WOTE 2006 Contribution

Standards for e-Voting:

The Work of the OASIS Election & Voter Services Technical Committee

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Introduction

One aspect that has been cited as an enabling feature of trusted electronic voting systems is the use of open public standards in the operation and process models that can be used across voting systems implementations. The vision is to create a transparent and certifiable solution between implementation components that can be independently verified and audited regardless of who the developer is.

Whilst known technology mechanisms and processes clearly add to the confidence surrounding the operation of an e-Voting system there are clearly many more aspects that when put together can represent a trusted and rigorously verifiable system.

The Council of Europe (CoE) Ministers commissioned a two year study of adopted legal, operational and technical best practices that essentially encompass a voter bill of rights for e-enabled elections.

The OASIS Election Markup Language technical work (EML) pre-dates the Council of Ministers work, originating from the USA and UK, and has subsequently been developed to both encompass and respect the CoE's findings on voter rights and also to provide open public transparent voting methods through the use of XML-based markup techniques. EML v4.0 has been adopted as a formal OASIS member standard in February 2006 and had previously been endorsed by the COE for use in elections.

This paper focuses on reviewing the aspects of the OASIS EML standard and shows how it can provide the facilitation for trusted electronic voting systems. Included in this is an assessment of the minimum functional mechanisms that ensure audit trail and crosschecking that allow verification of voting to be implemented. This baseline benchmark therefore can be used to compare to existing implementations to identify shortfalls and gaps that can expose critical operational factors that can compromise the results in an e-Voting system. Interestingly a combined paper and e-Voting system may also offer more security than paper or pure digital voting systems alone. A key factor in this is enabling voter verified ballots that consist of a dual-step process that allows the voter to independently confirm that their vote is being recorded accurately.

The OASIS Election & Voter Services Technical Committee

The OASIS Technical Committee was formed in March 2001 and since August 2001 has been chaired by a representative of the UK Government. The Committee Membership includes Governments, Corporations, Election Services providers, and Academia from North America and Europe.

The Charter of the Committee is:

> "to develop a standard for the structured interchange of data among hardware, software, and service providers who engage in any aspect of providing election or voter services to public or private organizations."

The Committee has recognised the need for information to be exchanged at several points in the election process because several parties and system suppliers could be involved. There is a need to service dissimilar systems and equipment, and voting has to be an open, transparent process. To this end it has developed the Election Markup Language (EML) which is now a full OASIS Standard.

What is e-Voting?

For the purposes of their work, the Committee has adopted a very wide definition of e-Voting. It is taken to encompass either an election or a referendum that involves the use of electronic means in all or part of the processes. The process begins with voter and candidate registration, through the casting of votes and ending with the counting and declaration of results.

It also includes various scenarios ranging from voting supervised by election officials in a controlled environment to remote voting where the casting of the vote is done by a device, such as a computer input device or voice activated telephone, that are not necessarily in a prescribed and controlled election location.

What is EML?

EML has been developed as a standard for the structured interchange of data among hardware, software, and service providers who engage in any aspect of providing election or voter services to public or private organisations. The objective has been to introduce a uniform and reliable way to allow systems involved in the election process to interoperate. The overall effort attempts to address the challenges of developing a standard that is:

- **Multinational**: Our aim is to have these standards adopted globally.
- **Flexible**: Effective across the different voting regimes (e.g. proportional representation or ‘first past the post’) and voting channels (e.g. Internet, SMS, postal or traditional paper ballot).
- **Multilingual**: Flexible enough to accommodate the various languages and dialects and vocabularies.
- **Multimedia**: able to support disabled and non-visual voting access methods
- **Adaptable**: Resilient enough to support elections in both the private and public sectors.
- **Secure**: Able to secure the relevant data and interfaces from any attempt at corruption, as appropriate to the different requirements of varying election rules.

EML currently includes process specifications, data definitions and XML Schemas for:

Pre-election processes:

- Candidate Nomination, Response to Nomination and Approved Candidate Lists
- Referendum options formulation
- Voter Registration information, including eligible voter lists
- Various communications between voters and election officials, such as polling information, election notices, etc.

Election Processes:

- Ballot information (contests, candidates, etc.)
- Voter Authentication
- Vote Casting and Vote Confirmation

Post Election Processes:

- Election counts and results
- Audit information pertinent to some of the other defined data and interfaces

Terminology

Terms used to describe the voting processes, such as ballot and candidate, carry different meanings in different countries and even within jurisdictions by those speaking the same national language. Within EML the basic concepts are defined as follows:

Ballot - A set of candidates or referendum options for a particular contest, within one or more elections for which votes are cast.

Candidate - An individual or party standing in a contest.

Cast Vote - A ballot containing the preferences of the voter.

Contest - A contest is that part of an election in which an individual can vote.

Election - An election comprises one or more related contests over a defined period of time.

Voter - A person who is eligible to vote.

Development of EML

It has taken over 5 years to develop the current version of EML, Version 4, using the open, public technical committee processes provided by OASIS (http://www.oasis-open.org). It started initially with input from just the UK and USA and the early versions reflected only the voting practices in those two countries. Other countries gradually joined in eg New Zealand and Australia, and their requirements were included.

The next major input came from the 43 member states of the Council of Europe, and the use of EML has been incorporated in its Recommendation Rec(2004)11 of the Committee of Ministers to member states on legal, operational and technical standards for e-voting, which was adopted by the Committee of Ministers on 30 September 2004 at the 898th meeting of the Ministers' Deputies.

Along the way lessons learnt have been fed in from e-voting pilots carried out in a number of countries, e.g. UK.

The Committee is currently working on version 5 which will include further enhancements and meet some new requirements. When this work is completed later this year it is the Committee's intention to submit EML to become an ISO Standard.

EML will continue to evolve and mature as more experience of e-voting techniques is gained and current concerns, e.g. security of remote voting, are addressed.

Benefits of EML

The benefits of adopting EML are expected to be:

For Election Officials:

- More choice of products and suppliers
- Less dependency on a single supplier
- Avoid proprietary lock-in
- Stability or reduction in costs
- Consistency in adoption of business rules

For Suppliers:

- Greater chance of doing business
- Standardised customer requirements
- Reduced development costs
- Accommodate future changes more easily
- Common core but allows local customisation / extension

How to use EML

As an international specification, EML has had to meet a very wide range of voting requirements and is thus generic in nature. Therefore it needs to be tailored for specific scenarios and to meet specific business rules and practices. It is very unlikely that any voting regime would be able to use EML straight out of the box. There will almost certainly be a need to "localise" EML to reflect national, regional or local circumstances. This will entail restricting certain parts, and/or adding local elements, but this is where the extensibility of XML can be used to great effect.

Security

Security is a major concern within e-voting and whilst EML doesn't pretend to solve all the known problems, many of which are fundamental Internet security issues rather than specifically e-voting ones, it has addressed the following aspects and provided solutions for:

- Identity authentication
- Right to vote authentication
- Vote sealing and non-repudiation of vote accuracy
- Vote confidentiality
- Voting Audit

EML in Practice

The following are good Case Studies of where EML is being used in live situations:

UK’s e-Voting Pilots

The UK Government has embarked on an election modernisation programme and as part of this has over the last few years conducted a number of e-voting pilots. These pilots have included the full range of remote e-voting channels in addition to traditional and postal voting methods. In support of these pilots a UK Localisation of EML was produced and has been used in some of the pilots.

UK’s CORE project

Another aspect of the UK’s election modernisation programme has been to e-enable the voter registration procedures. The Coordinated Online Register of Electors (CORE) project has produced a localised version of the EML voter registration XML schemas for use in future voter registration exercises and mandated their use on suppliers.

Belgium Local Elections

A localised version of EML is currently being developed to support the Flemish local elections in the autumn of 2006.

USA election proof of concepts

Several US ballot examples are currently being developed in open source implementations using EML v4.0 XML ballot results tabulation including scanned paper balloting and electronic form voting.

Paper and Electronic Voting Comparisons

While the debate continues as to the various benefits of traditional voting processes compared to newer ones involving electronic voting methods, the following table provides some aspects and analysis between them. Ultimately the optimal solution is one that combines the strengths of both, and we consider such a trusted voting methodology in the next section.

Table 1 - Comparing sole-use solutions of paper and e-voting

Paper Only

Strengths	Weakness
Direct voter ballot verification. Persistent nature of content. Familiar and traditional trust. Strong audit trail. Physical access can be controlled. Anonymous mechanism. Mature open marketplace of vendors. Established operational practices. Resistant to technology. attacks Distributed process No mechanical failures	*Ballot-box security. Clumsier counting. Voter intimidation. Ballot-box stuffing. Voter access. Disenfranchised voters. Large local variances. Speed of results. Slow to setup. Distances of citizens from polling stations.*
Opportunities	**Threats**
Provide foundation for trusted voting processes internationally.	*New technology exposes new weaknesses. Abuse by officials.*

e-Vote Only

Strengths	Weakness
Accuracy of counting. Speed of counting’ Multi-lingual support. Enforced procedures. Disadvantaged access. Encryption safeguards. Centralized distribution of ballot details. Operation can be certified.	*Mechanical failure. Sabotage Voters cannot directly verify actions. Ephemeral nature of content / audit / storage. Trust and “Big Brother”. Electronic break-ins. ‘Castle’ lure for attacker. Remote access.*
Opportunities	**Threats**
Standards create open marketplace. Open elections with citizen involvement. Less voter intimidation.	*Vendors align to political parties. Vote selling. Anonymity compromised. Manipulation by officials.*

Using EML with trusted voting mechanisms

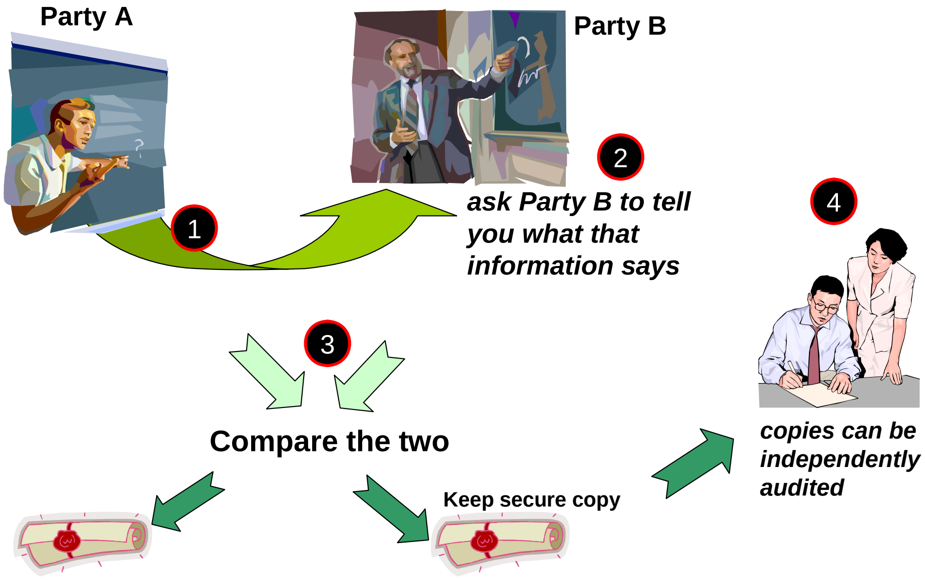
Recently work has been undertaken to examine mechanisms that can provide both voter verified ballots and 100% audit cross tabulation between multiple data sources in a trusted election process. EML can provide a pivotal role by providing an exactly matching vote recording mechanism that can then be crosschecked between the various data sources. Unlike proprietary vendor voting system records the function and purpose of each discreet part of EML voting records is defined and the purpose known. Interoperability testing further validates that functionality existent in the EML XML voting records exactly match the standard requirements and nothing else.

The challenge can be simply put as: how does the voter know and can independently verify that the computer has recorded their vote accurately and actually made it available to be counted?

This trusted voting method can be envisioned in two ways; first from the perspective of voter, and then from the audit recording and EML-based result counting software. In the envisioned trusted voting process two or more independent sources are always created for voting records that can then be crosschecked and verified.

Figure 1 below shows the voter perspective of establishing trust conceptually. The principles used here were first articulated by MIT as a two part trusted method - where one computer device is used to independently verify the operation of the original balloting device.

