OPTICAL VOTE-TRAKKER™: A "Mark-Sense" Absentee & Precinct Based Voting System that Minimizes Both Voter and System Errors

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OPTICAL VOTE-TRAKKER™ is the first true pixel-based mark-sense voting system in the election industry. The following are the advantages afforded by this patent-pending voting system that complement the world's first voter-verifiable touch-screen voting system from AVANTE International Technology, Inc.

1. EASE OF USE FOR VOTERS

The ability to directly image the ballots as submitted rather than reading them against a fixed template allows the use of a much more voter friendly format. The following are some of the critical advantages in terms of ease of use for voters:

- ♥ Full ballot information rather than just a series of numbered ovals can be presented to the voters even on the long ballots of 30-100 contests. This minimizes any transposing errors that can be made by the voters.
- ♥ Oval filling is evaluated based on pixels filled within the oval along with the full evaluation of the ovals in each and every contest on the ballots. The system is able to distinguish between hesitation marks and "real" marks more accurately than any other system.
- ♥ Voters may use a standard #2 pencil. The system also recognizes ovals filled with ballpoint pens of all colors (as long as the color adequately contrasts with the color of the paper) and markers of all colors.
- ♥ Folding or wrinkling of the ballots during the handling process will not affect the marked ballot reading accuracy.
- ♥ If jurisdiction and state laws permit, voters can actually fax in their ballots. The machine will be able to read the ballots automatically without any transposing by a polling official.

Comparative System Analysis on Ease of Use		
	DISCRETE-SENSOR BASED	**AVANTE PIXEL-BASED**
Marking of ovals with writing utensils other than pencils is acceptable	▪ Resolution is limited to the number of sensors that can be placed. ▪ Depending on light or IR sensors used, marking media and colors may be critical.	➢ Any color can be used (except highlighters). ➢ Exact pixels of filled oval are measured and recorded against the background, similar to copying machines.
Smudges, damages, and other paper-related errors are minimized.	▪ Sensitive to paper distortion during scanning. ▪ Wrinkled or folded ballots may cause scanning problems. ▪ Smudges and damages due to erasing, staining or handling can be a problem. ▪ It is not possible to fax ballots.	➢ The markers will adjust for moisture induced paper shrinkage, wrinkles and folds. ➢ Even ballots that have been faxed can be deciphered automatically. ➢ Over-votes and under-votes are automatically pulled out for manual re-examination with ballot images.

2. ACCURACY IN REFLECTING VOTERS' INTENT

OPTICAL VOTE-TRAKKER™ was tested under the new guidelines of the 2002 Federal Voting System Standard. There was a 0% error rate in reading all test ballots. (The new requirement is less than 1 error per 1.5 million marks). The ability to directly image the ballots as submitted rather than reading them against a fixed template means a much more accurate reflection of voters' intent. The following are some of the critical advantages in terms of accuracy and resolving voters' intent:

- ♥ Each of the ballots are imaged and stored as ballot images. The pixels filled in the ovals are quantitatively measured and recorded for each of the ovals. Besides the default setting of pixel requirements in counting the ballots such as 20% filled ovals, jurisdictions can also request the system to provide evaluation of voters' intent in all of the ballots with 10% and 50% filled ovals to check if there is a difference in the tallies. If the difference is not close to the separation votes of the candidates, there will be no need in manual recounts. In other systems high thresholds close to the full marking of the ovals are required before registering the voters' intent and thus required manual recount in close races.
- ♥ Similar to the VOTE-TRAKKER™, voters are presented with an oval of "SKIP CHOICE (S)" on the OPTICAL VOTE-TRAKKER™ ballot if they do not wish to participate in a specific contest. When a voter fills in this oval, the system automatically completes the choices with "SKIP CHOICES" up to the full amount of choices that can be made. This helps eliminate at least 50% of the voter intent issues related to the contests not being completed by voters.
- ♥ Transposing of errors from sample ballot by voters that could occur when using a mark-sense system that contains columns of ovals with numbering only. The voters' intent is more accurately reflected with a single pass of marking ovals as the voters go through the ballot rather than a back-and-forth reading and transposing of their choices.
- ♥ Oval filling is evaluated based on pixel filled within the oval along with a full evaluation of the ovals. The system is able to distinguish between hesitation marks and "real" marks more accurately than any other system. If the voters use standard #2 pencils, they can easily erase and remark their choices. The abilities of the pixel measurements help to resolve such differences in markings. The ballot image is presented automatically for manual deciphering if over-voting is detected.
- ♥ Besides the ability to handle possible folding and wrinkling of ballots during the mailing process, smudges made in the oval areas that affect the reading of the ballots will be detected automatically. The smudged ballot image will automatically be presented for manual deciphering and related party inspection.
- ♥ The unique ballot identifier, the page number identifier, the orientation and fiducial markers combined, eliminates the need to manually sort and orient the ballots in the same direction. This could save days to weeks for the jurisdiction and more importantly it eliminates handling errors.

