OASIS

ELECTION AND VOTER SERVICES TECHNICAL COMMITTEE

ELECTION MARK-UP LANGUAGE (EML): e-VOTING PROCESS AND DATA REQUIREMENTS

Document Control

Abstract

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Table of Contents

1. INTRODUCTION

1.1 Business Drivers

Voting is one of the most critical features in our democratic process. In addition to providing for the orderly transfer of power, it also cements the citizen's trust and confidence in an organization or government when it operates efficiently. In the past, changes in the election process have proceeded deliberately and judiciously, often entailing lengthy debates over even the most minute detail. These changes have been approached with caution because discrepancies with the election system threaten the very principles that make our society democratic.

Times are changing. Society is becoming more and more web oriented and citizens, used to the high degree of flexibility in the services provided by the private sector and in the Internet in particular, are now beginning to set demanding standards for the delivery of services by governments using modern electronic delivery methods.

Internet voting is seen as a logical extensions of Internet applications in commerce and government and in the wake of the United States 2000 general elections is among those solutions being seriously considered to replace older less reliable election systems.

Increasing the range of available voting channels to better reflect the use of new communication technologies may help to address some of the practical barriers to voting. The implementation of Internet voting would allow increased access to the voting process for millions of potential voters. Higher levels of voter participation will lend greater legitimacy to the electoral process and should help to reverse the trend towards voter apathy that is fast becoming a feature of many democracies. However, it has to be recognized that the use of technology will not by itself correct this trend. Greater engagement of voters throughout the whole democratic process is also required.

1.2 Technical Drivers

In the election industry today, there are a number of different services vendors around the world, all integrating different levels of automation, operating on different platforms and employing different architectures. With the global focus on e-voting systems and initiatives, the need for a consistent, auditable, automated election system has never been greater.

The introduction of open standards for election solutions is intended to enable election officials around the world to build upon existing infrastructure investments to evolve their systems as new technologies emerge. This will

simplify the election process in a way that was never possible before. Open election standards will aim to instill confidence in the democratic process among citizens and government leaders alike, particularly within emerging democracies where the responsible implementation of the new technology is critical.

1.3 The E&VS Committee

OASIS, the XML interoperability consortium, formed the Election and Voter Services Technical Committee to standardize election and voter services information using XML. The committee is focused on delivering a **reliable, accurate and trusted** XML specification (Election Markup Language (EML)) for the structured interchange of data among hardware, software and service vendors who provide election systems and services.

EML, the first XML specification of its kind, will provide a uniform, secure and verifiable way to allow e-voting systems to interact as new global election processes evolve and are adopted.

The Committee's mission statement is:

"*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 services performed for such elections include but are not limited to voter role/membership maintenance (new voter registration, membership and dues collection, change of address tracking, etc.), citizen/membership credentialing, redistricting, requests for absentee/expatriate ballots, election calendaring, logistics management (polling place management), election notification, ballot delivery and tabulation, election results reporting and demographics*."

The primary function of an electronic voting system is to capture voter preferences reliably and report them accurately. Capture is a function that occurs between "a voter" (individual person) and "an e-voting system" (machine). It is critical that any election system be able to prove that a voter's choice is captured correctly and anonymously, and that the vote is not subject to tampering.

Dr. Michael Ian Shamos, a PhD Researcher who worked on 50 different voting systems since 1980 and reviewed the election statutes in half the US states, summarized a list of fundamental requirements, or "six commandments," for electronic voting systems:

1- Keep each voter's choice an inviolable secret.
2- Allow each eligible voter to vote only once, and only for those offices for which he/she is authorized to cast a vote.
3- Do not permit tampering with voting system, nor the exchange of gold for votes.
4- Report all votes accurately
5- The voting system shall remain operable throughout each election.

6- Keep an audit trail to detect any breach of [2] and [4] but without violating [1].

In addition to these business and technical requirements, the committee was faced with the additional challenges of specifying a requirement that was:

- Multinational: our aim is to have these standards adopted globally
- Effective across the different voting regimes. e.g. proportional representation or “first past the post”.
- Multilingual – our standards will need to be flexible enough to accommodate the various languages and dialects and vocabularies.
- Adaptable – our aim is to provide a specification that is resilient enough to support elections in both the private and public sectors.
- Secure – The standards must provide security that protects election data and detects any attempt to corrupt it.

The Committee followed these guidelines and operated under the general premise that any data exchange standards must be evaluated with constant reference to the public trust.

1.4 Challenge and Scope

The goal of the committee is to develop an Election Markup Language. This is a set of data and message definitions described as a set of XML schemas and covering a wide range of transactions that occur during an election. To achieve this, the committee decided that it required a common terminology and definition of election processes that could be understood internationally. The committee therefore started by defining the generic election process models described here.

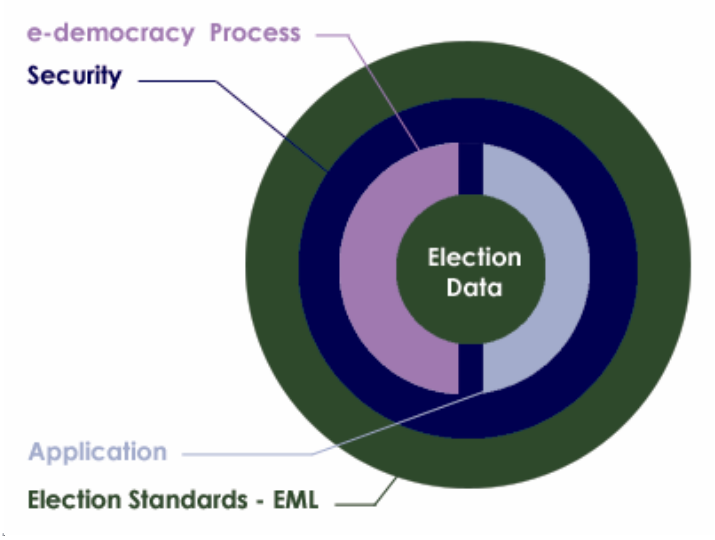
These processes are illustrative, covering the vast majority of election types and forming a basis for defining the Election Markup Language itself. EML has been designed such that elections that do not follow this process model should still be able to use EML as a basis for the exchange of election-related messages.

EML is meant to assist and enable the election process and does not require any changes to traditional methods of conducting elections. The extensibility of EML makes it possible to adjust to various e-democracy processes without affecting the process, as it simply enables the exchange of data between the various election processes in a standardized way.

The solution outlined in this document is non-proprietary and will work as a template for any e-voting system. The objective is to introduce a uniform and reliable way to allow election systems to interact with each other. The proposed standard is intended to reinforce public confidence in the election process and to

facilitate the job of democracy builders by introducing guidelines for the selection or evaluation of future election systems.

Figure 1A: Relationship overview



1.5 Documentation Set

To meet our objectives, the committee has defined a process model that reflects the generic processes for running elections in a number of different international jurisdictions. The processes are illustrative, covering the vast amount of election types and scenarios.

The next step was then to isolate all the individual data items that are required to make each of these processes function. From this point, our approach has been to use EML as a simple and standard way of exchanging this data across different electronic platforms. Elections that do not follow the process model can still use EML as a basis for the exchange of election-related messages at interface points that are more appropriate to their specific election processes.

Finally, the committee will be conducting pilot studies using the prototype EML standard to test it's effectiveness across a number of different international jurisdictions. The committee document set will include:

- **Voting Process and Data Requirements** (This Document): A general and global study of the electoral process. Introduces the transition from a complete human process by defining the data structure to be exchanged and where needed. An EML schema is introduced and clearly marked.

- **EML Specifications:** This consists of a library of XML schemas used in EML. The XML schemas define the formal structures of the election data that needs to be exchanged.
- **Scenarios:** A selected set of scenarios with variations in election type / country. The objective of the scenarios is to show how documents 1 and 2 can be used in practice. Each scenario will be made of two documents specific to the country and type of election under discussion.

1.6 Conformance

To conform to this specification, a system must implement those parts that are relevant to it, at the interfaces for which conformance is claimed.

A procurement speciation for a system that conforms to EML may specify what interfaces are required to conform to EML, in which case the procurement speciation shall specify the version number of the schemas to be used. For example, in the future, the specification for an election list system might specify that a conforming system must implement the following schemas:

Schema	Accept	Generate
EML110	v1.0	
EML310	v2.0, v2.1	
EML320	v1.0, v2.0	v2.0
EML330		v1.1
EML340		v1.0
EML350		v1.0
EML360		v1.3

A conforming system will then conform to the relevant parts of this specification and the accompanying schemas.

1.7 Issues under consideration

The following issues are under consideration by the committee for future versions of this document.

1.7.1 Audit

In the classical meaning, Audit is the process by which a legal body consisting of election officers and candidates representatives can examine the process used by which the vote is collected and counted to prove the authenticity of the result.

The election officer should be able to:

- Account for all the ballots and a count of ballots issues should match the total of ballots cast, spoiled and unused.
- Prove that voted ballots received are secure from any alteration.
- Provide mechanism to allow a recount when result is contested
- Allow for multiple observers to witness all the process.

Systems that conform to EML must provide compatible auditing facilities.

1.7.2 Candidates Nomination Fees

Many elections require a nomination fee from the candidates, this issue is currently not covered by this specification, the technical committee solicits views on the following.

- Should it fall under the TC committee terms of reference?
- If so, do we need to account for the fees into our schemas?
- Does this fall under the scrutiny process that is handled by the election officer to evaluate a nomination application if it meets the rules or not?
- If we include the fees as part of the schema, should be also include other nomination requirements like variation of age, number of signatures collected etc.

1.7.3 Challenged/Provisional Ballot

We need to have more information about the scenarios where a ballot or voter is challenged. In particular, input is solicited on the following:

- The scenario of a voter challenged in public elections.
- The scenario of a ballot challenged in public elections.

Other questions arising are, does an attended ballot as defined in the UK fall in the same category as a voter/ballot challenge or is this different scenario? Is a tendered ballot the same as the attended or challenged ballot or other rules apply?

1.7.4 Boundary change

Many elections are organized within geographical or organizational boundaries, this issue is currently not covered by this specification. The technical committee solicits views on the following:

- How a boundary change or redistricting is handled in details?
- How different it is between various nations?
- Do we need to define schemas? and if yes, what schemas are needed?

1.7.5 Election rules for the generation of the ballot

To create balloting information, input data is needed about the election, the options/candidates available and the eligible voters; EML provides the standard for exchanging such information between e-systems. However, a mapping process is required in the e-voting system to map the various raw input data into output data for one ballot for one voter, this document uses the term election rules to define how this mapping is to be done in a particular election. When a precise election rule is needed is it identified by the election rule ID.

