Providing accessibilities of "voter verified paper ballot" to visually impaired voters

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Most people object to the reading back of the VVPB using the original voting system as placing too much trust on the manufacturers of the voting systems. Some them oppose it even when such portion of the source codes are made public as required by some State election codes.

The objection may be technically correct that such reading back of the VVPB of DRE requires the system to back track to the database or at least the database table of the candidates being selected for reading back. The true and technically feasible way to provide the independent and private verification of paper ballots for the visually impaired voters is having a third party equivalent of machine-person. Such facility must be independent of the voting system manufacturer. This will require a system (hardware-firmware-software) that is commercial-off-the-shelf (COTS) that has 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 on 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 on the same ballot. When they are fed back for reading the ballot, they do not use third party OCR or a barcode reader as independent mechanism. Instead they still go back and use the template to compare on the marked area and use the table to read back to the voters. They are one and the same 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 of common industrial standards, or reading a condensed representation such as 2-D barcode (e.g. PDF-417) that has a public standard.

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 will still have practical issues:**

- OCR with text-to-speech engine system must read a complete ballot including those not selected unless incorporating special software. It will be equivalent to doubling the time of voting that even the visually impaired voters may object to.
- Even then, it still needs special programming to interpret and "read" only the voters 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 pre-program to "read" the signature of the County Clerk of the jurisdiction or must be programmed to disregard along with all other timing and other marks.
- If only those that have been selected are read, the use of the original software and database will be a pre-requisite. The reading from the same data stream that is used to print the voter verified paper ballot that some of the blind voters and their supporters object to.
- Another potential issue is the objection to 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 a separate programming on top of the otherwise open-source or public domain software.

We agree with many experts on the alternative approach of using barcode representation. To use a commonly available and open standard third party hardware and software system to

decipher a 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.

The use of 2-D such as PDF-417 are common and have relatively high data capacity to accommodate the requirements of reading as much as 500-1000 bytes of characters of 20-50 contests. Even with the data capacity of 2-D barcode, sometimes multiple barcodes may be required. There are technical difficulties inherent with this approach as well:

- Typical barcode reading using a handheld device is not adequately accurate for close to 100% read rate required for the election application. A detailed scanner such as standard fax machines or document imaging systems may be currently the only means that can provide such accuracy. As Mr. Noel Runyan[1] noted, it may present difficulty for some visually impaired voters to manage and some of them are just physically not possible.
- AVANTE believes it is possible to engineer a solution that the VVPB from the DRE or BMD and a directly printed 2-D barcode feed into an imaging device without manual handling. Such a system may have to be developed by a third party or by the original manufacturer of the system in terms of hardware "adaptation". This third party will 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, synthesized voices. Some visually impaired voters may find it objectionable.

In short, we have several options but none are perfect. Like Mr. Runyan, we believe something has to be compromised. This is the state of our technological know-how. We are sure we will be able to continuously improve on them over time. Here are the choices with it's limitation 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. The provisions and points to be aware of are:
    - At least the portion of such read back software 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.
    - 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 provisions and points to be aware of are:

[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)

- Only limited ballot-marking devices such as those made by AVANTE and Populex have the capability to print 2-D barcode. The more popular AutoMARK system is not currently programmed with such capability.
- 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 and ignore the rest of the printed data.
- 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.
- It costs at least $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 the lesser independence, the cost may be reduced to $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.