System Comparative Analysis on Accuracy in Reflecting Voters' Intent		
	DISCRETE-SENSOR BASED	**PIXEL-BASED**
Marking of ovals using writing utensils other than pencils is acceptable	▪ Resolution is limited to the number of sensors that can be placed. ▪ Depending on light or IR sensors used, marking media and colors may be critical.	♥ Exact pixels of filled oval are measured and recorded. ♥ Any colors can be used with similar success (except "highlighters"). ♥ Accuracy is unparalleled.
Smudges, damages, and other paper-related errors are minimized.	▪ Sensitive to paper distortion during scanning. ▪ Wrinkled or folded ballots may cause scanning problems. ▪ Smudges and damages due to erasing or stains or handling can be a problem. ▪ Faxed-in ballots cannot be recognized.	♥ There are markers on each page to self-adjust for alignment. ♥ The markers will adjust for moisture induced paper shrinkage, wrinkles and folds. ♥ Even faxed-in ballots can be deciphered automatically. ♥ Over-votes and under-votes are automatically pulled out for manual re-examination with ballot images.
Elimination of manual handling, which minimizes errors.	▪ Pre-sorting, pre-stacking, transposing, and other handling may induce errors.	♥ Pre-sorting, pre-stacking, transposing, and other potential errors made are minimized.
Voters' intent is automatically evaluated with under-voted and over-voted ballots "pulled" automatically for manual canvassing.	▪ POSITIVE/NEGATIVE read based on the threshold setting (e.g. 50% filled oval based on the sensor sensitivity) ▪ Ovals must line up to the sensors, less filled in ovals will be sensed and misreading may occur. ▪ Light sensor sensitivity may change over its lifetime. ▪ Voters' intent must be examined one ballot at a time for every ballot.	♥ The full pixel-filled density is measured and the ballot is imaged as a ballot image. ♥ Voters' intent can be evaluated by varying the level setting of marked ovals for a different marked %. For example, if nominal positive is set at 20%, 10% and 50% filled can be tallied to see if there is adequate variation for manual recounts. This difference is automatically tabulated for evaluation by all interested parties. ♥ Ballot images of over-voted and under-voted ballots are automatically "pulled" for additional manual examination during canvassing.

3. THE MOST SECURE ABSENTEE VOTING SYSTEM:

The use of more advanced technology in ballot deciphering enabled AVANTE to design its OPTICAL VOTE-TRAKKER™ system to have the most secure and tamper-resistant mark-sense absentee and precinct-based paper ballot system. The security features and management share similar security features designed into the now proven DRE VOTE-TRAKKER™. The following are some of the security features that are unique to this OPTICAL VOTE-TRAKKER™ system:

- ♥ Each printed ballot is printed with a machine-readable BALLOT-IDENTIFIER (BID) that includes the ballot style identification, page number and a unique identifier. This randomly generated identifier ensures the authenticity of every ballot printed and received.
- ♥ A unique and randomly generated ballot identifier is more secure than special paper stock. Special paper stock can be simulated.
- ♥ A unique and randomly generated ballot identifier is more secure than a serial number that can easily be forged.
- ♥ The machine readable BID enables ballots to be automated in handling during the mailing out, receiving, verification and deciphering process to track the chain-of-custody for each and all ballots used in the system for additional security.