The current document assumes election rules themselves are implementation specific, thus by specifying the election rule ID the e-system can do the necessary mapping between voter, candidate, election and bylaws of the election to produce the ballot.

The technical committee solicits views on the following:

- The need to generalize the election rules processes in more detail
- The need to standardized the data and EML schema for election rules

If a schema for the election rules is required, the technical committee solicits input on, the rules to be used when generating a ballot and how a ballot is to be associated to a voter

1.8 Terminology

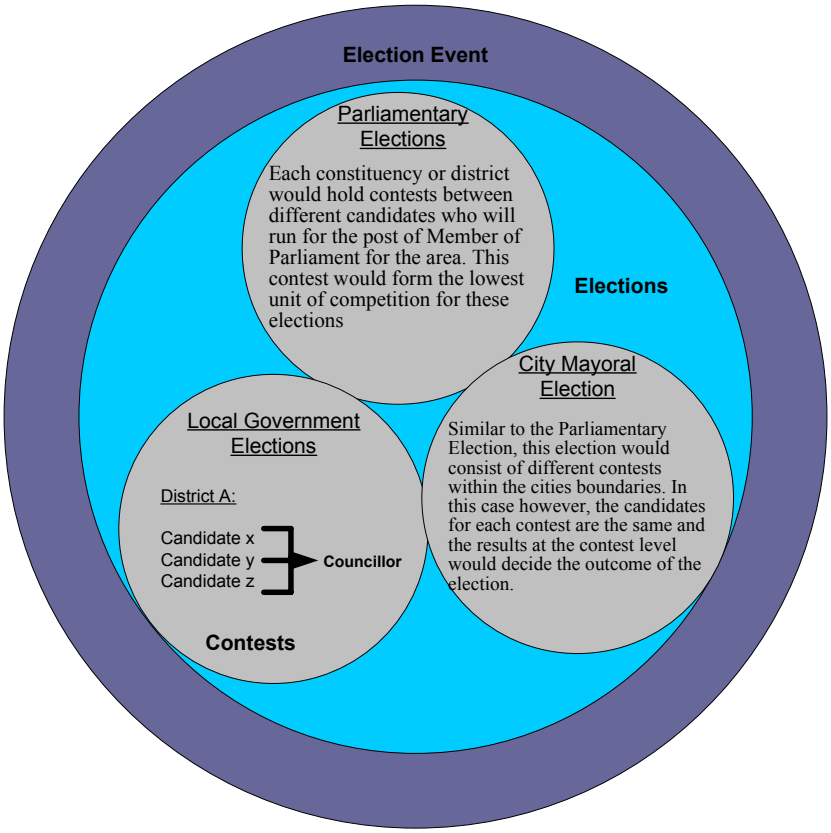
At the outset of our work, it was clear that the committee would need to rationalize the different terms that are commonly used to describe the election process.

Terms used to describe the election process, such as ballot and candidate, carry different meanings in different countries – even those speaking the same language. In order to develop a universal standard, it is essential to create universal definitions for the different elements of the election process. See appendix A for the terms used by the committee in this document.

Our approach was to regard elections as involving **Contests** between **Candidates or Options** which aggregate to give results in different **Elections**.

In practice however, electoral authorities would often run a number of different elections during a defined time period. This phenomenon is captured in our terminology as an **Election Event**. The model below uses a British context to describe our approach in general terms.

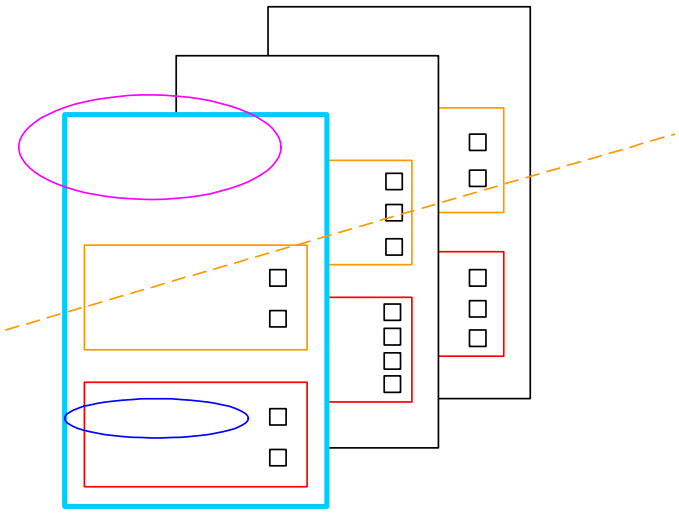
Figure 1B: The Election Hierarchy



In the detailed example below, there is an **election event** called the “Union Annual Election. This comprises two **elections**, one for the National Executive Committee (NEC) and one for the International Liaison Committee (ILC). Three positions are being selected for each committee, as a result, each **election** is made up of three **contests**. In region 1 (R1), the **contest** for each **election** has two **options** (or **candidates**).

Figure 1c below shows the three **ballots** (one for each region). The **ballot** is personal to the voter and presents the **options** available to that voter. It also allows choices to be made. During the election exercise, each voter in region 1 receives only the region 1. This ballot will contain the **candidates** for the (R1) contest for each of the two **elections.**

