Use case name: Common Data Format Scope for Interoperability

Use case number: UC-IEEE-P1622-3

Version: 2011-07-11-Draft

Goal: Facilitate data interchanges between state and local systems for voter registration, election data, ballot printing, vote capture, results reporting and auditing.

Summary: Interoperability has different meanings for different stakeholders. It is important to establish a comprehensive overview of interoperability that provides a framework for developing a common data format. From that framework, certain implementation levels can be defined into which elements of interoperability can be grouped. The first level would include registered voter data, geo-political data, election definition data, blank ballot images, and election results data. The second level would include ballot definition data (contests/candidates, but without specific ballot layout information), ballot cast records, and audit event logs. The third level would be the machine ballot definition data (with specific ballot layout information) and the fourth level would be the machine configuration data.

Actors: Voter Registration Systems (VRS), Election Management Systems (EMS), Blank Ballot Distribution Systems (BBDS), Electronic Poll Books (EPB), Vote Capture Devices (VCD), State Election Systems (SES), Electronic Poll Books (EPB), and Audit Management Systems (AMS).

Stakeholders: State and local election officials, voting system providers, voter registration system providers, audit coordinators, blank ballot distribution system providers, Federal Voting Assistance Program (FVAP), domestic and overseas voters, and the general public.

Preconditions/Assumptions: None.

Background: The P1622 project began almost a decade ago when the original intent of interoperability was to produce a common data format for accommodating the export and import of election night results from EMS to SES, geo-political data from VRS to EMS, and contest/candidate data from some VRS to EMS. Blank ballot images have always been available from EMS as a means for jurisdictions to have blank ballots printed for paper based optical scan voting. The project hoped to eliminate the need for each state to develop their own flavor of imports/exports and the time it would take to develop those protocols and have them certified. Interoperability was seen as data interchange outside of each system architecture. Since then, the concept of interoperability has grown to encompass data within EMS, VRS, VCD and all other Actors with the intent that databases can also be compatible between devices within system architectures.

Terminology:

- Registered Voter Data: the information that defines persons who can participate in an election, their party affiliations, and their location with respect to districts (federal, state and local).
- Geo-political Data: the information that defines districts (federal, state, and local) and vote centers from base precincts, which are defined by street mapping data.
- Election Definition Data: the information that defines contests, candidates, endorsements, and other election event related information.
- Blank Ballot Images: the information that represents the image of an unvoted ballot in a format compatible for processing through a specific VCD when printed on a paper stock specified for that VCD.
- Election Results Data: the information that represents the outcome of an election based on the aggregate of data from a system's VCDs.
- Ballot Definition Data: the information that defines the contests, candidates, endorsements, precinct, and other election event related information contained on each ballot style. This information does not include the XY coordinates for defining the ballot layout.
- Ballot Cast Records: the information that represents the selections captured from a voted ballot that was cast through a VCD.
- Audit Event Logs: the information that represents the activity, events and errors that occurred to a system or one of its components.
- Machine Ballot Definition Data: the information that defines the layout of a ballot's contest, candidates, control marks and other ballot presentation criteria required for a specific VCD.
- Machine Configuration Data: the information that defines the configuration of a VCD or other device for ballot capture, user interfaces, accept/reject criteria, security keys, record storage, report printing, communications, displays, instrumentation, and other system elements specific to that device.

High-level election data requirements: Interoperability has different meanings for different stakeholders. It is important to establish a comprehensive overview of interoperability that provides a framework for developing a common data format. From that framework, certain implementation levels can be defined into which elements of interoperability can be grouped. The first level would include registered voter data, geo-political data, election definition data, blank ballot images, and election results data. The second level would include ballot definition data (contests/candidates, but without specific ballot layout information), ballot cast records, and audit event logs. The third level would be the machine ballot definition data (with specific ballot layout information) and the fourth level would be the machine configuration data.

Level 1 Interoperability: Historically, data flows have been external to each system. EMS and VRS systems use import and export functions to transfer data between each other and to the State level systems (SES), VRS and EPB use similar function between each other, and EMS exports blank ballot images for BBDS. However, currently, each system has its own format that requires translation into each of the other systems' formats. As these systems already have the capacity to interoperate through those import/export functions, it is feasible for existing systems to be modified to transfer data in a format that complies with this level of interoperability.