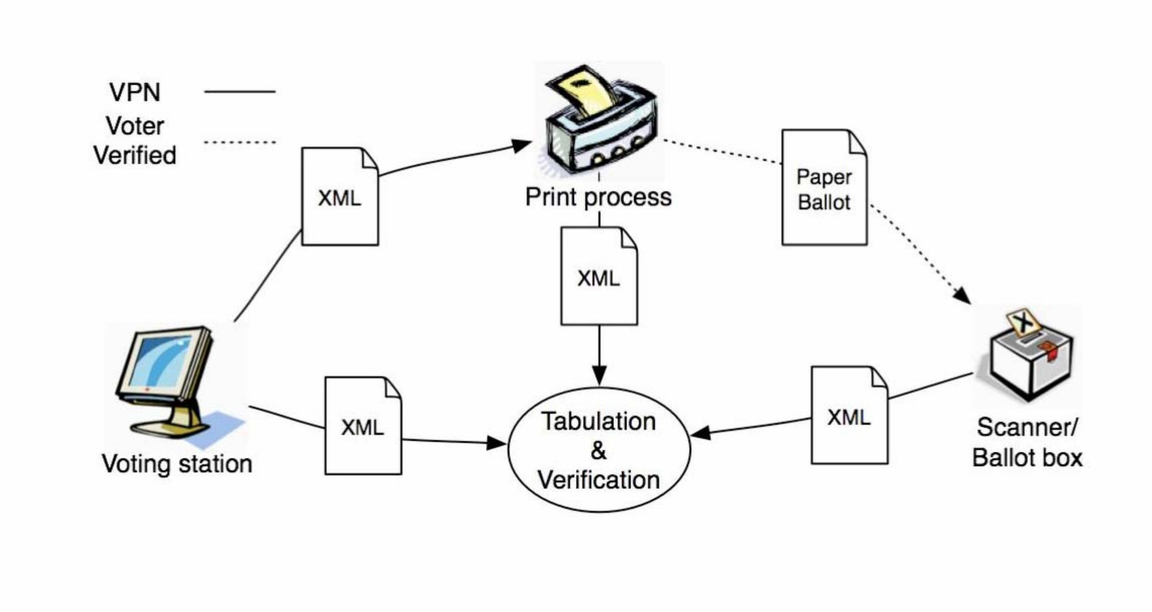
Figure 1 – Conceptual Trusted Logic


Party A
Party B
1
2
ask Party B to tell you what that information says
3
Compare the two
Keep secure copy
4
copies can be independently audited

Then figure 2 shows the process from the computer perspective and the recording of XML records of the events and ballot vote transactions so that independently generated and then secured XML records can be used to crosscheck and audit the whole process automatically. This method and approach is designed to mitigate common attacks and threats to voting systems.

An example would be ensuring 3 separate vote records derived from the use of an e-Voting device storing an EML XML vote record; a printing device that then formats a paper ballot from the EML XML vote record and a voter verified paper ballot is produced (typically including scanned barcodes). In such an approach EML XML records are produced independently by the printing and scanning devices themselves. All such voting records should exactly correlate and of course can be producing during the voting process by different manufacturers' devices, not just a single source solution. Figure 2 illustrates this overall approach.

Figure 2 – Practical Use Model for Voter Verified Paper Ballot example



Referring to figure 2 the VPN (Virtual Private Network) is the use of secure networking between the devices in the polling location that allows each independent device to participate in the voting process. Having the printing and scanning devices physically separated from the voting station and limiting the network services to only allowing the exchange of XML in EML formats removes the opportunity for the voting station to directly manipulate or control the external devices (compared to them being connected to peripheral ports on the voting station itself). The exchange of the XML records also provides the means to monitor and certify what content is actually transferred.

Overall the EML standards provide the tools and the means in XML to facilitate the underlying mechanisms in Figure 2. For example by combining the voter record content XML with the paper ballot layout content XML the print process can create the paper ballot that is then verified by the voter as matching their choices made at the voting station.

Most importantly these methods can be independently tested and demonstrated to be accurate by using a test suite of XML samples. Again also, vendors can independently supply components – such as an EML compatible printer.

Whereas today's voting systems use highly propriety and non-verifiable recording formats clearly higher levels of trust can be derived from using systems that conform to open public standards that allow the operational use of the recording formats used to be independently verified, stored and audited.

Also important is the ability to automate content checks of such vote records when using EML XML. Vote counting operations can be compromised if cast ballot records contain content other than just a simple record of the vote selections made. Clearly additional cues and hints could be concealed in proprietary vendor voting records that could direct counting software. Whereas with the public open standards the content can be prescribed and then software written to independently check that content conforms to those rules.

Also counting software itself can be built that independently computes the results and that too can be then verified using a suite of independently prepared test records.

Summary

The OASIS EML standard consists of tried and proven XML formats for storing both information pertaining to the operation of elections and also the election vote cast details, counts and election results. As such EML provides a comprehensive set of tools for implementing digital electronic voting.

The content of the EML records has also been designed to operate in a wide variety of election methods and ballot systems. This is particularly developed to incorporate the requirements adopted by the Council of Europe Ministers' report on electronically administered elections.

In addition EML can be incorporated into wider methods that seek to provide trusted voting systems. Such systems may combine both paper and e-Voting devices together to provide voter verifiable processes. The EML XML provides an excellent foundation for implementing auditable records from multiple sources within such a trusted operational model. Furthermore because EML provides a "lingua franca" between election systems and devices it can allow implementers to choose from a wider set of providers' equipment to build with.

Currently work is underway to develop EML v5.0 and to submit EML to the ISO adoption process.

Contacts and Additional Information

EML is a product of the OASIS Election & Voter Services Technical Committee. The processes, data and XML schemas defined by the Committee are detailed in a number of documents. These include:

- EML Process and Data Requirements
- EML Data Dictionary
- EML XML Schema Descriptions

These and other documents can be obtained through the OASIS website at www.oasis-open.org.

For more information on how to participate in EML activities, please contact the E&VS Technical Committee through http://www.oasis-open.org/committees/election