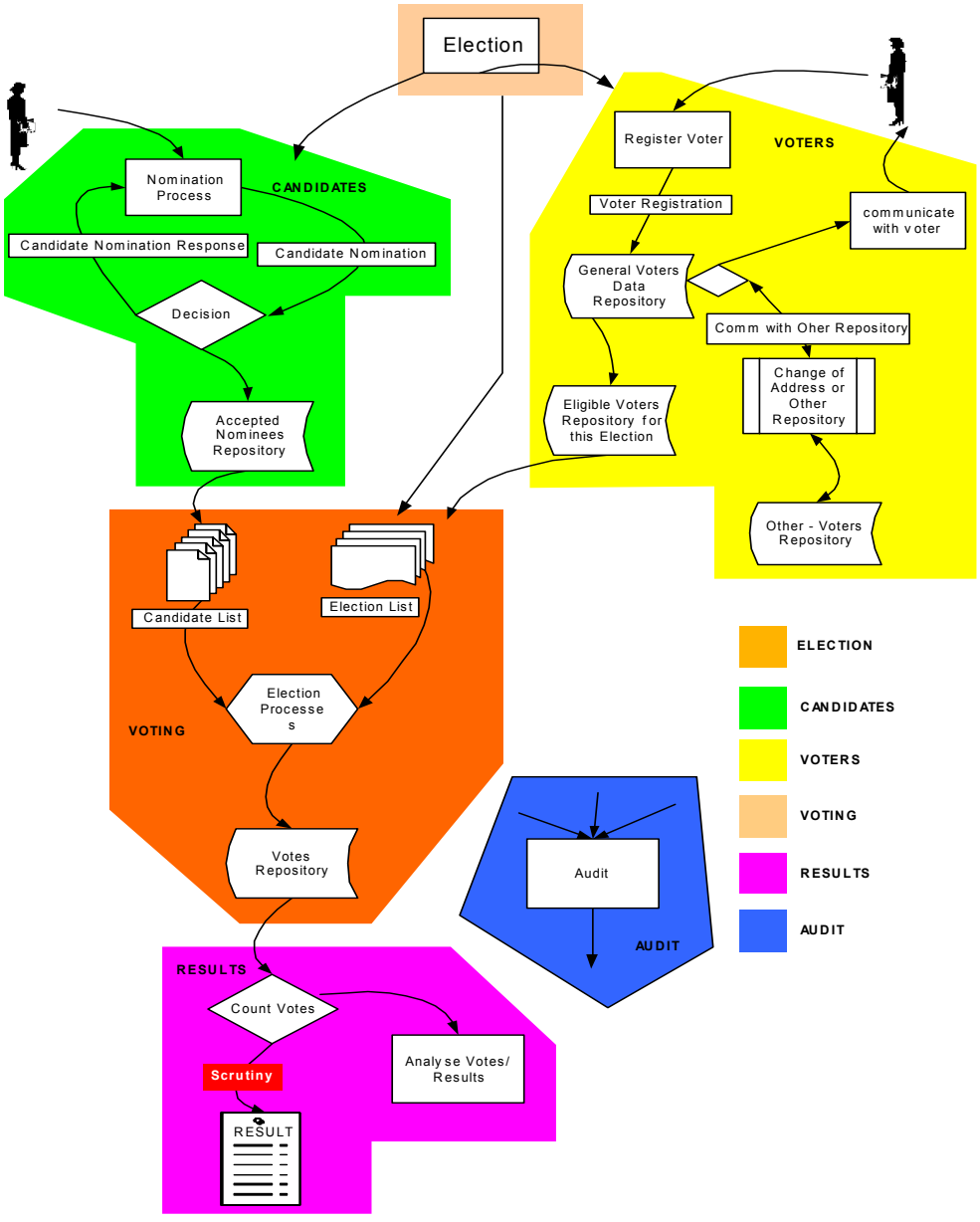
Figure1C: Union annual election



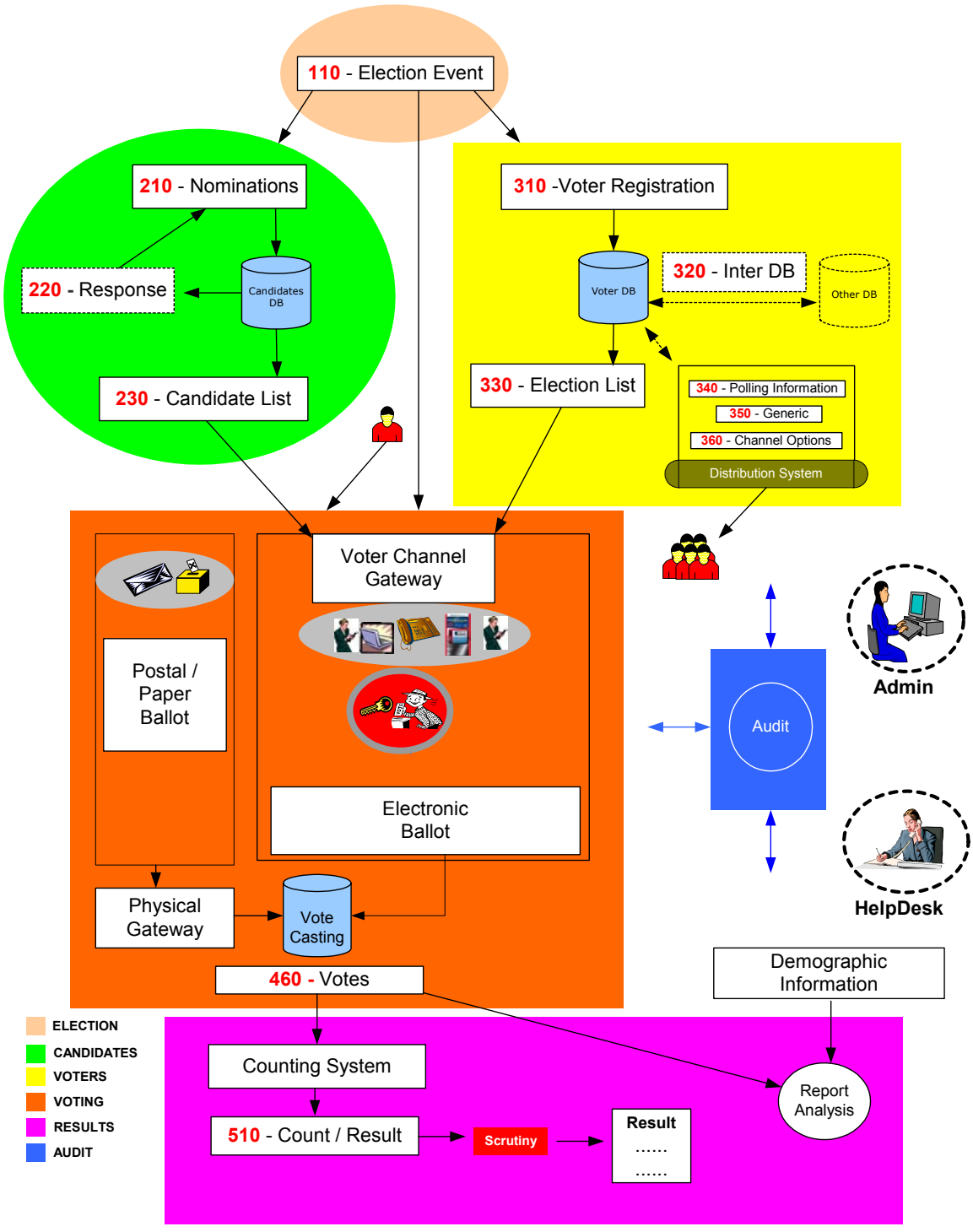
2. HIGH-LEVEL ELECTION PROCESS

Chapter 2 describes two complementary high level process models of an election exercise, based on the human and technical views of the processes involved. It is intended to identify all the generic steps involved in the process and highlight all the areas where data is to be exchanged. (**Figure A.** describes a model of the human process while **Figure B** attempts to replicate this model in electronic version)

2.1 *Figure 2A: High Level Model – The Human View*



2.2 *Figure 2B: High-Level Model – The Technical View*



2.3 Outline

This *high-level process model* is derived from real world election experience and is designed to accommodate all the feedback and input from the members of this committee.

For clarity, the whole process can be divided into 3 major areas, pre election, election, post election; each area involves one or more election processes. This document allocates a range of numbers for each process. One or more XML schema will be specified to support each process, this ensure consistency with all the figures and the schemas required:

- Pre election
  - Election (100)
  - Candidates (200)
  - Voters (300)
- Election
  - Voting (400)
- Post election
  - Results (500)
  - Audit
  - Analysis

Some functions belongs to the whole process and not to a specific part:

- Administration Interface
- Help Desk

- **Pre election**
  - Election (110)
  - Candidates (200)
    - Nomination (210)
    - Response to nomination (220)
    - Candidate List (230)
  - Voters (300)
    - Voter registration (310)
    - Inter database communication (320)
    - Election List (330)
    - Voter Communication
      - Polling Information (340)
      - Generic (350)
      - Voter Notification (360)

- **Election**
  - Voting (400)

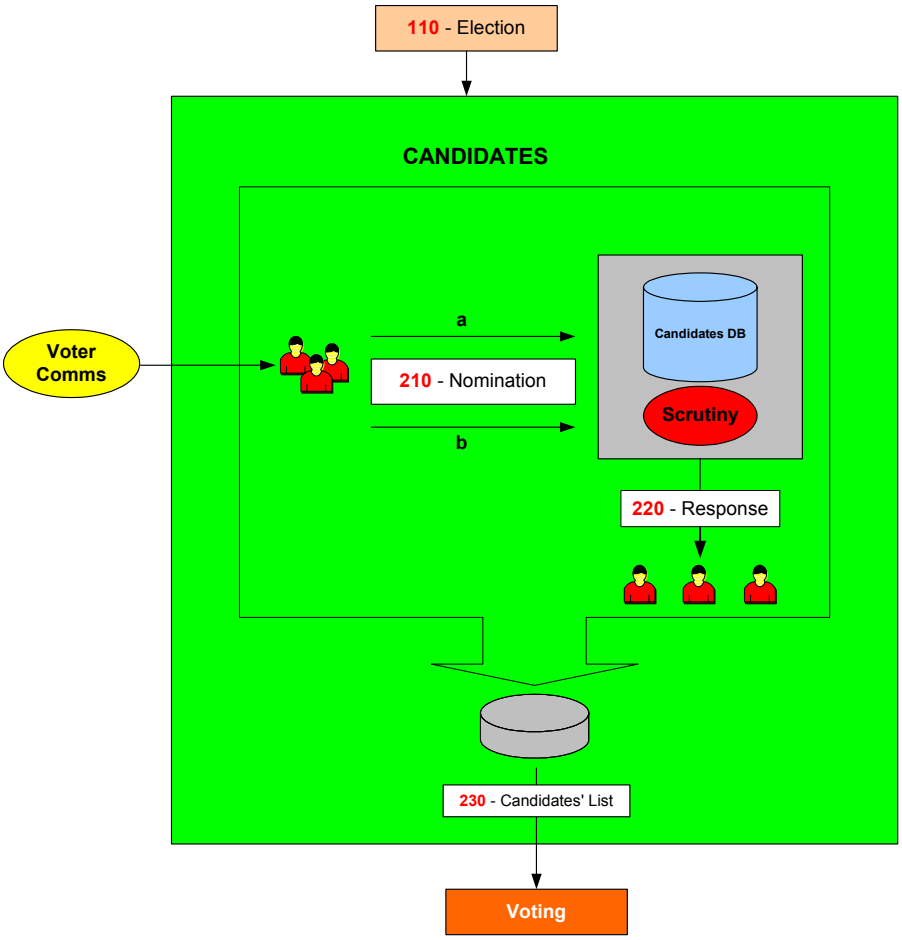
- Ballot (410)
- Authentication (420)
- Authentication Reply (430)
- Vote and Casting (440)
- Vote Confirmation (450)
- Votes (460)

- **Post election**
  - Counting (500)
    - Count Result (510)
  - Audit
  - Analysis

- **Global functions**
  - Administration Interface
  - Help Desk

2.4 Process Descriptions

Figure C: The Candidate Nomination Process



This is the process of approving nominees as eligible candidates for certain positions in an election. Schemas **210, 220** are specifically applicable to candidates' nominations and do not apply for issues like surveys, referendums.

Irrespective of local regulations covering the nomination process, or the form in which a candidate's nomination is to be presented, i.e. (written/verbal), the committee anticipates that the process will conform to the following format:

- Voter Communications [**350-Generic**] declaring the opening of nominations will be used to reach the voters population eligible to vote for a position x in an election y.

- Interested parties will respond in the proper way satisfying the rules of nomination for this election with the objective of becoming running candidates. The response is done using schema **210**.

- A nomination can be achieved in one of two ways:

    - One Nominee will reply by attaching to his nomination a list of x number of endorsers with their signature.

    - Each endorser will send a letter specifying Mr. X as his nominee for the position in question.

The election officer(s) of this specific election will scrutinize those replies by making sure the requirements are fully met. Requirements for nomination vary from one election type to another, for example some elections require the nominee to:

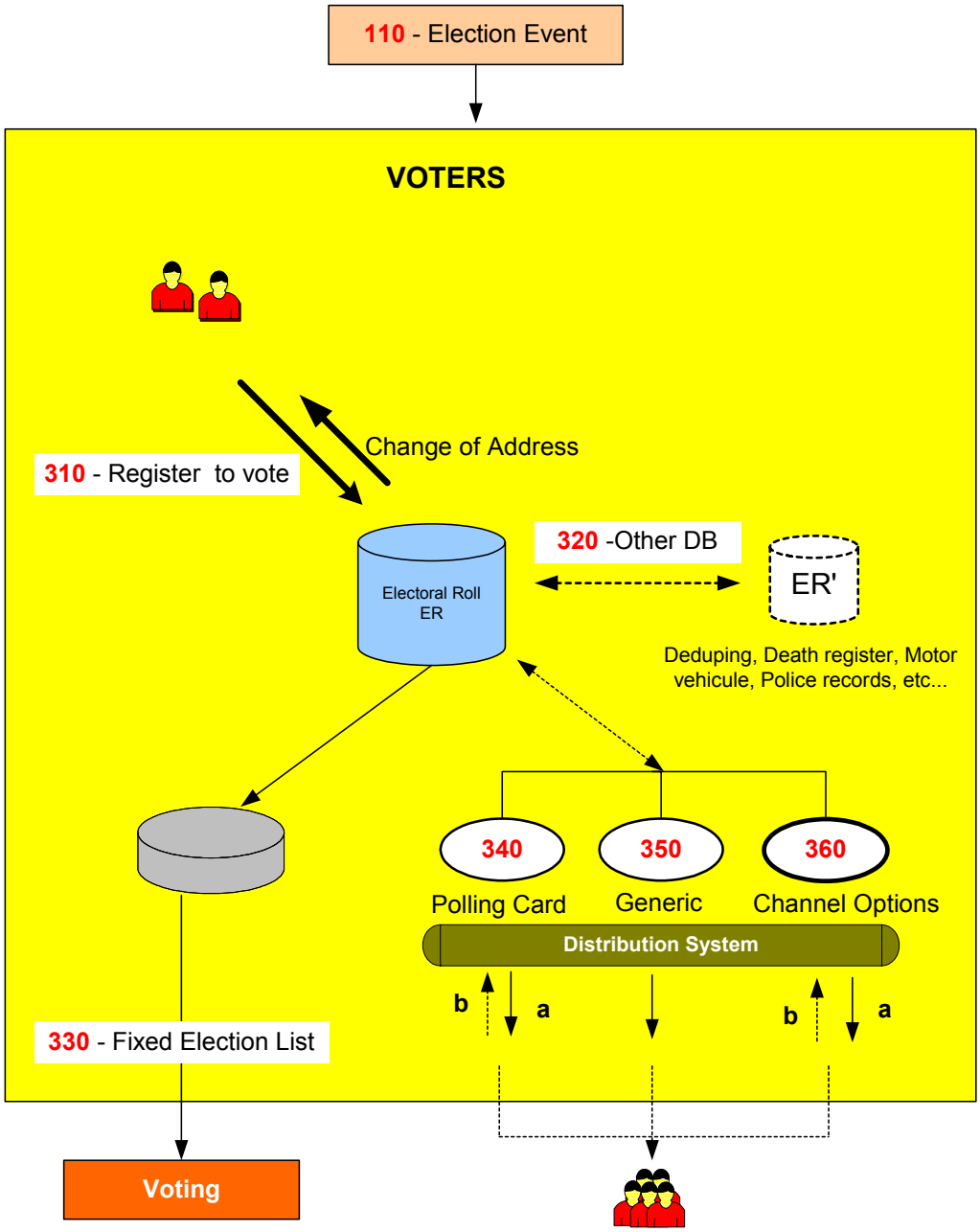
- Pay fees,
- Have x number of endorsers,
- Be of a certain age,
- Be a citizen more than x number of years,
- Etc.

Since the laws of nomination are very wide and cannot be enumerated we currently assume this function falls under the scrutiny of the election authority and outside the mission of this committee. Future versions of this document may look into those requirements and resulting schema.

Selected eligible nominees will be communicated using schema **220**.

The outcome of this process is a list of accepted candidates that will be communicated using schema **230**. It will be used to construct the contests and occurrence on the final ballot(s).

Figure 2D: Voter Registration.



The centre of this process is the Electoral Roll Database or the voters database. The input into this Database is the outcome of communications between "*a voter*" and "*an Election Authority*". The subject of this correspondence can vary from adding a voter to modifying a voter; deletion of a voter is considered as part of modification.

This schema of data exchange is recommended irrelevant of the method a voter uses to supply his information. For example, a voter could register online or simply by completing a voter's form and posting the signed form. In the latter case, this schema is to be followed when converting the paper form into the electoral DB.

Another potential communication or exchange of data is with other databases like another election authority, government body, etc.

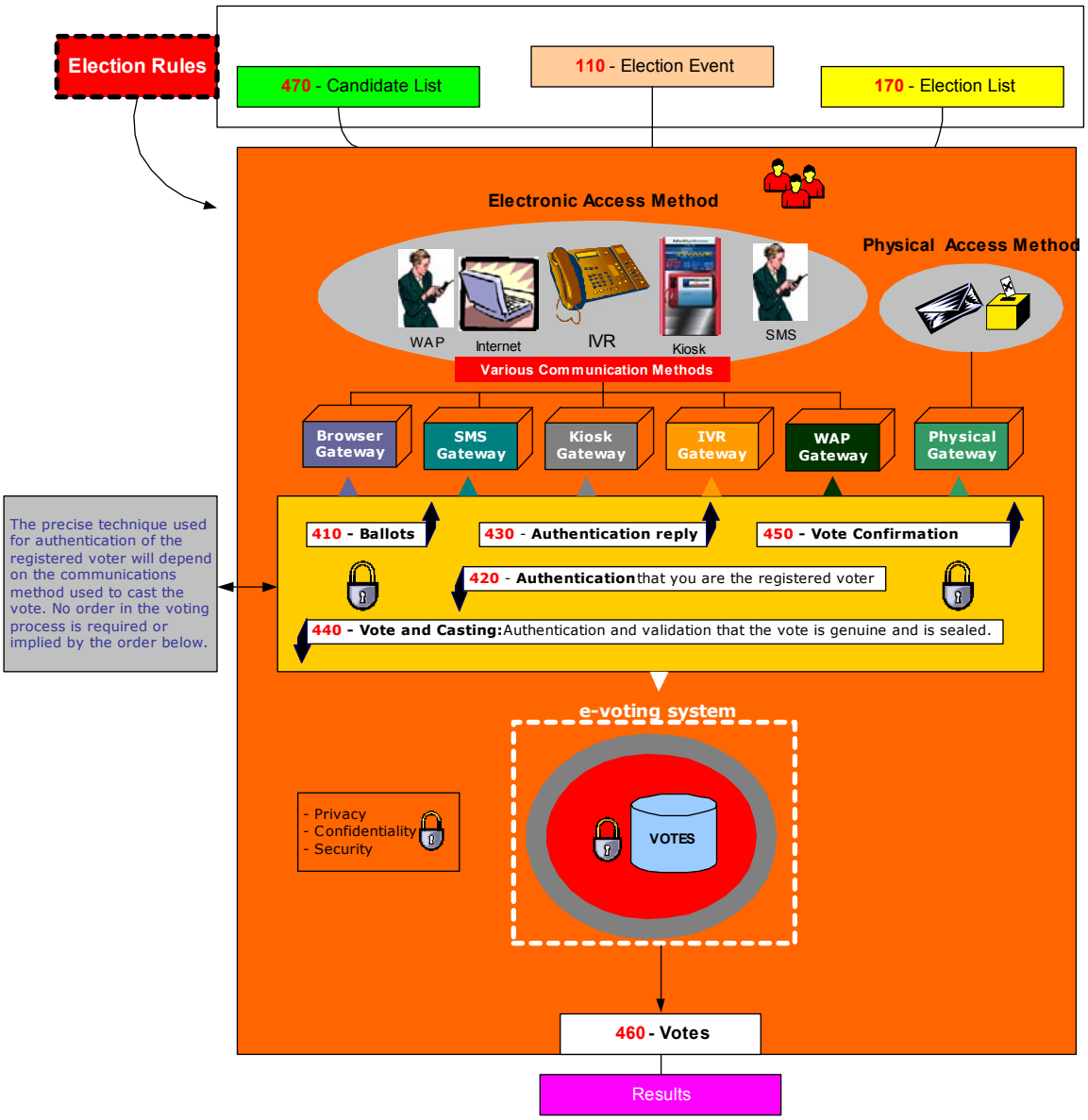
At a certain date, a subset of the voters DB is fixed from which the election list is generated [**Fixed Election List 330**]. The election list will include a list of all eligible voters/contest/elections for an election event.

It is here that we also introduce the concept of voter communications. Under this category we divided them into three possible types of communications:

- Channel options.
- Polling Information.
- Generic.

The communication method between the Election Authority and the voters is outside the scope of this document, so is the application itself. This document does specify the data needed to be exchanged.

Figure 2E: The Voting Process



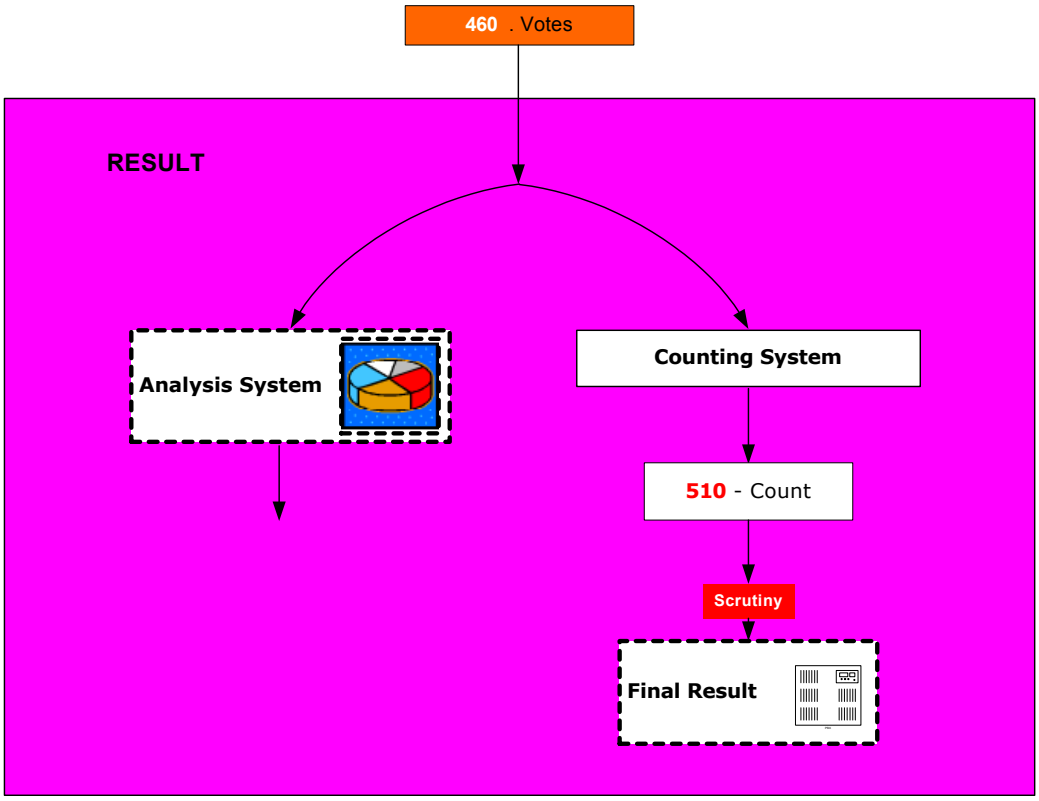
We assumed various systems would be involved in providing the voting process and regard each system as an independent entity.

As this figure shows, the voter will be voting using a choice of physical channels (Postal, Polling place, paper ballot) the “Physical access methods”, or the voter can vote using “Electronic access methods” where he/she will utilize a number of possible e-voting channels.

Each channel may have a gateway acting as the translator between the voter terminal and the voting system. These gateways are in typical proprietary environments where

the following schemas are to be used: 410, 420, 430, 440 and 450. These schemas should function irrespective of the application or the suppliers favored choice of technology.

Figure 2F: Vote Reporting



One of the post election items is the result. Others like Audit will be discussed further in the next version of this document.

The voting system should communicate a bulk of data representing the votes to the counting system or the analysis system-using schema **460**. The result by itself, which is the compilation of the **460,** is to be communicated by the schema **510**.

Recount can be very simply accommodated by a re-run of the schema **460**, on the same or another counting system.

The investigative requirements of a recount are to be covered in a future version of this specification as part of the audit function.

The votes schema **460** also feeds into an analysis system, which is used to provide for demographic or other types of election reports. The output of the analysis system is outside the scope of this document.

Other possible specifications, which could make use of the basic Vote and Count schemas include, specifications dealing with reporting of election results like "*the voter news services"* or "*AP reporting votes schema*".

2.5 Data Requirements

The diagrams and pictures above are meant to give a clear visual presentation of the overall process and detail main sections. Where a schema is identified as necessary, a number of Format (NNN) is marked and below we will detail each schema in terms of data content.

However while doing so we came across exceptions related to cultural divide, language, bylaws, different type of service possible etc. To limit the impact of these differences, the current specification limits itself to identifying a common set of data not related or affected by such differences. Thereby providing the core data that meets most election scenarios and something that meets most election requirements.

The “mandatory” elements below are the minimum set of common data elements that must be present when the schema is used. All other elements are “optional”, which means the optional elements may, or may not, be present in a message using this schema. Any system that claims to support the schema must always generate mandatory elements and most be able to generate optional elements when required. Any system that claims to support the schema must always process all mandatory and optional elements correctly on reception.

Note here that some of the optional data will be partly considered as required in one system and either optional or even not accepted in others. Data Protection legislation and Privacy regulations will play a major role in defining what is to be included and under which section.

Format used to signal both types of data:

MANDATORY TEXT
OPTIONAL TEXT

In the absence of any National requirement specifying alternatives, the names and addresses shall conform to the xNAL. An example of a name and address attributes are below:

Name-Structure

Title
First Name
Last Name
Middle Name
Maiden Name
Suffix

Address-Structure
Address Line 1
Address Line 2
Street Name
City Name
Postcode
Country

Contact-Structure
Email
Home Telephone
Work Telephone
Personal Mobile
Business Mobile
Fax
Preferred Method of Contact

110 – Election Event

Contains the data about an election. This is the starting point of the whole process. It is made of one or more contests over a period of time.

ELECTION EVENT ID
ELECTION EVENT NAME
ELECTION EVENT DESCRIPTION
ALLOWED CHANNELS (POLLING, INTERNET, POSTAL, SMS, TELEPHONE, WAP, KIOSK, DIGITAL TV, OTHERS)
ELECTIONS

ELECTION ID
ELECTION NAME
ELECTION DESCRIPTION
ELECTION STARTING DATE
ELECTION STARTING TIME
ELECTION ENDING DATE
ELECTION ENDING TIME
CONTESTS — **REPEATS**

- **CONTEST ID**
- **CONTEST NAME**
- **CONTEST DESCRIPTION**
- **CONTEST METHOD OF VOTE (FPP, STV)**
- **MAX VOTE**
- **MIN VOTE**

REPEATS

SEAL
LANGUAGE ID (ISO STANDARD, MULTIPLE LANGUAGES ALLOWED)

ANY

210 - Candidate Nomination

Describes the data used by a candidate to send in his nomination.

CANDIDATE NAME
NAME-STRUCTURE
CANDIDATE ADDRESS
ADDRESS-STRUCTURE
CANDIDATE CONTACT INFO
CONTACT-STRUCTURE
ELECTION ID
ELECTION NAME
CONTEST ID
CONTEST NAME
PROPOSERS (1 TO N) n=number of maximum of endorsers required.

PROPOSER NAME
NAME-STRUCTURE
CATEGORY (PRIMARY, SECONDARY, OTHER)
PROPOSER ADDRESS
ADDRESS-STRUCTURE
CONTACT INFO
CONTACT-STRUCTURE
JOB STATUS OR TITLE

AFFILIATION
PERSONAL PROFILE OR BIOGRAPHY
ELECTION STATEMENT
SEAL
LANGUAGE ID
ANY

220 - Response to Nomination

CANDIDATE NAME
NAME-STRUCTURE
CANDIDATE ADDRESS
ADDRESS-STRUCTURE
CONTACT INFO
CONTACT-STRUCTURE
ELECTION NAME
CONTEST NAME
NOMINATION ACCEPTED YES/NO
REMARK
AFFILIATION
SEAL
LANGUAGE ID
ANY

230 – Candidate List

CONTEST ID
CONTEST NAME
CONTEST DESCRIPTION
CANDIDATES

(**CANDIDATE ID**
CANDIDATE NAME
CANDIDATE AFFILIATION) **REPEATS**

SEAL
LANGUAGE ID
ANY

310 - Voter Registration

Used for initial registration or changing of any of the voter data. The rules are applied in order to validate that someone has the right to vote.

VOTER ID

NATIONAL/LOCAL ID
(LIKE SOCIAL SECURITY NUMBER, NATIONAL INSURANCE NUMBER, DRIVER LICENSE NUMBER, ETC...)
NAME
NAME-STRUCTURE
ELECTORAL ADDRESS
ADDRESS-STRUCTURE
ARMED FORCES (Y/N)
PROOF OF ID
MAILING ADDRESS
ADDRESS-STRUCTURE
MAILING CONTACT INFO
CONTACT-STRUCTURE
DATE OF BIRTH
EFFECTIVE DATE ADDED
EFFECTIVE DATE REMOVED
PREFERRED LANGUAGE OF VOTING
AFFILIATION
DATE SUBMITTED
TIME SUBMITTED
PREVIOUS ADDRESS
ADDRESS-STRUCTURE
PLACE OF BIRTH
SEX
ETHNIC GROUP
SPECIAL REQUESTS (VISUALLY IMPAIRED, DISABLED, NEED TRANSLATOR, ETC...)

PREFERRED METHOD OF VOTE (POSTAL, POLLING, ELECTRONIC)
SEAL
LANGUAGE ID
ANY

320 – Inter Db

a) ACTION REQUEST

TRANSACTION ID
SOURCE ID
DESTINATION ID
ACTION
ACTION DATE
ACTION TIME

VOTERS (*310-VOTER REGISTRATION (PER VOTER)*)

SEAL
LANGUAGE ID
ANY

b) REPLY TO ACTION REQUEST

TRANSACTION ID
SOURCE ID
DESTINATION ID
REPLY TO ACTION (Y/N, STRING – "EITHER OR" OR "BOTH")
ACTION DATE
ACTION TIME

VOTERS (*310-VOTER REGISTRATION (PER VOTER)*)

SEAL
LANGUAGE ID
ANY

330 - Election List

It is a set of voters [**310**] associated to an election identifier and to a contest ID.

ELECTION ID
CONTEST ID
OR
ELECTION EVENT

(**310-VOTER REGISTRATION (PER VOTER)**) **REPEATS**

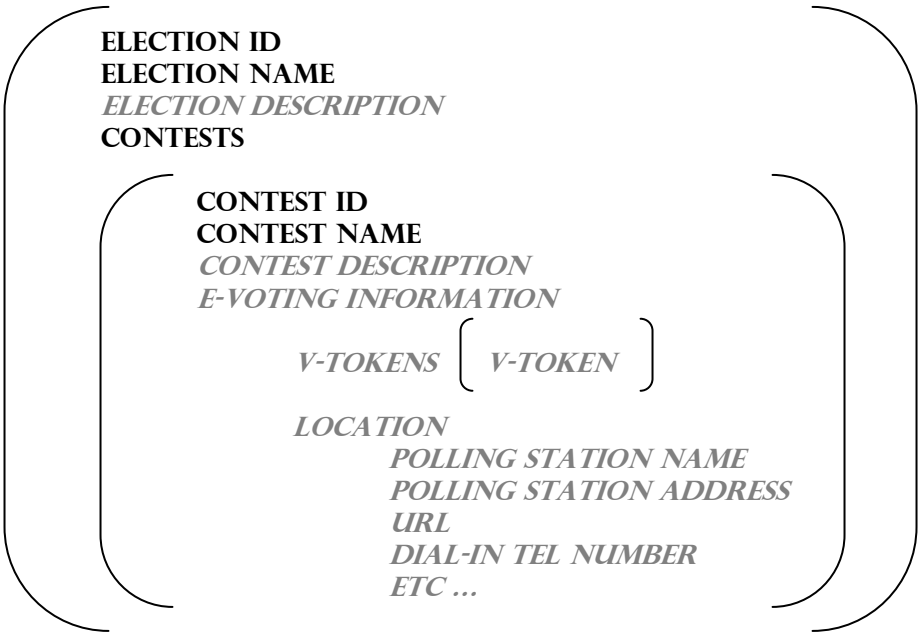
ELECTION RULE ID
SEAL

LANGUAGE ID
ANY

340 – Polling Information

ELECTION EVENT ID
ELECTION EVENT NAME
ELECTION EVENT DESCRIPTION
VOTE STARTING DATE
VOTE STARTING TIME
VOTE ENDING DATE
VOTE ENDING TIME

VOTER NUMBER
NAME
    NAME-STRUCTURE
MAILING ADDRESS
    ADDRESS-STRUCTURE
CONTACT INFORMATION
    CONTACT-STRUCTURE
ELECTION RULE ID
ELECTIONS



MESSAGE
SEAL
LANGUAGE ID
ANY

NOTE: Outgoing or incoming communications can be in any order.

350 – a) Outgoing - Generic Communications

VOTER ID
TRANSACTION ID
VOTER NAME
    NAME-STRUCTURE
MAILING ADDRESS
    ADDRESS-STRUCTURE
CONTACT INFO
    CONTACT-STRUCTURE
ELECTION EVENT NAME
ELECTION NAME
CONTEST NAME
GENERIC MESSAGE
RETURN ADDRESS
    ADDRESS-STRUCTURE
RETURN CONTACT INFO
    CONTACT-STRUCTURE
SEAL
LANGUAGE ID
ANY

350 – b) Incoming - Generic Communications

VOTER ID
TRANSACTION ID
VOTER NAME
    NAME-STRUCTURE
GENERIC MESSAGE
CONTACT INFO
    CONTACT-STRUCTURE
MAILING ADDRESS
    ADDRESS-STRUCTURE
ELECTION EVENT NAME
ELECTION NAME
CONTEST NAME
SEAL
LANGUAGE ID
ANY

360 – a) Outgoing – Channel Options

Voters will be notified of an election with related information and are required to select method of vote.
Consists of outgoing generic communications with an additional mandatory element called Allowed channels.

VOTER ID
TRANSACTION ID
VOTER NAME

NAME-STRUCTURE
MAILING ADDRESS
ADDRESS-STRUCTURE
CONTACT INFO
CONTACT-STRUCTURE
ELECTION EVENT NAME
ELECTION NAME
CONTEST NAME
GENERIC MESSAGE
RETURN ADDRESS
ADDRESS-STRUCTURE
RETURN CONTACT INFO
CONTACT-STRUCTURE
SEAL
LANGUAGE ID
ANY
ALLOWED VOTING CHANNELS (ALLOW MULTIPLE SELECTION)
POLLING
INTERNET
POSTAL
SMS
TELEPHONE
WAP
KIOSK
DIGITAL
TV
OTHERS

360 – b) Incoming – Channel Options

Incoming generic communication with an additional mandatory element called preferred method of vote.

Note: (This message may be sent in response to the message 360a. It can also be an unsolicited message from a voter wishing to select a preferred voting channel.)

PREFERRED METHOD OF VOTE
VOTER ID
TRANSACTION ID
VOTER NAME
NAME-STRUCTURE
GENERIC MESSAGE
CONTACT INFO
CONTACT-STRUCTURE
MAILING ADDRESS
ADDRESS-STRUCTURE
ELECTION EVENT NAME
ELECTION NAME
CONTEST NAME

SEAL
LANGUAGE ID
ANY

410 - Ballot

ELECTION EVENT ID
ELECTION EVENT NAME
ELECTION EVENT DESCRIPTION
BALLOT

BALLOT ID
ELECTIONS

ELECTION ID
ELECTION NAME
ELECTION DESCRIPTION
CONTESTS

CONTEST ID
CONTEST NAME
CONTEST DESCRIPTION
VOTING INFORMATION
ROTATION
MAX VOTES
MIN VOTES
MAXIMUM WRITE-INS
METHOD OF VOTING
MESSAGE
OPTIONS

OPTION ID
OPTION NAME
OPTION AFFILIATION
repeats

WRITE-IN OPTIONS

WI-OPTION ID
WI-OPTION NAME
WI-OPTION AFFILIATION
repeats

MESSAGE

ELECTION RULE ID
OR
VOTERS
VOTER ID
VOTER NAME
V-TOKEN
CONTACT DETAILS
CONTACT-STRUCTURE

MESSAGE
SEAL
LANGUAGE ID

ANY

420 – Authentication

The mechanism of ensuring that a voter has the right to cast a vote for a specific ballot. Referring to *Figure 3a* it is assumed a v-token is generated according to mechanism and criteria defined.

TRANSACTION ID
CHANNEL ID
V-TOKEN
LOGIN METHOD
LANGUAGE ID
AUDIT INFORMATION
    CHANNEL TYPE (P, I, W, ETC)
    CHANNEL ID (COULD BE AN IP ADDRESS OR ANYTHING ELSE)
    IP ADDRESS
    OPERATING SYSTEM INFORMATION
        TYPE
        VERSION
        LOCATION
    COUNTING SYSTEM INFORMATION
        TYPE
        VERSION
        LOCATION
        BATCH
    SEQUENCE
SEAL
LANGUAGE ID
ANY

430 – Authentication Reply

Respond to authentication request to allow or deny access.

TRANSACTION ID
AUTHENTICATED (Y/N)
*REMARK (*REASON WHY NOT AUTHENTICATED.*)*

    BALLOT ID
OR
    BALLOT SCHEMA (1 BALLOT ONLY)

SEAL
LANGUAGE ID
ANY

440 – Cast Vote

V-TOKEN
SEAL
(When the v-token is present, the seal proves that V-token is associated and bound to a certain vote indefinitely.)

ELECTION EVENT ID
ELECTION EVENT NAME

- **ELECTION ID**
- **ELECTION NAME**
  - **CONTEST ID**
  - **CONTEST NAME**
  - **SELECTION**
    - **OPTION ID/NAME OR WRITE-IN OPTION NAME**
      OPTION VALUE OR V-TOKEN OR BOTH
  - *SEAL*
  - *V-TOKEN*

AUDIT INFORMATION
- *CHANNEL TYPE (P, I, W, ETC)*
- *IP ADDRESS*
- *OPERATING SYSTEM INFORMATION*
  - *TYPE*
  - *VERSION*
  - *LOCATION*
- *COUNTING SYSTEM INFORMATION*
  - *TYPE*
  - *VERSION*
  - *LOCATION*
  - *BATCH*
- *SEQUENCE*

SEAL
LANGUAGE ID
ANY

450 – Vote Confirmation

Is meant to be a certain mechanism to respond to voter to confirm his vote was successfully and safely recorded. Whether the confirmation is a thank you message or a confirmation number that allows him to log to a certain page to check the status of his vote as in voted or not with timestamp but not the content of his vote. So again the content of the confirmation is system specific.

MESSAGE

V-TOKEN
CONFIRMATION REFERENCE
SEAL
LANGUAGE ID
ANY

460 – Votes

It is a collection of sealed votes/contest.

(440 – CAST VOTE) repeat

SEAL
LANGUAGE ID
ANY

510 – Count/Result

ELECTION EVENT ID
ELECTION EVENT NAME
ELECTION ID
ELECTION NAME
ELECTION RULE ID
CONTESTS

(**CONTEST ID**
CONTEST NAME
MAX VOTE
OPTIONS

(**OPTION ID**
OPTION NAME
AFFILIATION
VALID VOTES
REJECTED VOTES (MANDATORY REASONS, OPTIONAL REASONS)
ABSTENTIONS (BLANK)))

SEAL
LANGUAGE ID
ANY

3. SECURITY CONSIDERATIONS

3.1 Basic security requirements

The security governing an election starts way before the actual vote casting. It is not only a matter of securing the location where the votes are stored, and does not end there. An intensive analysis into security related concerns and possible threats that could in one way or another affect the election event resulted into the following:

Security considerations of e-voting systems include:

Authentication:

This is checking the truth of a claim of identity or right to vote. It aims to answer questions such as "Who are you and do you have the right to vote?"

There are two aspects of authentication in e-voting systems:

- Checking a claim of identity.
- Checking a right to vote.

In informal e-voting systems the two aspects of authentication, checking a claim of identity and checking a right to vote, may be closely linked. Having checked the identity of the voter, a list of authorized voters may be used to check the right to vote.

In many elections and contest the rules under which the election takes place force a clear separation between checking of the claim of identity, which may be done some time before the ballot takes place, from checking the right to vote at the time of the vote is cast

In the physical voting world, authentication of identity is made by using verifiable characteristics of the voter like handwritten signatures, address, etc and physical evidence like physical ids, driver's license, employee ID, Passport, etc. all of this can be termed physical **credential.** This is often done at the time an electoral register is set up which can be well before the actual ballot takes place.

Checking the authenticity of the right to vote may be performed at various stages in the process. Initial authenticity checks may be done related to the voter's identity during registration. However, at the time of casting a vote, it will be always be necessary to check the right to vote, unless the rules of the election allow the identity of the voter to be reveled, it will not

be necessary to check the physical identity of the voter. Most public election systems require that the verification of the voter at the time of casting of a vote needs to be done anonymously without a direct link to the voter's identity.

In order to carry out this final check on the right to vote at election time there is a need to be able to represent the right to vote to the election system for which the true identity of the voter remains anonymous. Thus without it being possible to trace the right to vote back to an identified voter.

Finally, when counting and auditing votes it is necessary to be able to check that the votes are placed by those whose right to vote has been authenticated.

Public democratic elections in particular will place specific demands on the trust and quality of the authentication data. Because of this and because different implementations will use different mechanisms to provide the voter credential, precise mechanisms are outside the scope of this document.

Privacy/Confidentiality:
This is concerned with ensuring information about voters and how votes are cast is not revealed except as necessary to count and audit the votes. It must not be possible to find out how a particular voter voted (see also discussion on anonymity above). Also, before an election is completed, it should not be possible to obtain a count of how votes are being cast.

Where the user is remote from the voting system then there is a danger of voting information being revealed to someone listening in to the communications. This is commonly stopped by encrypting data as it passes over the communications network.

The other major threat to the confidentiality of votes is within the system that is collecting votes. It should not be possible for malicious software that can collect votes, to infiltrate the voting system. Risks of malicious software can be reduced by physical controls and careful audit of the system operation.

Furthermore, the results of voting should not be accessible until the election is complete. This can be achieved by very careful control over the voting system but is much to guarantee if votes are stored encrypted until the election is complete.

Integrity:
This is concerned with ensuring that ballot options and votes are correct and unaltered. Having established the choices within a particular ballot and the voter community to which these choices apply, the correct ballot information must be presented to each voter. Also, when a vote is placed it is important that the vote is kept correctly until required for counting and auditing purposes.

Using authentication check codes on information being sent to and from a remote voter's terminal over a communications network, generally protects attacks on the integrity of ballot information and votes. Integrity of the ballot and voting information held within computer systems can be protected to a degree by physical controls and careful audit of the system operation. However, much greater confidence in the integrity of voting information can be achieved by using digital signatures or some similar cryptographic protection to "seal" the data.

Non-repudiation:
This is concerned with extending the integrity of a vote and its relation to an authenticated right to vote to ensure that once a vote has been cast it is genuine. Once a vote has been cast in accordance with the rules it should not be possible to change or withdraw that vote.

For a vote to be "non-repudiable" it is necessary to be able to ensure that a right to vote cannot be misused (i.e. is authenticated – see above), but also that, depending on the rules of the election, a vote can only be caste once and cannot be altered, even by the voter.

For data, such as a vote, to be "non-repudiable" is generally considered necessary to include a trusted source of time into the integrity and authentication protection. Thus, there is a clear ordering of events and in the case of a known compromise of passwords or other information used for authentication, it is clear whether the vote was cast before or after the compromise.

3.2 Terms

The following security terms are used in this document:

- **Identity Authentication** identification: the means by which a voter registration system checks the validity of the claimed identity.
- **Right to vote authentication:** the means by which the voting system checks the validity of a voters right to vote.
- **V-token**: the means by which a voter proves to an e-voting system that he/she has the right to vote in a contest.

- **Vote sealing**: the means by which the integrity of voting data (ballot choices, vote cast against a given v-token) can be protected (e.g. using a digital signature or other authentication code) so that it can be proved that a voter's authentication and one or more vote are related.

3.3 Specific Security Requirements

Electronic voting systems have some very specific security requirements that include:

1. Only legitimate voters are allowed to vote (i.e. voters must be authenticated as having the right to cast a vote).
2. Only one set of choices is allowed per voter, per contest.
3. The vote cannot be altered from the voter's intention.
4. The vote may not be observed until the proper time.
5. The voting system must be accountable and auditable.
6. Information used to authenticate the voter or his/her right to vote should be protected against misuse (e.g. passwords should be protected from copying).
7. The voter's actual identity may need to be anonymous (i.e. some legal requirements of various countries conflict. Some countries require that the vote cannot be tracked back to the voter's identity, while others mandate that it must be possible to track every vote a legitimate voters identity).
8. The casting options available to the voter must be genuine.
9. Proof that all genuine votes has been accurately counted.

There are some specific complications that arise with respect to security and electronic voting that include:

1. Several technologies may be employed, in the voting environment.
2. The voting environment may be made up of systems from multiple vendors.
3. A voter may have the option to vote through alternative delivery channels (i.e. physically presenting themselves at a poling station, by post, by electronic means).
4. The voting systems need to be able to meet various national legal requirements and local voting rules for both private and public elections.
5. Need to verify that all votes are recorded properly without having access to the original input.
6. The mechanism used for voter authentication may vary depending on legal requirements of the contest, the voter registration and the e-voting systems for private and public elections.

