Requirement Suggestions for Barcodes

This document includes suggested requirements that are not in the current draft requirements for VVSG 2.0. The below requirements include…

- suggested modifications to current requirements
- suggested requirements to cover specific barcode use cases
- suggested requirements to cover the exclusion of barcodes

Modified Requirements from the VVSG 2.0

9.1.5-C Paper record intelligibility

The recorded ballots selection must be presented in a human-readable format understandable by the voter.

 Applies to: Paper-based system architectures

**Discussion**
The requirement ensures that a human-readable version of the data is printed whenever a barcode is used to encoded ballot selections.

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<th>Status</th>
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<tr>
<td>Updated</td>
<td>March 11, 2019</td>
</tr>
<tr>
<td>Source</td>
<td></td>
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<td>Notes</td>
<td>It is imperative to pair this with 9.1.5-D and 9.1.5.x to ensure the intention of both requirements is met for QR and barcodes. For reference 9.1-F.x is Encoded data and matching text must be printed on the same physical construct.</td>
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9.1.5-D – Matching selections

All representations of a voter’s ballot selections produced by the voting system must agree with the selections made by the voter.

 Applies to: Paper-based system architectures

**Discussion**
Related to QR or barcodes that contain ballot data. Imperative when paired with 9.1-F.2 for codes, this ensures that the code is exactly the same as the human-readable text version such that a review of either the human-readable text or the code would result in the same ballot data.

Exception: Error correction/detection information is used to protect digital data from error or tampering. This information would not be meaningful to a human, so there is no reason to demand that it also appear in the human-readable part of the record. Examples of error correction/detection
Information include checksums, error correcting codes, digital signatures, and message authentication codes.

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<td>Feb 2019</td>
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VVSG 1.1:

Notes:
Proposed Requirements for the VVSG 2.0

x.x-x – Encoding Documentation

Voting system documentation must include the standard or specification used to encode information on the ballot together with documentation about precisely what is being encoded.

Discussion
This documentation can point to a specific standard used to encode information (e.g., QR Code Standard) or provide details of the schema used to encode information if it is not a standard format.

x.x.-A – Encoding Interoperability

Voting system documentation must include publicly documented specification for any encoding that describes the protocol or data format.

Discussion
This documentation can be a reference implementation that provides enough detail to allow a reviewer to decode the information using their own tools or scanners. Additionally, this information should provide enough information to allow a reviewer to generate the same barcode/encoding using their own selections.

x.x.-A.1 – Reference for encoding

Voting system documentation must include or point to:

- a reference implementation in open-source (or at least disclosed) software for encoding and decoding information and
- how to export relevant code books specific to any given election.
- a reference implementation that enables the generation of a facsimile of the encoded information

Discussion
This documentation can be a reference implementation that provides enough detail to allow a reviewer to decode the information using their own tools or scanners. Additionally, this information should provide enough information to allow a reviewer to generate the same barcode/encoding using their own selections.
x.x.-A.2 – Reference for ballot reproduction

Voting system documentation must include or point to:

- a reference implementation in open-source (or at least disclosed) software for encoding and decoding information and
- how to export relevant code books specific to any given election.
- a reference implementation that enables the generation of bit map replica of a cast ballot

Discussion
This documentation can be a reference implementation that provides enough detail to allow a reviewer to decode the information using their own tools or scanners. Additionally, this information should provide enough information to allow a reviewer to generate the same barcode/encoding using their own selections.

x.x-x – Encoding Transparency

The voting system must provide the human readable format of:

- voter selections recorded on the ballot
- Information necessary to present the correct ballot (e.g., ballot style)

Applies to: Voting system

Discussion
An example is if a voting system prints a barcode, it must also print the human readable format of the information that is encoded in the barcode. It is understood that the literal translation of the barcode into human readable text may not be understandable by the voter and an additional explanation of what the translation means may need to be provided.

x.x-x – Off premises generated QR and barcodes.

QR and barcodes that are generated off premises and which contain ballot selections must allow the voter to verify and change ballot selection prior to casting. The voter must have the ability to confirm and correct or change ballot selection generated off premises prior to casting their ballot.

Applies to:

Discussion
Some voting avenues such as ISB allow a user to generate a code at home and bring it on-site to be read by a device in the voting system. This would be an easy avenue for an attacker to construct their own code and introduce it to the voting system. Additionally, voters may not be able to verify the contents of the barcode at home, and therefore must be given an opportunity to verify, change, and correct their ballot selection prior to casting their ballot.

