likely be done even without certifying the scanners. This is essentially what the Humboldt County Elections Transparency Project did in the late 2000's.

3. Once we have enough confidence in the open source scanners, they could be used as the primary scanner for *some* of the vote-by-mail ballots (e.g. in a pilot of the open source scanners that precedes a full-scale rollout). This option could possibly be done prior to certifying the scanners, by taking advantage of California bill SB 360 (2013-2014).

4. Finally, once the open source central scanners are certified, they could be used to scan *all* of the vote-by-mail ballots (while the interim system could be responsible for counting in-precinct ballots). In this scenario, the interim system could perhaps even be used as a fail-safe backup in case of an unexpected issue with the open source system (or else as a check, in the same way that the open source scanners were used as a check in bullet point (2) above).

5.3. Requirements-gathering

This section contains recommendations related to gathering requirements. For committee recommendations of specific requirements, see the Requirements section below.

5.3.1. Key Decisions

The following are some key decisions about requirements that need to be made at some point when designing and developing the voting system. Some pro and con tradeoffs are included.

At this point, the intent here is to just present options with some discussion, not a particular recommendation.

Assumptions:

- Votes are cast (recorded, submitted, and stored) on paper in a human-readable form.
- An electronic representation of ballots made either by voting machines or scanners serves only as a copy of the official paper ballot.
- Ballots marked are on paper that meets the California regulations for printing (counterfeit resistance).
- By 2020, CA [AB973][bill-ab-973-2017] requires support of *Remote Accessible Vote By Mail* ballots (AB2252) for voters with disabilities or overseas and military voters. Home computers are used to print ballots on ordinary paper, but returned via special mail envelopes.
- Voting types to be considered:
    - Vote by mail (preprinted and special accessible/overseas)
    - Vote on election day at a polling location (precinct voting)

- Vote prior to election day at an early vote center
- Vote by people with disabilities requiring special equipment (ballot marking device)

5.3.1.1. Will Vote Centers be used for early or election day voting?

California SB 450 ("Elections: vote by mail voting and mail ballot elections") authorizes counties to conduct elections using vote centers. The Department of Elections should develop a sense as soon as possible of the likelihood of using vote centers because that could affect the requirements and design of the system. Making this decision earlier could decrease costs since the design and development wouldn't have to cover multiple scenarios.

While voters can be assigned to the traditional election-day precinct polling site, with the right equipment, each poll site could have the full features of a vote center, i.e. allow voters from any precinct to vote at that site.

Vote Centers could be used for:

1. Early voting only
2. Election day voting at selected locations
3. All election day polling locations

5.3.1.2. Should precinct polling and vote centers use the same paper ballots as vote by mail?

Background: If a voting machine is used to prepare ballots for printing, the paper ballots marked could use the same printing and layout as a vote-by mail ballot, or could have a simpler and shorter format listing just the contests and selected choices (called *paper cast vote record* in California Election Code). The shorter format could be on smaller paper, possibly only a single sheet, vs a larger multipage scanned mail ballot. Voting machines (ballot marking devices) could be used only by voters with disabilities, while most voters at a precinct or vote center uses a normal mail ballot, or all voters there could use voting machines with printed ballots.

Mail-Only Format Pros:

- Only one style of ballot printing is required
- No need for precinct voters to use voting machines– voters without disabilities can use a "low-tech" solution of only a marker or pen
- Central storage and recounting has all the same ballot size/type
- Better ballot secrecy because all ballots look the same.
- Reduced requirements for printers and possible problems with printer malfunction and paper jams.
- Mail ballot voting could be done with no electric power

Mail-Only Format Cons:

- Printing on large mail ballot paper, usually double sided requires special, possibly nonstandard,

equipment. Sheets might need to be hand-inserted individually.

5.3.1.3. Should hand-marked ballots be preprinted or printed on demand?

Background: If precinct voting is based on the low-tech paper ballot marked with a pen, pads of preprinted paper ballots could be used. However, separate pads are required for each ballot type, party preference and language preference used at that precinct. A vote center might need to store ballots for all ballot types in the county, each in all languages. An alternative is to use blank ballot card stock with a printer to create any desired ballot type and language preference, known as “ballot on demand” (BOD).

Ballot on Demand Pros:

- Reduced printing cost and paper use: no need to stock extra preprinted ballots in case all voters show up.
- Easier to accomodate multiple languages
- Allows any poll site to be a vote-center. Eliminates the problem of people at the wrong poll site casting provisional ballots with an incorrect ballot type.

Ballot on Demand Cons:

- On site printers can fail and probably require AC power.
- Printing on large mail ballot paper, usually double sided requires special, possibly nonstandard, equipment.

5.3.1.4. Should voting at a precinct or vote center be primarily based on paper ballots hand-marked with a pen, or voting machine with a printer?