7. The user may be voting from an insecure environment (e.g. a PC with no anti-virus checking or user access controls).

Objectives of this security specification include:

1. Be an open specification.
2. Not to restrict the authentication mechanisms provided by e-voting systems.
3. Specify the security characteristic required of an implementation, allowing for freedom in its precise implementation.

3.4 Security Architecture

The architecture proposed in this paper is designed to meet the security requirements and objectives detailed above, allowing for the security complications of e-voting systems listed.

The architecture is illustrated in figure E below, and consists of distinct areas:

- Voter identification and registration.
- Right to vote authentication.
- Protecting exchanges with remote voters.
- Validating Right to Vote and contest vote sealing
- Vote confidentiality.
- Candidate list Integrity
- Vote counting accuracy
- Voting system security controls

Voter identification and registration:
The Voter identification and registration is used to identify an entity (e.g. person) for the purpose of registering the person has a right to vote in one or more contests, thus identifying legitimate voters. The security characteristics for voter identification are to be able to authenticate the identity of the legal person allowed to vote in a contest and to authenticate each person's voting rights. The precise method of voter identification is not defined in this standard, as it will be specific to particular voting environments, and designed to meet specific legal requirements, private or public election and contest rules. The voter registration system may interact with the e-voting system and other systems to define how to authenticate a voter for a particular contest.

Voter identification and registration ensures that only legitimate voters are allowed to register for voting. Successful voter registration will eventually result in legitimate voters being given a means of proving their right to vote to the voting system in a contest. Depending on national requirements or specific voting

rules/bylaws the voter may or may not need to be anonymous. If the voter is to be anonymous, then there must not be a way of identifying a person by the means used to authenticate a right to vote to the e-voting system. Right to vote authentication is the means of ensuring a person has the right to cast a vote, but it is not the identification of the person.

Right to vote Authentication:
Proof of the right to vote is done by means of V-token, which is generated for the purpose of authentication that the voter has a legitimate right to vote in a particular contest.

The security characteristic of the V-token and hence its precise contents may vary depend on the precise requirements of a contest, the supplier of the voter registration system, the e-voting system, the voting channel or other parts of the electoral environment. Thus, the content of the V-token will vary to accommodate a range of authentication mechanisms that could be used, including; pin and password, encoded or cryptographic based password, hardware tokens, digital signatures, etc.

The contents of the V-token may also depend on the requirements of a particular contest, which may mandate a particular method be used to identify the person and the voter. For example, if a country has a national identity card system, it could be used for the dual purpose of identifying the person and providing proof that the person is entitled to vote, provide the legal system or a private election voting rules allow a personal identify to be associated with a vote. However, this would not work for countries or private voting scenarios that require the voter to be anonymous. For such a contest the mechanism used to identify that a person has the right to cast a vote must not reveal the identity of the actual person, thus under such voting rules voter identity authentication and right to vote authentication are not the same information or semantics.

The security characteristic required of the V-token may also vary depending on legal requirements of a country or electoral rules used in a particular contest. Also, the threats to misuse of v-tokens will depend to a large degree on the voting channels used (e.g. physical presence at voting station, Internet, mobile phone). Bearing this in mind the XML schema of the V-token components must allow for various data types of authentication information to be contained within it.

It must be possible to prove that a V-token is associated with vote cast and the rules of the contest are followed, such as only one vote is allowed per voter, per contest. Thus providing non-repudiation requirements that all votes were genuine, cast in accordance with the rules of the contest, no vote has been altered in any way, all the votes counted in a contest were valid when audited to do so.

Protecting exchanges with remote voters:

The V-token may be generated as part of the registration system, the e-voting system, or as interaction between various components of a voting environment, as illustrate in Figure E. The V-token will need to be provided securely to the voter so that this can be used to prove the right to vote.

The exchange of information when casting a vote must be protected by secure channels to ensure the confidentiality, integrity of voting data (V-token(s) and vote(s) cast) and that this is correctly delivered to the authenticated e-voting system. If the channel isn't inherently secure then this will require additional protection using mechanisms, such as: a postal system with sealed envelopes, dedicated phone channel, secure e-mail, secure internet link (SSL), peer to peer server/client authentication.

Validating Right to Vote and contest vote sealing

When a vote is cast, to ensure that it cannot be altered from the voter's intention, all the information used to authenticate the right to vote and define the vote cast must be sealed to ensure the integrity and non-repudiability of the vote. This seal may be implemented using several mechanisms ranging from digital signatures (XML and CMS), cryptographic seals, trusted timestamps and other undefined mechanisms. The seal provides the following security functions:

- The vote cannot be altered from the voter's intention.
- The voting system must be accountable and auditable.

The right to vote may be validated at the time the vote was cast. If votes are not checked for validity before sealing then the right to vote must be validated at the time that votes are subsequently counted. Also, when counting or otherwise checking votes, the validity of the seal must be checked.

If votes are sealed and recorded without being checked for validity at the time they were cast, then the time that the vote was cast must be included in the seal, so that they may be checked for validity before they are counted.

In some election scenarios it is required to audit a vote cast to a particular voter, in this case a record is also needed of the allocation of a V-token to a voter's identity. Such systems also provide non-repudiation of the voter's actions. In such cases a voter cannot claim to have not voted or to have voted a different way, or that his vote was not counted. In many election scenarios were this type of auditing is required, it must not be easy to associate a V-Token to the Voter's identity, therefore this type of records must be under strict control and protected by security mechanism and procedures, such as; encryption, key escrow and security operating procedures.

Vote confidentiality:
All cast votes must not be observed until the proper time, this requires confidentiality of the vote over the voting period, how this is achieved will vary from e-voting system to e-voting system. Mechanism of vote confidentiality, range from trust in the e-voting systems internal security functions (processes and mechanisms) to encryption of the data, with key escrow tools.

Candidate list integrity:

To ensure that the voter is present and that the candidate list is genuine, there must be a secure channel between the voting system and the person voting or the data must be sealed, this secure channel must ensure that there is no man-in-the-middle that can change a vote from what the voter intended. To meet this requirement either the candidate list may need to have unpredictable characteristics with a trusted path to convey that information to the voter, or trust is placed in the complete ballot/vote delivery channel. As there must be a secure part to convey the V-token to the person entitled to vote, a way of ensuring that a voter is always presented with a genuine list of candidates is to encode the candidate list as part of the V-token.

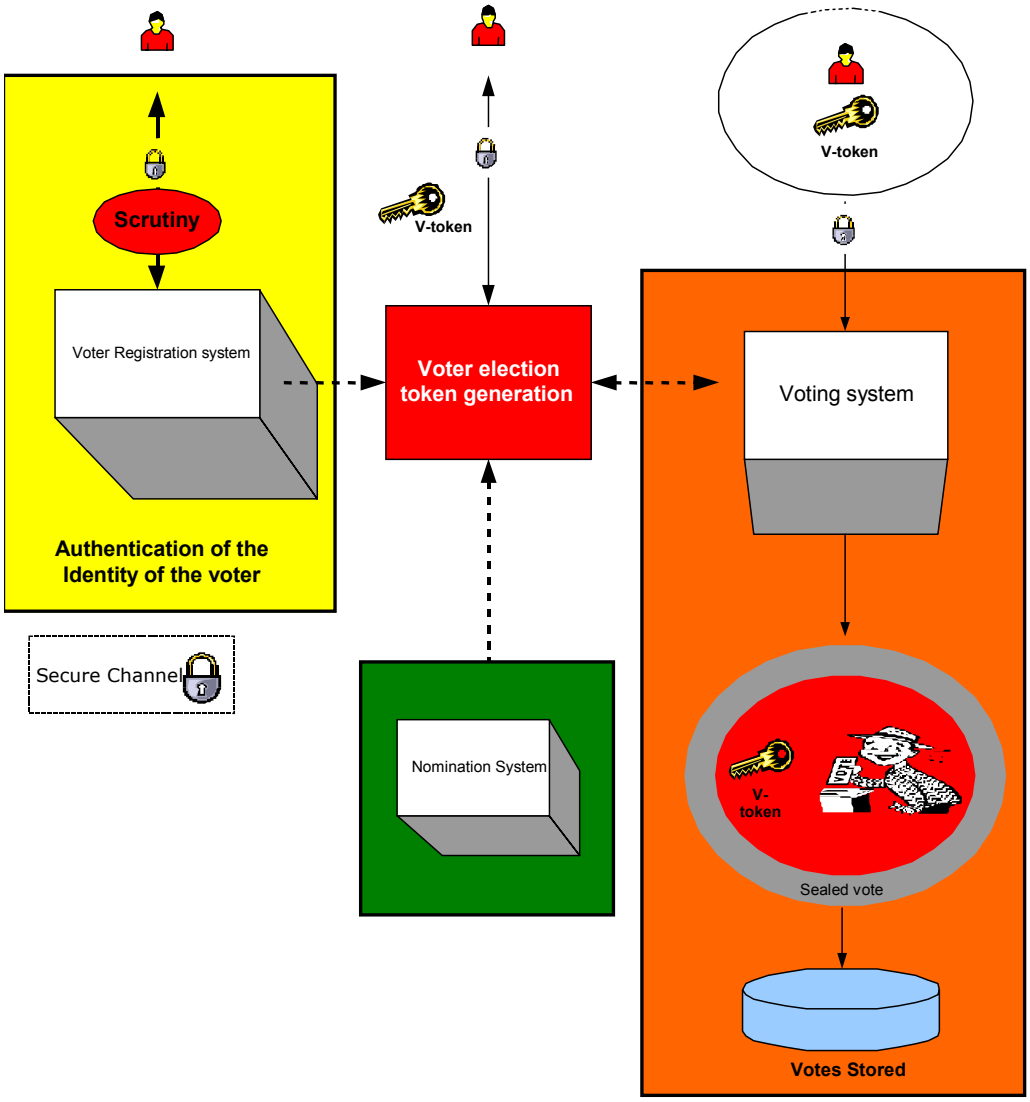
Vote counting accuracy:

Audit of the system must be able to prove that all vote casts were genuine and that genuine votes were included within the vote count. Voter may need to be able to exercise that proof should they so desire. Thus auditing needs data that has non-repudiation characteristics, such as the V-token/vote sealing.

Voting System Security:

The overall operation of the voting systems and its physical environment must be secure. Appropriate procedural, physical and computing system controls must be in place to ensure that risks to the e-voting systems are met. There must be a documented security policy based upon a risk analysis, which identifies the security objectives and necessary security controls.