The one exception to this case would be vote by mail systems with remote ballot marking. In this case, the voter must delegate this verification and correction to an election official. See x.x-x.1 below.

<table>
<thead>
<tr>
<th>x.x-x – Ballot Selections Generated Off Premises</th>
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<td>When reading in off premises generated ballot selections the voting system must require a voter to individually confirm each selection and offer the voter an opportunity to make a change before moving to the next selection.</td>
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Applies to:

Discussion
Some voting avenues such as ISB allow a user to generate a code at home and bring it on-site to be read by a device in the voting system. This would be an easy avenue for an attacker to construct their own code and introduce it to the voting system. Additionally, voters may not be able to verify the contents of the barcode at home, and therefore must be given an opportunity to verify, change, and correct their ballot selection prior to casting their ballot.

The is requirement gives the voter a chance to change each individual selection and allows for an additional opportunity for voter verification of their ballot selections.

Protects against coercion
The one exception to this case would be vote by mail systems with remote ballot marking. In this case, the voter must delegate this verification and correction to an election official. See x.x-x.1 below.

Status: New
Updated: May 7, 2019
Source:
Notes: Concerns about usability issues and causing long lines.
**9.1-5.x - Encoded data and matching text must be printed on the same physical construct.**

A barcode must be printed on the same piece of paper as the human-readable text version, and should be difficult to separate the human-readable and barcode versions.

 Applies to: Paper-based system architectures

**Discussion**

This prevents error or mismatching of the human-readable text with the respective barcode encoded data when used to represent ballot choices.

In addition to being printed on the same paper, the portions of the ballot or audit trail containing the human-readable text and barcode representation must be difficult to separate. For example, this prevents perforations between barcode representing the ballot selection and the human-readable version.

Include benefits for auditability purposes for multipage ballot

| Status: | New |
| Updated: | March 11, 2019 |
| Source: |
| Notes: | This requirement can be relaxed to allow separation of barcode and text, if there is a unique ballot ID that can be used to match the two. However, separating the two and then trying to rematch the pieces by ID could be a difficult process. |

**x.x-x — All data decoded from QR and barcodes should be validated as it passes in and between the voting system devices.**

Data carried by QR and barcodes should go through an input validation process, cleaning the data to eliminate erroneous or tampered inputs.

**Discussion**

This prevents an adversary from leveraging machine-readable codes to instigate common input error attacks such as buffer overflows, as well as inputting administrative commands to control the device.

| Status: | New |
| Updated: | March 11, 2019 |
| Source: |
| Notes: | |
x.x.x – Encoding Restrictions

Voting systems must only scan/read-in and print human readable/alphanumeric text, symbols (e.g., @,-,*,&), pictographic symbols, or handwritten marks.

Discussion
This requirement does not allow the use of barcodes/QR codes and only allows the use of alphanumeric text.

Status: New
Updated: May 7, 2019
Source: Notes:

x.x.x – Encoding Restrictions

Voting systems must only scan/read-in or print human readable/alphanumeric text and symbols (e.g., @,-,*,&), pictographic symbols, or handwritten marks, with the following exceptions:

- Timing marks/registration marks/
- Mark sense

Discussion
This requirement does not allow the use of barcodes/QR codes and only allows the use of alphanumeric text.

Status: New
Updated: May 7, 2019
Source: Notes:

x.x.x.1 – Remote voting with barcodes

Vote by mail systems using QR and barcodes that are generated off premises and which contain ballot selections must contain human readable ballot selection and allow an election official to verify and correct errors when the barcode and human readable content differs.

Applies to: Paper-based system architectures

Discussion
The since the voter cannot confirm and correct selection generated off premises prior to casting or recreation of their ballot, an election official must be able to perform these functions prior on behalf of the voter. Voters may not be able to verify the contents of the barcode at home, and cannot verify the contents prior to entry into the vote capture and tabulation systems, therefore an election official must have the ability to verify and correct errors in the barcode prior to casting their ballot.
Since the human readable version can be verified by the voter, the ballot selections encode in the barcode incorrectly should be changed to match the human readable version.

Status: New
Updated: March 9, 2019
Source:
Notes: