Appendix 4:
Cost comparison of alternative solutions: DRE+VVPB printer versus polling-place-based optical scan + ballot marking device

BACKGROUND:
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1. Unlike a central-count optical scan voting system, a precinct-based (or polling-place-based) system scans the ballots at the polling place, as they are cast. After marking their ballots, voters insert them into the scanner. If they have over-voted, the scanner will reject their ballot and inform them to contact a poll worker in order to exchange their spoiled ballot for a replacement. In such cases, the spoiled ballot is placed in a privacy envelope to ensure ballot privacy, then marked as spoiled and deposited into a secure box for storing spoiled ballots. If voters have under-voted, the scanner will warn them of that condition, and give them the option of retrieving their ballot and marking additional contests. However, if the under-vote is intentional, voters can instruct the scanner to accept the under-voted ballot. Once a ballot has been cast and counted by the scanner, the scanner deposits the ballot into a secure ballot box. An example of such a scanner is described at:
http://www.essvote.com/HTML/docs/Model100.pdf
This example is for illustrative purposes only; the Verified Voting Foundation does not endorse any specific brand or vendor of voting systems nor does it have any financial ties to any such vendors.

2. A ballot marking device provides a touch screen interface that can be used by visually-impaired voters (i.e., to display the ballot in very large fonts) and an audio interface for blind or language-impaired voters. In many ways, it looks like a DRE but it is not one. The big difference is that instead of storing the voter's choices electronically, it fills in the ovals on a standard optical scan ballot. You can think of such a device as a computerized marking pen. Examples of ballot marking devices were provided in Appendix 3.

3. Since Connecticut's State Plan states the SotS's ultimate goal is to "replace all lever voting systems within the state", we assume each polling place would ultimately require a sufficient number of voting stations of whatever type to accommodate the same number of voters per polling place. The State Plan indicates that existing Connecticut law requires one lever voting machine for each 900 (or fraction of 900) electors whose names appear on the last completed registry of the municipality.

Current industry metrics for DREs and optical scan voting systems show them typically accommodating 300 voters or less per voting station. (Santa Clara County, California used a metric of 250 voters per DRE voting machine.) If so, then depending on voter turnout, each lever machine would probably require at a minimum 2 voting stations to replace it and perhaps as many as 3 or 4. The State Plan further states that there are 3,308 lever voting machines and 746 polling places, and that only 3 of Connecticut's 169 municipalities (i.e., 1.8%) currently use optical scan voting systems in their polling places. If we then assume that the 98.2% of municipalities using lever machines have 732 polling places (i.e., 98.2% times 746), then there are approximately 4.5 lever machines per lever machine polling place (i.e., 3,308 divided by 732). However, we will use more optimistic assumptions and assume that each lever machine will require only 1.8 (rather than 3) voting stations to replace it, and thus will compute costs based on an average of 8 non-lever voting stations per polling place.

COST COMPARISON:

In this first model using polling-placed optical scanners and ballot marking devices, only one device of each type is required at each polling place. For most voters, all you need to provide is a fold-up voting booth and some ballot marking pens. Counties which previously employed optical-scan-based voting systems most likely already possess the needed voting booths.

1. Cost estimate to equip a polling place with ballot marking device + polling-place-based optical scanner

The current estimate for the cost of a ballot marking device is $4,500. A similar, estimate for a polling-place-based optical scanner is $5,000, and a similar estimate for a fold-up voting booth is $250. For a polling place with 8 voting stations, the total capital cost would be:

(1) Ballot marking device	$4,500
(1) Polling place optical scanner	$5,000
(8) Fold-up voting booths	$2,000
Total	$11,500

Note that if the jurisdiction already had an optical scan ballot system in place, then they would already have the fold-up voting booths, saving $2,000. If they already have a polling-place-based optical scanner, the capital outlay would be only $4,500 for the ballot marking device.

2. Cost estimate to equip a polling place with DRE voting machines + VVPB printers

The average cost of a typical DRE voting machine is about $3,500 (which includes its own fold-up voting booth) and the cost of a disabled-accessible (i.e., audio-equipped) voter-verified paper ballot printer could add as much as $1,000, for a maximum combined cost of approximately $4,500 per voting station. However, we will assume a lower average cost of $500 per accessible VVPB printer, which brings the average cost per voting station to $4,000. (NOTE: Connecticut's HAVA State Plan estimated $5,000 per DRE voting machine, without a VVPB printer.)

For a polling place with 8 voting stations, the total capital cost would be:

(8) DRE voting machines	$28,000
(8) Disabled-access VVPB printers (with audio feedback)	$ 4,000
Total cost	$32,000

The DRE solution is therefore almost 3 times more expensive than a solution using ballot marking devices and polling-place-based optical scanners, just in terms of initial capital outlay. Even if one uses extremely optimistic assumptions (e.g., that the average DRE cost is only $3,000 and the vendors throw in the VVPB printers for free), then the DRE solution is still more than twice as expensive. When you factor in the increased maintenance costs (because there are physically more units to maintain) and the increased costs for logic and accuracy tests, security audits, the larger number of poll workers needed to operate DRE polling places, etc., the DRE solution will likely prove even more expensive in operating costs.

Even if one makes the probably unrealistic assumption that existing lever machines can be replaced one-for-one by DREs (as was assumed in the State Plan), then one would still need 4.5 DREs on average per polling place. If we are even more optimistic and assume we need only 4 DREs per polling place, the resulting capital outlay still exceeds that of the alternative solution based on optical scan ballots by nearly 40%:

(4) DRE voting machines	$14,000
(4) Disabled-access VVPB printers (with audio feedback)	$ 2,000
Total cost	$16,000

Finally, note that this analysis does not include the cost of printing the optical scan ballots that are used in the "polling-place-based optical scan + ballot marking device solution". However, neither does it include the costs of printing the VVPBs produced in the "DRE+VVPB-printer" solution. To first order, these are considered to be roughly comparable because both consume paper and ink (or toner). In fact, one can argue that the per-ballot printing costs for mass-produced optical scan paper ballots may be lower than the per-VVPB printing costs for individually-printed VVPBs.