Figure 1 illustrates the Level 1 high level data interchange that would be necessary between the EMS and VRS systems with the SES, and between an EMS and BBDS systems, and between VRS and EPB. Regardless of the structure of a State's VRS (top-down or bottom-up), registered voter data will be transferred between the two levels to maintain each system's database. VRS not only contains registered voter data and geo-political data, but it is sometimes used to create election definition data that subsequently needs to be imported into EMS systems. A State may push language for state-wide contests to local jurisdictions and those jurisdictions will use whatever system they deem best for entering that initial data (either EMS or VRS). Once entered into a system, if there is a need to transfer that information into another system, then the data will be exported from one and imported into the other system. In addition to election definition and geo-political data, the number of registered voters per precinct can also be transferred from a VRS into an EMS for the purposes of estimating quantities by ballot style for paper ballot production and, from an EMS to a VRS, for reporting voter turnout percentages in the election results data.

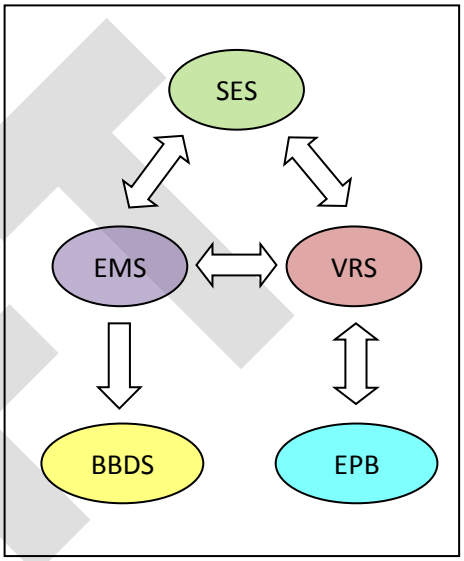

Figure 1. Level 1 Interoperability

EMS systems can already provide blank ballot images for paper ballot production by print shops. Those same blank ballot images can be provided to a BBDS to facilitate electronic distribution to overseas voters. The blank ballot images can be printed remotely, marked by the voter and physically returned to the voter's local election office. The ability for the ballot to be scanned by the voting system is dependent on whether the printer is capable of producing a ballot that meets the voting system's ballot specifications. Some of the critical characteristics are: line thicknesses, image registration/skew, image scaling, paper size/thickness/color, and toner/ink density. Alternately, the ballot style image could be made electronically markable through third party measures. If the ballot is not scannable by the voting system, then the voter's selections would have to be transferred onto a scannable ballot (then scanned, tabulated and uploaded), or manually entered into the EMS.

After polls have closed, election results data from each precinct is reported into the central offices of the local jurisdictions, and the EMS is required to export the election results data for uploading to the SES. This activity is commonly known as the "State Roll-up". The SES accumulates the totals from all jurisdictions within a state to publicly provide the results on state-wide contests.

Level 2 Interoperability: On a lower level, an EMS can provide data to other systems. Figure 2 illustrates the high level data interchange between BBDS and AMS systems with an EMS.

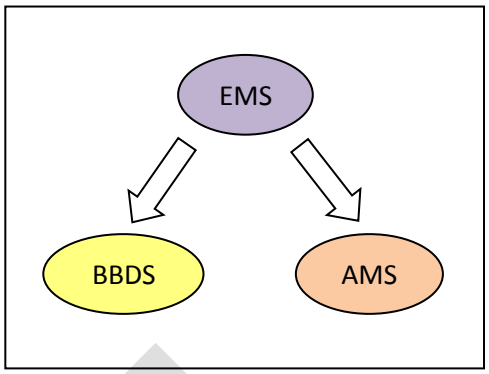

Figure 2. Level 2 Interoperability

For BBDS, an EMS can export data which includes the following information:

- election header,
- contest list,
- contest selections,
- contest 'vote for' quantity, and
- ballot/precinct IDs.

This ballot information would not provide the contest order, rotation, layout or formatting information. Those items are part of the Level 3 Interoperability. At Level 2, if these Level 3 items were legally required by a voter's jurisdiction, they would have to be manually loaded into the BBDS for ballot printing or ballot presentation to the voter.

With the information in the above list, ballots can be laid out on a display screen, marked electronically, and printed or printed on paper and marked manually. In either case, for the cast ballot selections to be entered into the EMS election results, they would have to be manually transferred to an actual scannable ballot (then scanned, tabulated and uploaded), or the selections could be manually entered into the EMS.

For AMS, an EMS can provide election results data, ballot cast records and audit event logs to facilitate the auditing, analysis and possible forensic investigation of an election. The information would be available through data exports provided in the EMS.

Note: Current EMS already provide this audit information through either data exports and/or reports (electronic or printed), but the formats vary from system to system.

In addition to a common data format for audit logs, it would also be beneficial to have a common lexicon for audit log entries through which an analysis of an audit log can be done more efficiently and effectively. However, the creation of that lexicon may be beyone the scope of this use case.

Level 3 Interoperability: On an underlying level within the EMS, the machine ballot definition data could be provided to BBDS systems. This information can be broken out into three segments.