System Comparative Analysis on Security and Tamper-Resistance

	DISCRETE-SENSOR BASED	PIXEL-BASED
Ballot Security and Integrity	▪ Uses special paper for authentication. ▪ Ballots are serialized and controlled by polling officials.	• Each ballot is encoded with a randomly generated unique tracking number for authenticity. • The authenticity of the ballot is proven with this identifier independent of paper stock.
Manual Handling and Pre-Sorting Errors Eliminated	▪ The ballot style, ballot page, and orientation must be pre-sorted. Only one ballot style can be scanned. ▪ Manual handling adds to potential errors.	○ Each ballot is encoded with a unique barcode identifier for automatic identification. ○ The markers help to eliminate the need for pre-sorting and orientation stacking. ○ Markers also help to accommodate paper shrinkage, minor damages, and other problems that may need transposing of ballots.
Ballot Imaging Capability	▪ YES/NO based on the threshold setting. ▪ No ballot image is captured.	○ Imaging of the complete ballot before deciphering. ○ Oval filling is evaluated based on pixels filled in within the oval. ○ Over-voted and under-voted ballots are automatically tagged and posted for manual examination by all parties to ensure high confidence. ○ Difference of voters' intent induced by the different levels of marked ovals is automatically tabulated for ease of evaluation by all interested parties.

4. LOWEST COST OF OWNERSHIP FOR THE JURISDICTION:

The OPTICAL VOTE-TRAKKER™ shares the same election management system as the DRE touch-screen VOTE-TRAKKER™. Both ballot generation and ballot consolidation are fully integrated. The cost of ownership is by far the lowest in the industry whether they are used independently or together.

- ♥ Ballot generation is done only once for both the DRE and OPTICAL systems.
- ♥ Typically election officials in a jurisdiction take approximately 2-4 hours to learn the user-friendly Windows-based ballot generation program. There is no need to pay the vendor to generate the ballots for each election.
- ♥ Ballots can be printed on standard copying paper (if state law permits) for the lowest cost of a few pennies for each ballot page. Even with special paper the cost of the paper is the only difference in cost.
- ♥ Printing can be done using standard commercial laser printers. Thus, they can be printed on demand. This helps eliminate waste and haste errors and costs.
- ♥ Because of the ability to print ballots on demand, last minute changes on specific ballot styles can be done easily and cost effectively in house or contracted out.
- ♥ The unique ballot identifier, the page number identifier and the orientation markers combined save the cost of manually sorting and stacking the ballots. This saves days and weeks of manual work and, of course, it also eliminates handling errors.
- ♥ If the state laws permit, jurisdictions may accept ballots faxed in from absentee voters. The unique ballot identifier ensures the authenticity of the ballots. The machine will be able to read the ballots automatically without needing transposing by the polling official.
- ♥ The use of commercial-of-the-shelf (COTS) scanners and printers means lower cost of purchasing and operation. Both the purchasing and operational costs will be lowered over time when COTS hardware and software improved.

System Comparative Analysis on Cost-of-Ownership		
	DISCRETE-SENSOR BASED	**PIXEL-BASED**
No special paper or printing is required to create ballots. Cost of printing and mailing are lowered.	▪ Uses special paper for authentication. ▪ Ballots are serialized and controlled by polling officials. ▪ All these factors add to the costs of election.	• Each ballot is encoded with a randomly generated unique tracking number for authenticity. • The authenticity of the ballot is proven with this identifier independent of paper stock.
Errors and re-scanning due to alignment and paper shrinkage or distortion are minimized and so are the costs.	▪ Sensitive to paper distortion during scanning. ▪ Wrinkled or folded ballots may cause scanning problems.	• There are markers on each page to self-adjust for alignment. • The markers will adjust for moisture induced paper shrinkage, wrinkles and folds.

Faxed In ballots can be accepted and read automatically	▪ Sensitive to paper distortion, smudges, and damages. ▪ Faxed-in ballots cannot be recognized.	• The markers will adjust for slight distortions or shrinkage or expansion. • Even faxed-in ballots can be deciphered automatically.
Pre-sorting and orientation stacking manual work is eliminated. All of the manual handling delays the tally results and increases the cost of operation for each election by thousands for each thousand ballots counted.	▪ Most must be pre-sorted. The system can only scan one ballot style at a time. ▪ Most must be pre-oriented so that the system can recognize the marks at the right place. ▪ Most must be pre-sorted for each page. ▪ The system can only scan one page of the same ballot style at a time.	• Each ballot is encoded with a unique barcode identifier for automatic identification and automatic deciphering in accordance to ballot style number and ballot page after authenticating the unique random BID. • Each ballot page is encoded with a barcode page number for automatic identification. • As many pages as needed for each ballot can be read without pre-sorting. • Ballot images are kept for all ballots scanned for any subsequent examination.
Recount is minimized with examination of voters' intent automatically. The minimized needs for manual recounts lower the cost for both the jurisdiction and the contestants.	▪ POSITIVE/NEGATIVE read based on the threshold setting (e.g. 50% filled in oval based on the sensor sensitivity). ▪ Ovals must line up to the sensor and less filled in ovals will be sensed and misreading may occur. ▪ Light sensor sensitivity may change over its lifetime. ▪ Over-votes and under-votes must be carefully sorted out one at a time for recount.	• Voters' intent can be evaluated by varying the level setting of marked ovals for different marked %. For example, if nominal positive is set at 20%, 10% and 50% filled can be tallied to see if there is adequate variation for a manual recount. • Over-votes and under-votes on any ballots are automatically "pulled" for manual examination for voters' intent during canvassing with their ballot images.
Ballot imaging facilitate recount. All interested parties can evaluate any questionable ballot images.	▪ YES/NO based on the threshold setting ▪ No ballot image is captured. Original ballots must be sorted manually for specific examination.	• Imaging of the complete ballot before deciphering. • Oval filling is evaluated based on pixels filled within the oval. • Differences induced by different filled pixels are tabulated for ease of recount.
Lowest cost of ownership will continue to improve over time.	▪ Captive use of specialty paper, scanner and printing can only increase in cost over time.	• All COTS hardware such as scanners and printers decrease in costs and improve in performance over time.

5. THE MOST ADVANCED MARK-SENSE TECHNOLOGY ENABLES THE MOST SECURE, ACCURATE, AND INEXPENSIVE ABSENTEE VOTING SYSTEM:

The use of more advanced technology in ballot deciphering enabled AVANTE to design its OPTICAL VOTE-TRAKKER™ system to have the most advanced mark-sense paper ballot voting system.