Also keep in mind that any jurisdiction that deploys DREs must still continue to print paper ballots (e.g., optical scan ballots) to meet the needs of their absentee voters. So it is false to argue that a jurisdiction will avoid having to print any paper (e.g., optical scan) ballots if they deploy DREs+VVPB printers in their polling places. Regardless of what they do, jurisdictions will need to continue printing mass produced [optical scan] paper ballots for their absentee voters.

While deploying DREs+VVPB printers may reduce the number of such mass-produced paper ballots that need to be printed in advance of the election, its does not eliminate the need to print any. Thus, jurisdictions will still be faced with all of the costs of contracting for the printing of such paper ballots. Certain fixed costs are involved regardless of the number of ballots printed: the labor cost of designing and laying out the ballot, and the one-time printer setup charges.

Thus, while deployment of DREs + VVPB printers may reduce the total cost of printing mass produced [optical scan] paper ballots, the cost per ballot for printing those ballots used by absentee voters will actually go up because of the fixed costs. If the printers who print these ballots give price breaks at various levels for large orders, the loss of such discounts for smaller orders will also add to the cost per ballot for the printing of absentee voter ballots.

For example, if the deployment of DREs + VVPB printers reduces by a factor of 4 the total number of mass-produced paper ballots printed, the corresponding reduction in those ballot printing costs will be significantly less than a factor of 4 because of the fixed costs. Furthermore, any reduction in the number of mass-produced paper ballots that are printed will be offset by the costs incurred in printing a corresponding number of VVPBs.

3. Other advantages of the optical scan/ballot marking approach
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The ballot marking devices do nothing more than assist voters in completing their optical scan paper ballots. (They essentially replace a human assistant, who compromises ballot secrecy, with an automated assistant, which does not compromise that secrecy.) Unlike DRE voting machines, the ballot marking devices do not store any electronic ballots nor count any votes. Accordingly, they avoid most of the authentication, security, and auditability issues associated with DRE voting machines.

A primary advantage is that one eliminates the potential conflicts between electronic ballots and paper ballots that one faces with a DRE voting machine + VVPB printer solution because no votes are stored electronically in the ballot marking device. For each voter, there is one (and only one) ballot of record: the optical scan paper ballot that the voter completes and verifies (either with or without the assistance from the ballot marking device). Since the optical scan paper ballot is its own "voter-verified paper ballot", there is no need for additional printers and the added cost and complexity they impose.

Another significant advantage is that all voters use an identical, paper, optical scan ballot, which means that the ballots for all types of voters (including both absentee and non-absentee voters) can be handled and counted using the same type of equipment.

A. Absentee voters fill out their optical scan ballots by hand. When these are received at the registrar of voters, they can be scanned using the same type of optical scan ballot scanners that are used at the polling places or using a higher capacity scanner.

B. Blind or disabled voters at the polling place can use a ballot marking device to complete their optical scan ballots. Blind voters would use the audio interface on the ballot marking device to complete their ballots, and would use a similar audio interface either on the ballot marking device or on the polling-place-based optical scanner to verify their ballots.

C. Able-bodied voters at the polling place can always fill out their optical scan ballots by hand, or, if they so choose, they can use the ballot marking device, if it is not busy or if they are willing to wait in line for it. However, any blind or disabled voters would always have priority (over able-bodied voters) in using the ballot marking device. NOTE: having at least some able-bodied voters use the ballot marking device is a good thing, because it helps to preserve ballot secrecy, since at many polling places there may be only one (or even zero) blind or disabled voters. Besides, if the device is just sitting there idle, voters may as well use it. Having at least some able-bodied voters using it provides a further check that it is operating as intended.

Additional advantages include:

A. Unlike many DRE voting machines whose "SmartCards" might be compromised to enable multiple votes, a ballot marking device only allows each voter to vote once, because that voter is given only a single optical scan paper ballot when they sign in. All of the security, anti-counterfitting, and audit features of existing optical scan paper ballots (e.g., tear-off ballot stubs with serial numbers [to prevent chain-voting], watermarks, etc.) are retained. Accordingly, at the end of the day, the total number of optical scan paper ballots that have been cast, spoiled, or which remain unused can be tracked and counted and reconciled against the sign-in logs.

B. Since the ballots are scanned at the polling place using the polling-place-based optical scanners, incorrectly-completed ballots (e.g., over-voted ballots, smudged ballots, etc.) should be rejected by the scanner. The voter can then exchange the spoiled ballot for a new blank ballot so that the voter can correct his or her mistake. Also, since the ballots are counted in the polling place, there is less opportunity for ballots or ballot boxes to be lost in transit, as sometimes occurs in central-count tabulation systems.

C. Like DREs and lever machines, polling-place-based optical scan systems produce initial tallies at each polling places immediately at the close of voting. Initial tallies can be printed and posted.

D. Because most incorrectly-completed or unreadable ballots will be rejected by the polling-place-based optical scanner, if a manual recount is called for, most ballots (except possibly absentee ballots) should not present significant problems when trying to infer voter intent, and this should facilitate efficient recounts, either by machine or by hand. While some absentee ballots may be filled out in a noncompliant manner and thus may require careful (and time consuming) adjudication of voter intent, that would also be the case for any solution which employed DREs at the polling places. Either way, the absentee ballots present the same problems.