Background: After voters check in at a precinct, they could be given a paper ballot (similar or the same as a mail ballot) and pen to mark it. Alternatively, they could be given a blank ballot sheet and sent to a voting machine (e.g. computer/tablet) where choices can be entered and reviewed. To access the correct ballot type, the voter may be given a *token* containing the ballot type or else the blank ballot sheet could have a ballot type code preprinted. When the voters completes selections, the paper is inserted into a printer, then the final printed ballot is checked prior to casting into a ballot box.

Machines used by all non-mail voters Pros:

- Paper+Digital CVR has the highest security/integrity. Digital signatures can be printed on ballots to authenticate paper.
- Time to vote can be less than marking.
- Mistakes can be undone without needing another ballot to mark.
- Machines could read a QR code from a vote at home app to print a ballot immediately.
- Precinct vote counts are available at the end of the day without having to scan ballots centrally or at a precinct. (But scanning a ballot ID is required upon depositing the paper ballot to distinguish cast vs abandoned ballots.)
- A separate non-mail ballot format from voting machines would be the same for ordinary voters

and those with special needs.
- Extra machines provide redundancy vs a single disability-access machine.
- Vote centers could handle all ballot types without the need for a ballot on demand system.
- Election-day machines could only allow authorized write-ins to be recorded, simplifying write-in voting and enabling end of day totals that include write-ins.
- A full precinct scanner is not required– just a simple bar code scanner to track paper cast by entering into a ballot box. (The bar code is matched against the electronic CVR.)

Machines used by all non-mail voters Cons:

- Requires more equipment, with increased cost, complexity, and the possibility of something going wrong.
- More possible problems with paper jams and printer malfunction.
- Voters need to be occupying a machine whole voting.
- Mail ballot processing is still a separate sizable operation.

5.3.1.5. If voting machines are used at a precinct, should there be one printer per voting station?

Background: Each electronic voting station could be configured with a printer to make the ballots to be cast. Alternatively, there could be many voting stations (e.g. just a tablet computer), then a separate printing station would be used to print completed ballots. With separate printing stations, a *token* is required to be scanned to identify the ballot completed at a voting station.

Voters using a home computer or phone to record personal ballot choices could bring a QR code printed or saved in a smartphone and go directly to the printing station. A token might be required to verify the ballot type.

Note: a *token* could simply be a bar code with ballot type and unique random number printed on the outside of a privacy folder. The number has no association with a voter– just a way to associate the ballot entered at a voting station with the ballot to be printed. Another form of token in use is an RFID chip.

5.3.1.6. If voters at precincts use mail ballots for marking, should ballots be scanned centrally or at the precinct/vote center?

Precinct ballot scanner Pros:

- Overvotes/Undervotes and invalid or ambiguous marks can be reported by the scanner prior to submitting
- Precinct vote counts are available immediately at the end of the day
- Reduces the need for central scanning equipment

Precinct ballot scanner Cons:

- More equipment is required than central-only scanners

- If the scanner and ballot collection is integrated (the scanner feeds into a ballot collection bin), custom equipment may be required.
- Not required if all ballots are printed by a voting machine

5.3.1.7. If a precinct scanner is used, does the scanner need to be integrated with a ballot collection bin?

Background: Custom-built precinct ballot scanners sold by election vendors usually include a ballot collection bin within same box containing the scanner. The scanner feeds the ballot into the collection box, or else reverses the paper feed in case of an error detected. An integrated device likely means custom hardware vs COTS equipment.

5.3.1.8. If a precinct scanner is used (or central scanner), does it need to include an imprinter to record a ballot/scan ID?

Background: To match a specific paper ballot in a ballot box with a scanned CVR, either the order of insertion must be maintained, or a unique identifier associated with the scan needs to be added to the ballot. Alternatively, ordered ballots could be rescanned centrally during a recount or audit and matched as a batch with the original scan.

Scanner Imprinter Pros:

- This would permit more sophisticated auditing approaches that involve selecting individual ballots at random, which could reduce time and costs (e.g. risk-limiting audits). Without this feature, auditing needs to be done in larger “batches,” or ballots need to be kept in careful order to allow accessing individual ballots.

Scanner Imprinter Cons:

- It is not clear if COTS scanners support the feature of printing while scanning. Available imprinters are expensive and might reduce scan speed.
- The scanner hardware would become more complicated since there would be another “moving part” that can break, and may require consumables, e.g. printer ink or ribbon changes.

5.3.1.9. If a voting machine is used to print ballots, does the ballot collection box need to have an integrated scanner?

Background: Using a voting machine with voter-verified ballot does not constitute casting a ballot– the act of submitting the ballot after verification is the cast ballot. Voters might choose to discard a ballot and revote, so a simple bar-code scanner is useful to match the electronic CVR with paper ballots submitted (i.e. exclude discarded ballots). Discarded ballots could be scanned instead, but a voter could still walk off with a ballot, or a ballot might not print correctly.

5.3.1.10. Is voting equipment required to run off a battery (without outside AC power) for a set outage duration or all day?

No outside power Pros:

- Eliminates extension cords and possible special power requirements.
- Voting can continue in a power outage.
- Some equipment (tablets and laptops) have a built in battery that can work during a power outage.

No outside power Cons:

- Limits the type of equipment used
- Might require special external batteries and power conversion

5.3.1.11. What kind of printing technology should be used at a poll site or vote center?

- Laser Printer (single/double sided)

  Pros:

  - High quality, durable printing
  - Toner lasts for a large number of pages
  - Fast printing

  Cons:

  - Requires AC power (limited life on backup power)
  - Tracking/replacing toner cartridges is required

- Ink Jet

  Pros:

  - Low power
  - Available as portable battery powered COTS

  Cons:

  - Ink cartridges drain quickly and dry out between elections
  - Ink can smear before drying
  - Head cleaning might be required

- Direct Thermal (on special paper)

  Pros:

  - Low power
  - No consumables that need monitoring and reloading

  Cons:

    - Requires special paper
    - Limited life - dissapearing ink
    - Temperature sensitive
    - Lower resolution

- Thermal Transfer (uses a ribbon) Pros:

    - Low power
    - High quality printing

  Cons:

    - Ribbon usage needs to be tracked and replaced
    - Not normally used for letter size printers

5.3.1.12. What size paper should be used for precinct voting and vote by mail?

Background: Vote-by-mail ballots are typically printed on wide paper stock (sometimes 11”x17”) folded to fit within a mailing envelope. Precinct voting with a scanner does not need to be folded, and could be a different size than mailed ballot.

With a larger paper size, more columns could be used, larger fonts, and fewer sheets. With a smaller paper size (8.5”x11” or 8.5”x14”), standard printers and scanners could be used. LA County published a usability study of mail ballot design including 2 paper sizes (8.5x11” and 10.5x17”).

If voting machines are used to print a *paper cast vote record*, then only the selections made are shown, so a single sheet could be used.

5.3.1.13. What options should be provided to people with disabilities?

- Voting machines (BMD) at all precincts
- Voting machines at selected precincts or vote centers with transportation provided
- Vote by mail using home computer and printer

5.3.1.14. Should “remote accessible vote-by-mail” printing used by voters with disabilities to vote by mail using home computers also be used for disability-access precinct voting?

Background: California Election code specifies that remote accessible vote by mail capability should be provided by 2020 for people with disabilities and military and overseas voters. Software to prepare these RAVBM ballots could in principle be used at a precinct poll site or early vote center. Some states have used a similar system (e.g. Prime-III) for disability access voting at precincts.

5.3.1.15. Does ballot collection order or CVR recordings need to be randomized to protect voter privacy (be disassociated by order of appearance at a precinct)?

Background: To protect voter privacy, either the time and order of appearance of a voter must not be recorded, or else the order of scanned or submitted ballots must be randomized. Otherwise voter order and ballot order could be correlated and secrecy compromized. If ballot box order must be randomized, then poll workers might need to shuffle ballots.

Scanned ballots imprinted with an ID could have sequential number assigned, could simplify pulling ballots with a specific ID, e.g. for a ballot requiring adjudication, or in an audit. Otherwise, a randomly assigned unique ID could be imprinted, and stored electronic cast vote records could have order randomized.

5.3.1.16. Should scanned ballot images or compiled CVRs be an open public record, possibly electronically accessible?

In the interest of making the election process transparent, the electronic records of scanned ballots and/or CVRs could be made public (vs sealed paper ballot storage containers). Is open ballot data possible within the legal requirements of privacy and not being able to identify and prove a vote? Would open ballot data be part of end-end verifiability or mutually exclusive to it?

5.3.1.17. End-to-end verifiability

It should be determined how much additional work would need to be done to make the voting process end-to-end verifiable, and whether and which designs are more compatible (e.g. among approaches listed above, hand-marked vs machine-printed ballots). Also, is this something that could be incorporated later on in the process, or does it need to be incorporated from the beginning?

Is it possible to have end-end verifiability without also being able to prove how one voted?

5.4. Requirements

This section lists some of the requirements the system should satisfy.

5.4.1. Accessibility

- In addition to an audio component and touchscreen, the voting system should support accessible features including, but not limited to: sip and puff input, a keyboard for write-in votes, voice activation, synchronized audio and video, joystick input, Tecla switch, and tactile buttons. These two letters from Mr. Fred Nisen (Supervising Attorney for Voting Rights, Disability Rights California) provide more detail.

5.4.2. Other

- [TODO: should we recommend (1) supporting manually marked ballots in the polling place, or (2) requiring the use of a computer ballot-marking and/or ballot-printing device?]
- [TODO: should we recommend (1) pre-printed ballots at polling places, or (2) printing ballots on-