Accessibilities of "voter verified paper ballot" to visually impaired voters

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The following is a discussion based on some information and discussions on a report by "Voter Action" in Washington in conjunction with "Demos" in New York by Mr. Noel Runyan.[1] AVANTE has tremendous respect for Mr. Noel Runyan and his careful and diligent work in improving the accessibility of our nation's voting systems. The following comments are offered in the spirit of clarification and perspective from a manufacturer who has given different options careful consideration.

The technical objection to the reading back of the VVPB from the data stream that is used for the printing of VVPB, using the original voting system, placing too much trust on the manufacturers of the voting systems. Some even oppose it, when this specific portion of the source code is made public, as required by some State election codes.

Technically, a truly and totally independent and private verification of paper ballots for the visually impaired voters is having a third party equivalent of "machine-person" to read back the votes as recorded on the voter verified paper ballot. Such facility should be independent of the voting system manufacturer. The best mode of operation will require a system (hardware-firmware-software) that is commercial-off-the-shelf (COTS) and preferably based on open standards. Even a third party developed system that is open-source may not be independent enough if they are not truly COTS. After all, it is dependent and controlled by yet another manufacturer.

Most people forgot that all of the current ballot-marking devices (BMD) use templates to print or mark on pre-printed ballots, or print and mark the ballot. When such printed/marked ballots are fed back for the reading back, they do not use third party OCR or a barcode reader as an independent mechanism. Instead, they retrieve and use the same template to compare on the marked area and use the table to read back to the voters. They are one and the same in terms of independence whether reading from the data stream for printing or reading back by using the template after scanning.

The only commercial-of-the-shelf (COTS) means of reading a paper ballot is the use of optical character recognition (OCR, that still lacks common industrial standards), or reading a condensed representation such as 2-D barcode (e.g. PDF-417) that has public standards.

In the case of the BMD system, the use of OCR coupled with a text-to-speech engine represents the most direct method that may be able to use third party or open source software. The accuracy is still not yet adequate to provide 100% accuracy and thus may cause confusion. **Even if accuracy is not a problem, it still has many practical issues:**

- OCR engine coupling with text-to-speech engines that are COTS must read a complete ballot including those not selected. Unless of course, one incorporates special software. It will be equivalent to doubling the time of normal 20-30 minutes of voting that even the visually impaired voters may object to.
- Even then, it still needs special programming to interpret and "read" only the voter's filled ovals as a selection and read back interpretive words like "filled oval" and "unfilled oval". By itself, COTS OCR will not know what a filled or unfilled oval means. And sometimes, the system may be required to be pre-programmed to "read" the signature of the County

[1] "Improving Access to Voting-A Report on the Technology for Accessible Voting Systems", By Noel Runyan; February 14, 2007 (http://demos.org/pubs/improving_access.doc)

Clerk of the jurisdiction, or must be programmed to disregard such markings along with all other timing and other marks. Again one has to inject non-COTS software.

- If only those candidates that have been selected are read, the use of the original software and database will be a pre-requisite. There is no technical difference with the method of reading from the same data stream that is used to print the voter verified paper ballot. This is exactly what some of the blind voters and their supporters object to.
- Another potential issue is the use of the “computer voice” that some visually impaired voters object to. If a recorded voice is to be used, it will need yet separate programming on top of the otherwise open-source or public domain software.
- That is, OCR is not a real solution for total independent verification for the visually impaired voters.

We agree with Mr. Runyan that the alternative approach of using barcode representation is a more feasible solution.

To use a commonly available and open standard third party hardware and software system to decipher a condensed representation of the selections made and printed on the VVPB may be technically the only feasible and practical solution. The most commonly used machine-readable representations are 1-D and 2-D barcodes. Using the low data density of 1-D barcode will be inevitably cumbersome when there are multiple contests that are typical in US election. It may need as many lines of barcodes as the number of contests.

2-D barcodes such as PDF-417 have relatively high data capacity to accommodate the requirements of reading as much as 500-1000 bytes of characters of 20-50 contests. PDF-417 is based on open standards that allow independent verification by anyone. Even with the data capacity of 2-D barcodes, sometimes multiple barcodes may be required but they are still manageable. However, there are other technical difficulties inherent with this approach that may not be easily overcome:

- Typical barcode reading using a handheld device is not adequately accurate for a close to 100% read rate required for the election application. A detailed and controlled scanner such as a standard fax machine or document imaging system may be currently the only means that can provide such accuracy. As Mr. Runyan noted, it may present difficulty for some visually impaired voters to manage and in some cases may be just physically not possible.
- AVANTE believes it is possible to engineer a solution that the VVPB from the DRE or BMD with a printed 2-D barcode is fed into an imaging device without manual handling. Hardware adaptation of such COTS imaging system must be developed by a third party or by the original manufacturer. This third party will also have to be responsible to develop software to automatically read the barcode and ignore the rest. It may not be as independent and certainly not COTS with an open standard anymore.
- To be totally independent of the original voting system, the only possible read back voice is again, a synthesized voice. Some visually impaired voters may find it objectionable again.

In short, we have two options but none are perfect or totally independent of either a third party solution provider that may or may not be the original voting system provider. Like Mr. Runyan, we believe something has to be compromised.

Unfortunately, this is the state of our technological know-how. By the very nature that we have to use technology to provide voice assistance, it is almost inevitable that specific hardware and software must be used. Someone other than the visually impaired voters may have to ensure its

correctness of such system in advance. Procedures and processes must be in place to prevent any tampering. We are sure we will be able to continuously improve on it over time when new technological breakthrough becomes available. In the meantime, the following may be the only choices that each bears their respective limitations and costs:

1. Use a text-to-speech synthesized voice (may incorporate recorded voice of candidates) to read back what was printed from the **data stream** that is sent to the printer of VVPB. To make this option more independent and acceptable, we should include the following provisions:
    - At least the portion of such read back software should be open source to allow independent verification.
    - Incorporate a third party developed software module that is open source (and better yet a public domain developed with sponsorship from EAC) to read the data stream using the database table provided by the manufacturer of the voting systems.
    - All visually impaired voters must accept the synthesized voice.
    - This approach costs almost nothing. They are available today from all manufacturers that are providing VVPB solution.

2. Use a text-to-speech synthesized voice to read the **2D barcode** representations of the selections and other relevant ballot identifiers. The caveats are listed below:
    - Only limited ballot-marking devices have the capability to print 2-D barcode.
    - All visually impaired voters must accept the synthesized voice.
    - This approach must still incorporate a third party developed software module to extract the barcode data image and ignore the rest of the printed data images.
    - This third party developer may be sponsored by EAC to provide a public domain software module but must also work with the original voting system manufacturer to ensure proper adaptation to accept the VVPB in whatever form-factor.
    - Its cost may be as high as $2,000 for physical hardware adaptation and incorporation of another computer independent of the original voting system. If such ballot- reading module is to be loaded into the original voting system, some form of “handshake” must be worked out. For lesser independence, the cost may be reduced to the range of $1000 each.

We hope it is clear to all that it is not the intent of AVANTE to discourage and/or encourage specific approaches. We only wish to point out the reality and facts of the current available technologies and those that have been incorporated in our nation’s voting systems today.