rate when converting printed text to computer-readable data, particularly hand written text. This required a high level of human intervention to proof-read and correct the converted data. As optical scanning hardware and software improved towards the end of the 1990s, the error rates dropped. However, the next generation of scanning systems, ICR systems, went even further in increasing scanning accuracy rates.

3. Intelligent Character Recognition (ICR) scanning systems

ICR takes OCR systems one step further by using computer software to apply intelligent logic tests to scanned characters so as to more reliably convert them into computer-readable data.

ICR systems apply rules of spelling, grammar and context to scanned text in order to make “intelligent” assessments as to the correct interpretation of the data. This enables much more accurate conversion of scanned text than does the more simple OCR system, particularly with handwriting.

ICR software requires fast, powerful computers to perform efficiently. Reliable ICR systems only became available in the mid to late 1990s with the development of cheap, powerful computer products.

As ICR systems become more reliable, their use for electoral applications will increase. They are particularly suitable for capturing data from forms. ICR systems are also being examined for their suitability to capture hand written numbers from ballots used for more complex electoral systems, such as alternative vote and single transferable vote systems. To date, automatic data capture systems have not been used for these electoral systems owing to the complexity of the task.

4. Imaging technology

In addition to capturing images for conversion into data, scanners can also capture images to be stored as computer-readable images. Photographs, drawings and images of text can be stored and reused in computer-readable form.

Computerized images have many electoral applications. Images can be included on websites and printed in publications. Staff photographs can be placed on an electoral authority's “Who we are” Internet page and in its Annual Report. Photographs of polling stations can include on websites and instruction manuals. Examples of completed forms can be scanned as images and printed in training manuals.

Paper-based forms can be imaged and stored in electronic form. Copies of the images can then be downloaded over a computer network without the need to access the original paper copies. The Australian Electoral Commission is currently engaged in imaging all of its millions of voter registration forms and placing them on a computer network accessible from any of its offices nationwide. This system will be used to check signatures or any other details included on the forms by accessing the imaged forms on demand.

Imaging technology can also be used for identity verification purposes. Photographs can be digitized and placed on identity cards. Images of finger prints or facial features can be digitized and stored on smart cards. Software identity systems can be used to compare the image of the person presenting a smart card with the image of the person encoded on the card to determine whether it is the same person.

C. Direct Recording Electronically (DRE)

The increasing sophistication of computer technology towards the end of the 1990s led to the most recent development in the evolution of voting systems: Direct Recording Electronic (DRE) systems.

Use of DRE systems is expanding and in Belgium, Brasil, India and Venezuela most if not all voters use a DRE device to vote while in the United States and other countries the percentage of voters using DRE devices to vote is increasing.

Using DRE systems, voters mark their votes directly into an electronic device, using a touch screen, push buttons or a similar device. Where write-in ballots are permissible, an alphabetic keyboard is sometimes provided to allow voters to cast write-in votes.

With DRE systems there is no need for paper ballots. Voting data is stored by the electronic device, on a computer hard disk or a portable diskette, CD-ROM or smartcard. For backup and verification purposes, some systems copy voting data onto more than one storage medium. For example, in Belgium, voting data is written both to a hard disk and to a smartcard issued to the voter. After voting, the voter places the used smartcard in a ballot box. The smartcard can be used as backup should the hard disk copy fail, or as a way of auditing the data recorded on the hard disk.

When the polls close, the data from the various voting locations are amalgamated in a central computer, which calculates the vote totals. Data can be transmitted to the central computer either on removable portable devices such as diskettes, or by a computer network.

Since the 1990s the telephone has also been used as a type of DRE voting system. Voters are able to record votes directly into computer systems using the key pads on their telephones, and to identify themselves with Personal Identity Numbers (PINs), by following a series of recorded instructions.

The introduction of DRE voting options at locations away from polling places, like internet voting and telephone voting, raises the issue of identifying the voter remotely which has not yet been solved to security standards required by the need to ensure that the person voting is indeed a voter, that he can not vote more than once and that the vote is secret.

Internet voting

While security and identity concerns has lead to caution toward the use of Internet voting, many countries are considering it seriously, for at least some elections, not only to make it easier for the voter but also in an effort to boost voting, since the end of the 20th century witnessed a tendency for voter absenteeism.

It can be expected that not before long these concerns can be answered and Internet voting will become safe, secure and widespread. The potential of the Internet to change the dynamics of both the election process and the wider political process should not be underestimated.

Pros/Cons about automated voting and counting processes

There are a number of automated devices that are marketed as a means of improving voting methods and reducing costs, especially staffing costs. It is claimed that some of the machines offer a high degree of reliability and resistance to electoral malpractice. Many are now capable of providing audit trail facilities. These include electronic voting machines (EVMs) which have been used in countries such as Australia, Belgium, Brazil, the United States, and Venezuela over the last few years, and recently for the first time in the whole of India. Although no reliable cost-effectiveness analysis exists on the use of new technology for voting and the count, there is evidence that technology such as EVMs may reduce election costs over time, especially costs associated with the printing and storage of ballot papers and also the vote count. The use of optical mark reading (OMR) devices to count votes can also provide accuracy and time-effectiveness in the electoral process while still ensuring the existence of a paper ballot that can be physically examined if necessary in the course of post-election disputes.

It is important to weigh the use of new electoral technology against the level of public trust and confidence in the electoral process, to involve stakeholders in pilot testing new electronic systems, and to obtain major stakeholders' agreement to the introduction of new technology. Due to the potential lack of transparency of electronic voting and counting, the use of EVMs may generate distrust among detractors who can argue that such technology can easily lend itself to manipulation. This is not surprising, given the security deficiencies, and omissions and errors in recording votes regularly reported in the use of DRE (direct-recording electronic, or touch screen) machines and other EVMs in the USA.

The accuracy and integrity of these machines is only as good as that of the companies and persons designing, programming, testing, and maintaining them. There are ways of introducing EVMs that can provide integrity, cost, and time benefits to the election process – provided that clear controls and accountability measures, such as regular audits and back-up systems, have been implemented.

It is not wise for a poor or underdeveloped country to go high-tech while failing to feed and develop its own people. The use of electoral high technology such as digitized voter registration cards, computerised electoral registers, and electronic voting and counting should be weighed against other pressing national priorities such as health and education. Electoral technology may be more sustainable where it can be used for other continuing functions. Its introduction also needs to be considered not just against the immediate costs and alternative uses of funds, but future costs and human skills required for their maintenance. Assessing sustainability needs to consider the longer-term consequences.

The counting process is a prime target in many countries for automation and cost reduction, and many automated machines both record votes and tally them. Unless paper audit trails are recorded for each vote, transparency may be lacking in these automated counts. The counting process is considered to be a vulnerable part of an election, and always needs to be conducted in a transparent manner by well trained staff.

The requirement for openness at all stages of the counting and tabulation of votes may also limit the cost-saving measures that can be introduced into manual vote-counts. Stakeholders in the general election in Guyana in 1997 and the Union elections in Zanzibar (Tanzania) in 1995 and 2000 complained that events which took place during the tallying phase of the count adversely affected the election results and underlined the importance of transparency in the entire counting process. Both cases involved changes made by unknown persons to some of the count results subsequent to figures being issued from polling stations. Opposition parties in both instances believed that the interference did affect the outcome of the elections.

Respectfully Submitted,

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