Figure 3a: Voting system security



3.5 Internet voting security concerns

One of the channels that can be used for electronic voting is the Internet, this media raises particular security concerns and questions like:

- How do I know that that the candidate information I am being presented with is the correct information?
- How do I know that I'm using a trusted ballot paper that accurately records my vote?
- How do I know there isn't a man-in-the-middle who is going to alter my ballot when I place it?
- How do I know that it is the genuine e-voting server I'm connected to that will record my vote rather than one impersonating it that's just going to throw my vote away?
- How do I know that the voter's computer does not have malicious software which will attempt to alter the ballot choices as represented to the voter or alter the voter's selection?

The type and importance of a particular contest will have an effect on whether the above concerns exist and whether they do, or do not, represent a tangible threat to the voting process and its outcome. The table listed at Appendix B shows the concerns that have been identified as possibilities if the Internet is to be used in public election voting scenarios. The table shows how the concerns can be translated to technical threats and lists characterizes of security services that may be used to counter such threats. How the security services are implemented is outside the scope of this document allowing freedom to the system providers.

Appendix A: Glossary/Terminology

E-VOTING TERMS

The table below contains a list of voting terms used within this process document. The entries in bold relate to core terms that have been centrally defined by the committee and are essential to understanding the use of terminology within this document.

Additional suggestions from committee members have also been included..

TERM	DEFINTION	ORIGIN
BALLOT	**Appropriate to one voter and will contain the set of candidates or options for a particular contest within one or more elections.**	E&VSTC
VOTED BALLOT	**This is a ballot containing the voters Preferences**	E&VSTC
BALLOT FORMAT	A format for rendering a ballot	USA
BALLOT LAYOUT	A template for a physical ballot	USA
BALLOT MESSAGE	Fixed text, image, instructions, etc. that appears on a ballot page	USA
BALLOT STYLE	Unique combination of contest and candidates	USA
CANDIDATE	**An individual in standing in a contest or one of a set of proposal on an issue [See option]**	E&VSTC
CANDIDATE LIST	**A list of candidates or issues involved in a contest.**	E&VSTC
CONSTITUENCY	The whole area to which the elective office relates and may include a number of POLLING DISTRICTS	UK
CONTEST	**A competition between a set of candidates for a particular post or on a particular issue**	E&VSTC
ELECTION EVENT	**An election event is a series of elections that for some reason are group together into one event, for example they may be completely different elections but for logistic reason they are all run on the same day.**	E&VSTC
ELECTION	**An election is used in the traditional sense, such as country's government election, local government election, or other local community elections. A series of elections may, or may not, be combined**	E&VSTC

	into one ballot for a voter within an election event. A collection of related contests over a defined period of time	
FOOTER	Text, image, or other detail that appears immediately after a contest or candidate listing	USA
HEADER	Text, image, or other detail that appears immediately before a contest or candidate listing	USA
ITEM	The thing voted upon whether it is an office, position-elect or referendum	USA
ITEM_TYPE	Describes the type of ITEM (such as first-past-the-post, plurality, proportional vote, etc	USA
POLL SITE INTERNET VOTING	This refers to the casting of ballots at public sites where election officials control the voting platform	US
REMOTE INTERNET VOTING	This refers to the casting of ballots at private sites, where the voter or a third party controls the voting client.	US
NON-VOTER	Someone either who is on the register but has not voted, or someone who is ineligible to vote on Age or other grounds	UK
OPTION	**The options are the choices presented to a voter for a particular contest and can comprise the list of candidates, choices, answers, etc.**	E&VSTC
PARTY AFFLIATION	Political party affiliation associated to a CONTEST or CANDIDATE	USA
POLLING DISTRICT	The smallest geographical entity within which the VOTERS are subdivided for registration and voting purposes	UK
POLLING DISTRICT	A specific geo-political area that defines a boundary for a BALLOT CONTEST	USA
POLLING DISTRICTS SPLIT	Unique combination of all DISTRICTS in a specific jurisdiction	USA
ROTATION	The concept of presenting candidates (for the same contest) in a different order for different ballots	USA
SELECTION	The CANDIDATE, answer, etc which is the option or choice for ELECTION	USA
SEQUENCE	Order in which a CANDIDATE or CONTEST appears on a BALLOT	USA
UNDERVOTE	Indicates whether it is allowable to VOTE for fewer than the allowable SELECTIONS	USA
VOTE	A positive act, which records the voter's choice of CANDIDATE but in such a way as to ensure the secrecy of the BALLOT	UK
VOTELIMIT	Defines the number of vacancies to be filled in a	USA

	particular ITEM	
VOTER	**A voter is someone who is on the election list**	E&VSTC
WRITEIN	Describes the number of write in CANDIDATES allowed	USA

E-VOTING PROCESS TERMINOLOGY

PROCESS	DEFINITION	ORIGIN/LINKS
REGISTER VOTER	This involves getting personal date onto the electoral roll	E&VSTC
CANDIDATE NOMINATION	The method of confirming eligibility to be a candidate in a contest and storing the relevant data.	E&VSTC
VOTING PROCESS	This involves the following two activities, the authentication of the voter and the casting of an individual vote.	E&VSTC
COUNTING PROCESS	The process of turning voted ballots into the results of a contest.	E&VSTC
VOTER IDENTIFICATION	The means by which a voter registration system identifies the entity (e.g human) entitled to vote.	E&VSTC
VOTER AUTHENTICATION	The means by which an e-voting system identifies that a voter has the right to cast a vote in a contest.	E&VSTC
VOTE SEALING	The means by which voter authentication and one or more vote can be proved to be related (e.g. possibly the a cryptographic way of sealing together a vote and proof the voter was legitimate).	E&VSTC

Appendix B: Internet Voting Security Concerns

Concerns raised on Internet voting	Resulting Technical Threats	Possible generic security service countermeasure
1: Impersonation of the right to vote. ***The concern here is that a person attempts to impersonate to be a legitimate voter when he/she is not.*** ***The initial task of verifying that a person has the right to vote must be part of the voter registration process.*** ***A person must not be given the right to vote until after proper due diligence has been undertaken during voter registration that the person has a right to vote in a contest.***	Inadequate, incorrect or improper identification of person during registration of voters	Trusted voter identification and registration using: • Security Procedures. • Best Practices. • Secure communications channels. The voter registration authority must follow standard Security Operating Procedures (SOPs) which ensure due diligence has been done.
	Inadequate privacy of the exchange between the person and the electoral system during voter registration	Channel between voter and registration system must provide: • Connection Confidentiality • Connection Integrity
2:Voter is not presented with correct ballot information due to incorrect candidate identification.	Incorrect identification during candidate registration.	Trusted candidate identification and registration are needed using: • Security Procedures. • Best Practices. • Secure communications channels. • Authentication and identification of candidates

Concerns raised on Internet voting	Resulting Technical Threats	Possible generic security service countermeasure
		The candidate registration must follow standard Security Operating Procedures (SOPs) which ensure due diligence has been done.
3: Registration system impersonation	Inadequate authentication of registration system	Channels to and from the registration system must provide point to point authentication.
4: Impersonation of a legitimate registered voter	Incorrect authentication at the time of casting vote.	Trusted voter authentication (i.e. the right to cast a vote in this contest)
	Inadequate privacy of the exchange between the voter and the electoral system when vote is cast.	Channel to provide: • Connection Confidentiality • Connection Integrity Between voter and e-voting system
5: Obtaining the right to vote illegally from a legitimate voter. ***This may be by intimidation, theft or by any other means by which voting right has been obtained illegally.*** ***For example, by Stealing a voting card from a legitimate voter.***	Stealing the voter's voting card (e.g. the V-token data)	Some secret data only known to the voter's is required to be presented at the time of casting a vote. Before a vote is counted as a valid vote proof must be provided that the voter's secret data was present at the time of casting the vote.
	Any means of getting a legitimate voter to reveal his V-token data.	
6:Voting system impersonation	Inadequate authentication of registration system	Channel to provide: Point to point authentication
	Inadequate authentication of voting casting point (e.g. polling station/ballot box)	Channel to provide: Point to point authentication

Concerns raised on Internet voting	Resulting Technical Threats	Possible generic security service countermeasure
7:Voter is not presented with correct ballot information	Inadequate integrity of the ballot information • Given to the user • Held in the voting system	Trusted path to voter on ballot options
		Integrity of the ballot information
		Integrity of cast votes
	The casting options available to the voter are not genuine	Trusted path between voter and vote recording
	Trojan horse, man in the middle attack	Trusted path to voter on ballot options
8:How do I know the voting system records votes properly	Integrity of the voting system	Non-repudiation of the vote
		Non-repudiation the vote was cast by a genuine voter
		Audit of voting system
		Connection confidentiality
	Insecure channel between the voter and the vote casting point	Connection Integrity
		Connection Confidently
	Voter's intent is recorded accurately	Trusted path between voter and vote recording
		Non-repudiation of the vote recorded
	Proof that a genuine vote has been accurately counted.	Audit
9:How can I be sure the voting system will not disclose whom I have voted for.	Voter's identification is revealed	Voter's identification is anonymous
		Vote confidentiality
10:How can it be sure that my vote has been recorded	Loss of vote	Proof of vote submission
11: How can I be sure there is no man-in-the-middle that can alter my ballot	Vulnerable client environment; • Trojan horses • Virus	Physical security
		Procedural security
		Unpredictable Coded voting information
	Interception of communication	Integrity of communications channel between client and server system

Concerns raised on Internet voting	**Resulting Technical Threats**	**Possible generic security service countermeasure**
12: All votes counted must be have been cast by a legitimate voter	Voter impersonation	Voter authentication
	Audit facility fails to provide adequate proof.	Non-repudiation of the vote record
		Non-repudiation that legitimate voters have cast all votes.
	Breaking the vote counting mechanisms	Independent audit
13: Only one vote is allowed per voter, per contest	Voter impersonation at registration	User registration security • Procedures • Voter Identification
	Multiple registration applications	
	Multiple allocation of voters credentials	Voter authentication
14: The vote cannot be altered from the voter's intention.	Vulnerable client environment; • Trojan horses • Virus	Trusted path from voter's intent to vote record.
		Vote integrity
		Vote non-repudiation
15: The vote may not be observed until the proper time	Votes may be observed before the end of the contest	Voter confidentiality
16: The voting system must be accountable and auditable		Non-repudiation of vote data.
		Audit tools
17: Identification and authentication information to and from the voter must be privacy protected	Loss of privacy	Channel to provide: • Connection Confidentiality
18: The voter's actual identity may need to be anonymous	Voter's identification is revealed	Voter's identification is anonymous

Concerns raised on Internet voting	Resulting Technical Threats	Possible generic security service countermeasure
19: Denied access to electronic voting station	Denial of service attack	This needs to be counted by engineering the system to provide survivability when under denial of service attack.