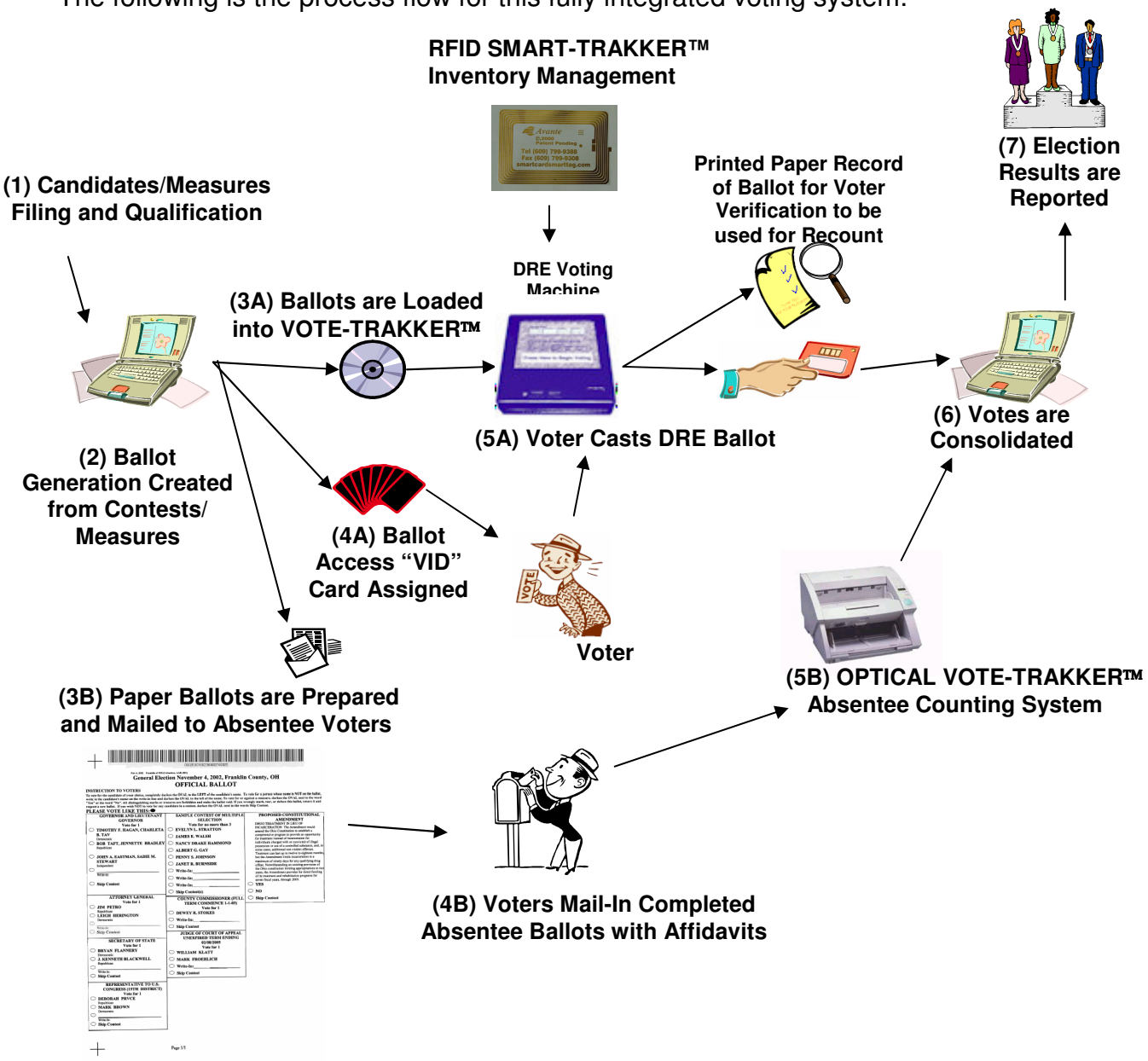
- The randomly generated ballot identifier creates the most secure and tamper-resistant mark-sense absentee and precinct-based paper ballot system.
- The incorporation of automatic recognition of marks for orientation, page number, and paper distortion helps to provide the lowest cost of ownership in terms of operational costs.
- The ability to automatically "pull" out the over-voted and under-voted ballot images for automatic manual examinations enhances voter confidence and lowers the cost of recounts.
- Voters' intents created by different amount of filled ovals are automatically tabulated to enhance confidence in close races. The ballot images help to lower the cost of a recount if required.

"MARK-SENSE" System Comparative Analysis		
	DISCRETE-SENSOR BASED	**PIXEL-BASED**
Technology Mechanism	▪ Lining of visible light sensors along the paper path. ▪ Light sensor may be sensitive to visible light or may include IR spectrum.	• Imaging of the complete ballot before deciphering. • Oval filling is evaluated based on pixels filled in within the oval.
Mark-sense Limitation	▪ Resolution is limited to the number of sensors that can be placed. ▪ Depending on light or IR sensors used, marking media and colors may be critical.	• Exact pixels of filled in ovals are measured and recorded. • Any colors can be used with similar success (except "highlighters").
System Availability	1. Sequoia 2. ES&S 3. Diebold 4. All of these systems are tested based on 1990 FEC standard	• AVANTE • Most of the features described above are patent-pending. • The system had passed 2002 FEC standard testing by ITA.

6. FULLY INTEGRATED MARK-SENSE ABSENTEE VOTING AND DIRECT RECORDING TOUCH-SCREEN VOTING SYSTEMS:

AVANTE designs its OPTICAL VOTE-TRAKKER™ system to complement its pioneering error free voter verifiable paper record DRE voting system. They are fully integrated in terms of ballot generation, tallying, and consolidation for an efficient management of the election process.

The following is the process flow for this fully integrated voting system.

