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

<table>
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<th>Discussion</th>
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<tr>
<td>The requirement ensures that a human-readable version of the data is printed whenever a barcode is used to encoded ballot selections.</td>
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<tr>
<td>Updated:</td>
<td>March 11, 2019</td>
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<tr>
<td>Source:</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

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<tr>
<td>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.</td>
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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>VVSG 1.1:</td>
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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.

This requirement is

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, which can be read using the reference implementation

**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 – Barcode Accuracy Implementation**

Voting system documentation must include or point to:

- disclosed source code (not necessarily open-source, though that would be best) to produce the human-readable rendering of the ballot that corresponds to the barcode.

**Discussion**

Access to this source code provides third parties the opportunity to implement and vet the software.

**x.x.-A.2 – Barcode Accuracy Implementation**

Voting system must include a tool that allows the following:

- recreation of a ballot from a barcode
- disclosed source code (not necessarily open-source, though that would be best) to produce the human-readable rendering of the ballot that corresponds to the barcode.

**Discussion**

Access to this source code provides third parties the opportunity to implement and vet the software.

**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.

Status: New
Updated: March 9, 2019
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x.x-x – Ballot Selections Generated Off Premises

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.

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.
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

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.
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.

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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.

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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.

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Updated: March 9, 2019
Source:
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