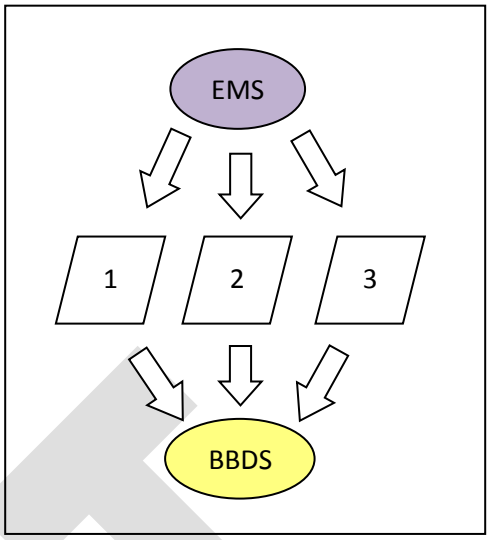

Figure 3. Level 3 Interoperability

1) The first segment would be the information required for generating an electronic ballot and would also be a portion of the data required for printing a physical paper ballot. The information would include:
    - election header,
    - contest list/order,
    - contest selections/rotations,
    - contest 'vote for' quantity,
    - endorsements/cross-endorsements,
    - straight party/recall contest associations, and
    - ballot/precinct IDs.

    With this information, ballots can be laid out on a display screen and marked electronically or printed and marked manually. In either case, for the cast ballot selections to be entered into the EMS election results, they would have to be manually transferred to an actual scannable ballot (then scanned, tabulated and uploaded), or the selections could be manually entered into the EMS.

2) The second segment would be the information required for printing a scannable ballot. This information would include the first segment and also the:
    - voting target shape/size/color/position,
    - timing/control/special marks and their shape/size/color/position, and
    - ballot/precinct ID coding and their shape/size/color/position.

    As iterated previously, the ability for the ballot to be scanned by the voting system is dependent on whether the printer is capable of producing a ballot that meets the voting system's ballot specifications. Some of those critical characteristics are: line thicknesses (resolution), image registration/skew, image scaling, paper size/thickness/color, and toner/ink density.

3) The third segment is information that characterizes the appearance of the ballot. This information would include items such as:
    - font types/sizes/color,
    - background color/watermarks/color striping, and
    - instructional text.

    Some jurisdictions have state statutes and/or regulations that mandate some if not all of these characteristics. For those jurisdictions, the ballots presented to their voters (and returned to them for counting) would have to include this information, whether it be presented on paper and manually marked or presented on a display and electronically marked.

Level 4 Interoperability: At the base level within the EMS, the machine configuration data that is downloaded to the VCDs could be provided to VCDs from other voting systems. This information would provide all the detail required for the machine's operation, including:

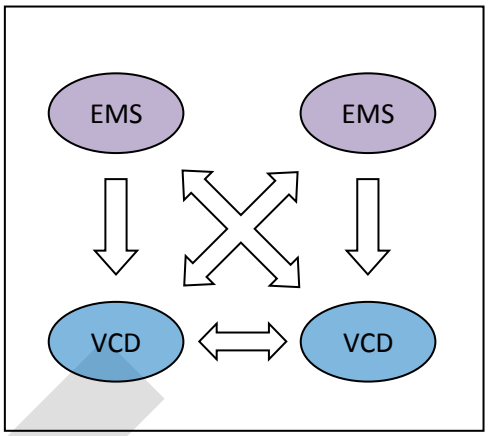

Figure 4. Level 4 Interoperability

- Memory media ID
- Election header information (title, date, version, poll center ID, copy number)
- Security and verification data (signatures, check counter values, serial numbers)
- Election Data (counter groups, voter groups, base precincts, district categories, languages, contests, candidates, rotations, relationships, endorsements, 'vote for' number, ballot style IDs, voting box type/size/position/justification, sequencing index, report format)
- Rejection criteria for overvotes, undervotes, blank voted contests, and blank voted ballots
- Ballot sorting options
- Cast vote records (data and/or images), tally results
- Modem upload phone number
- Audit logs

For DRE display interface devices, the information would also include:

- Header/footer sizes, number of columns, scaling factors
- Button type/size/position/justification
- Flags for voting, rendering, text wrapping
- Background colors for page/labels/contests/candidates
- Instructional text, write-ins, audio, and default volumes

Although the downloaded memory devices would be interchangeable between VCDs, only those memory devices created by one EMS for an election would be allowed to upload to that EMS.

Notes: The interoperability between Vote Capture Devices will likely be a concept for future voting systems as it is unlikely that any current or near term voting systems will be able to conform to that level of a common data format given the constraints of their existing designs.

Author and date: Draft version 0.5, created July 11, 2011 by Ian S. Piper

Appendix A

Interoperability Diagram

– Overview All Levels