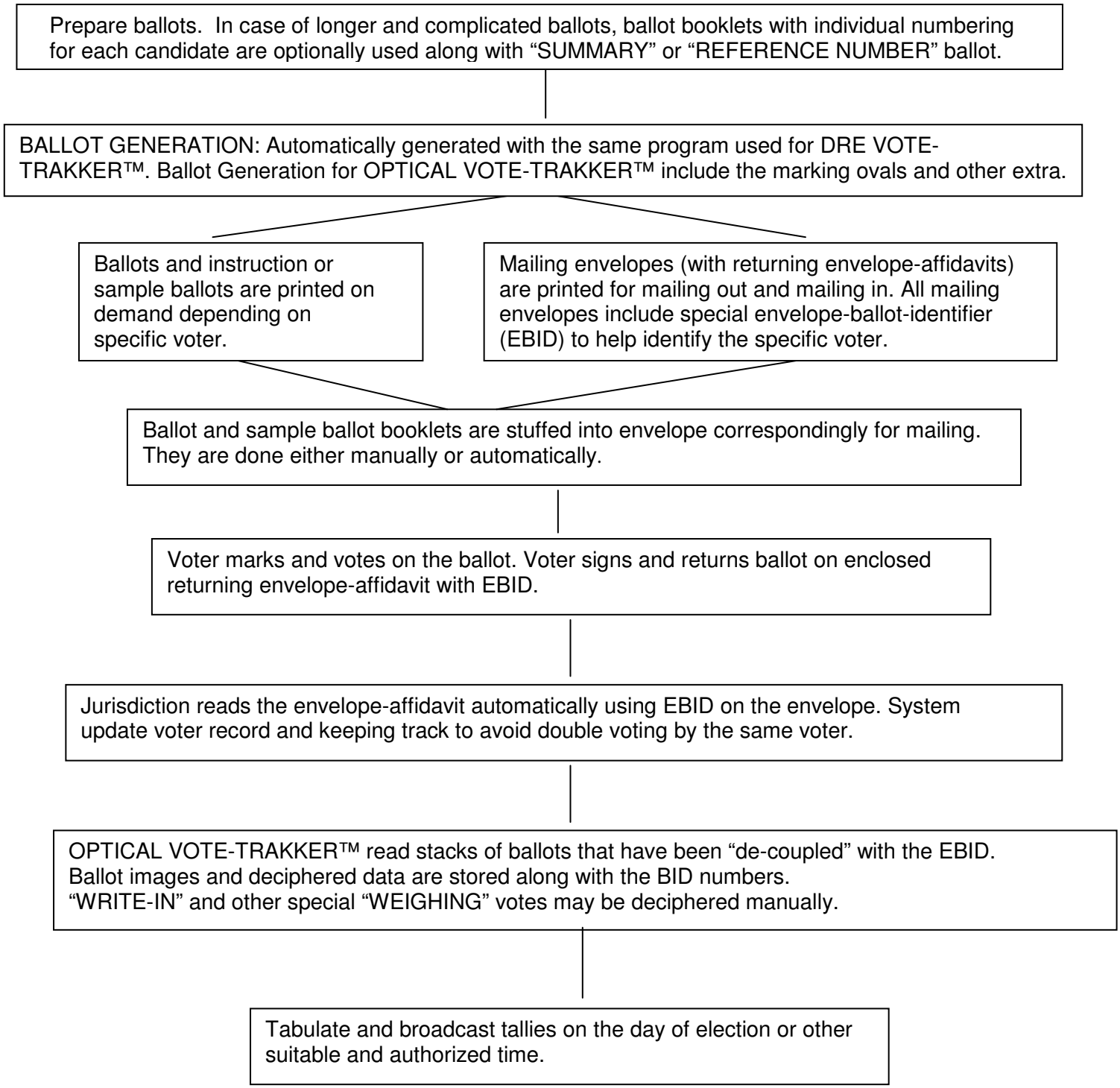


VOTE-TRAKKER™ (EVC 308-SPR & OPTICAL) SYSTEM PROCESS OVERVIEW

(Rev. 5-10-03)

The following is an illustration of the flow-chart of processes in implementing OPTICAL VOTE-TRAKKER™:

OPTICAL VOTE-TRAKKER™ SYSTEM AND PROCESS



The following an illustration of a typical ballot page with unique ballot identifier and fiducial markers that enables the OPTICAL VOTE-TRAKKER™ voting system: