http://www.oasis-open.org

April 27, 2005

Trusted Logic Voting Systems with OASIS EML 4.0

(Election Markup Language)

Presenter:
David RR Webber
Chair OASIS CAM TC
http://drrw.net

Contents

- **Trusted Logic Voting (TLV)**
  - Needs, Approach and Implementation
- **Using OASIS EML**
  - History, Overview, Processes, Transactions
- **Applying OASIS EML**
  - Example process steps and actions
  - Supporting US-style elections
- **Summary**

OASIS

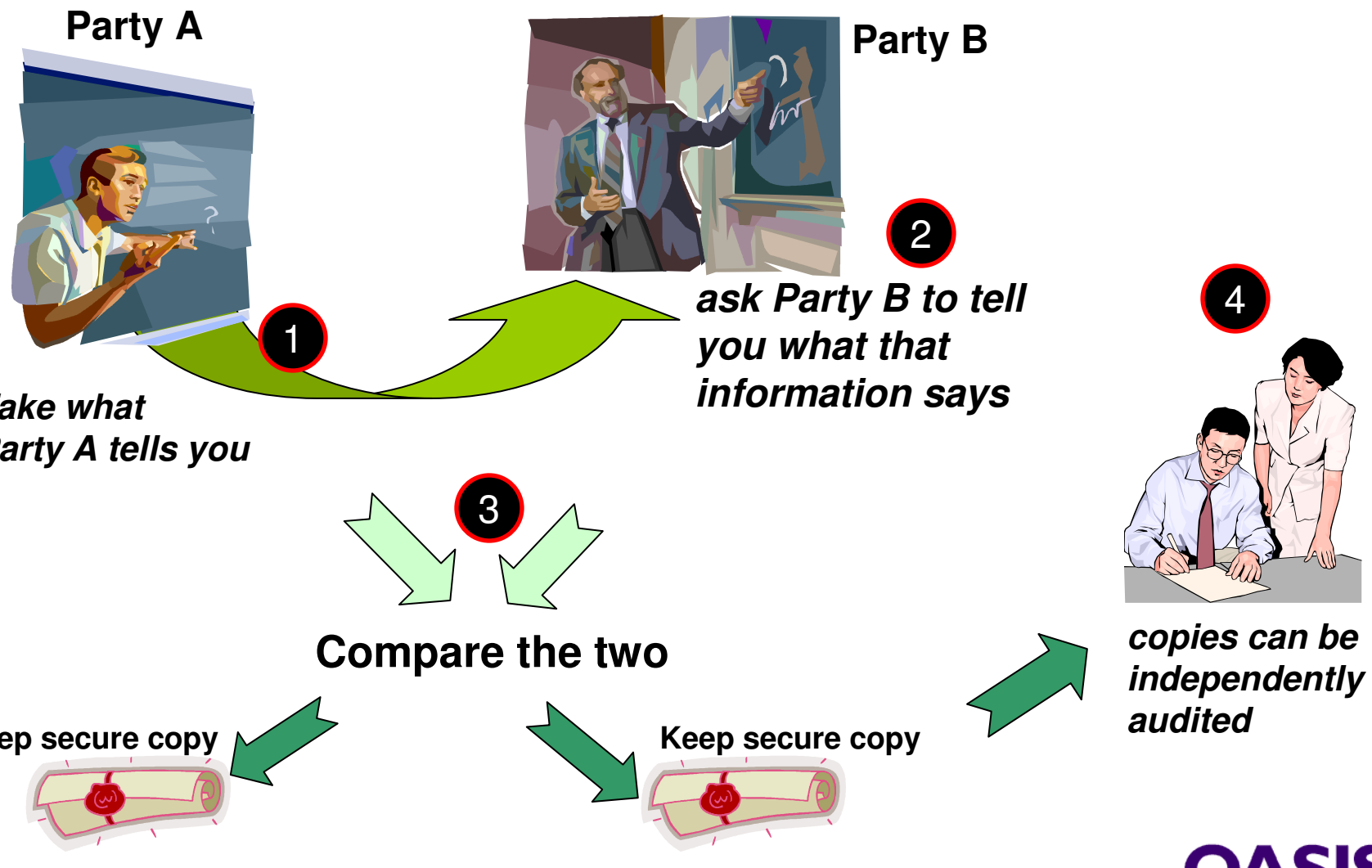
Trusted Logic Voting Needs

- How can we ensure the voting machine does not cheat on the human operator who cannot “see inside”?
- How can we know that every vote is counted as cast?
- If you have two parties that you cannot trust, how do you create a process that works between the two – in a way that if either cheats you will know?
- How can you create an audit trail that allows 100% crosschecking while keeping voter privacy?
- Use existing work in the field on multi-party *trusted logic process* (e.g. MIT approach using the “Frog Principle”*)

*see: http://www.vote.caltech.edu/media/documents/vtp_WP2.pdf

OASIS

Trusted Logic Concept



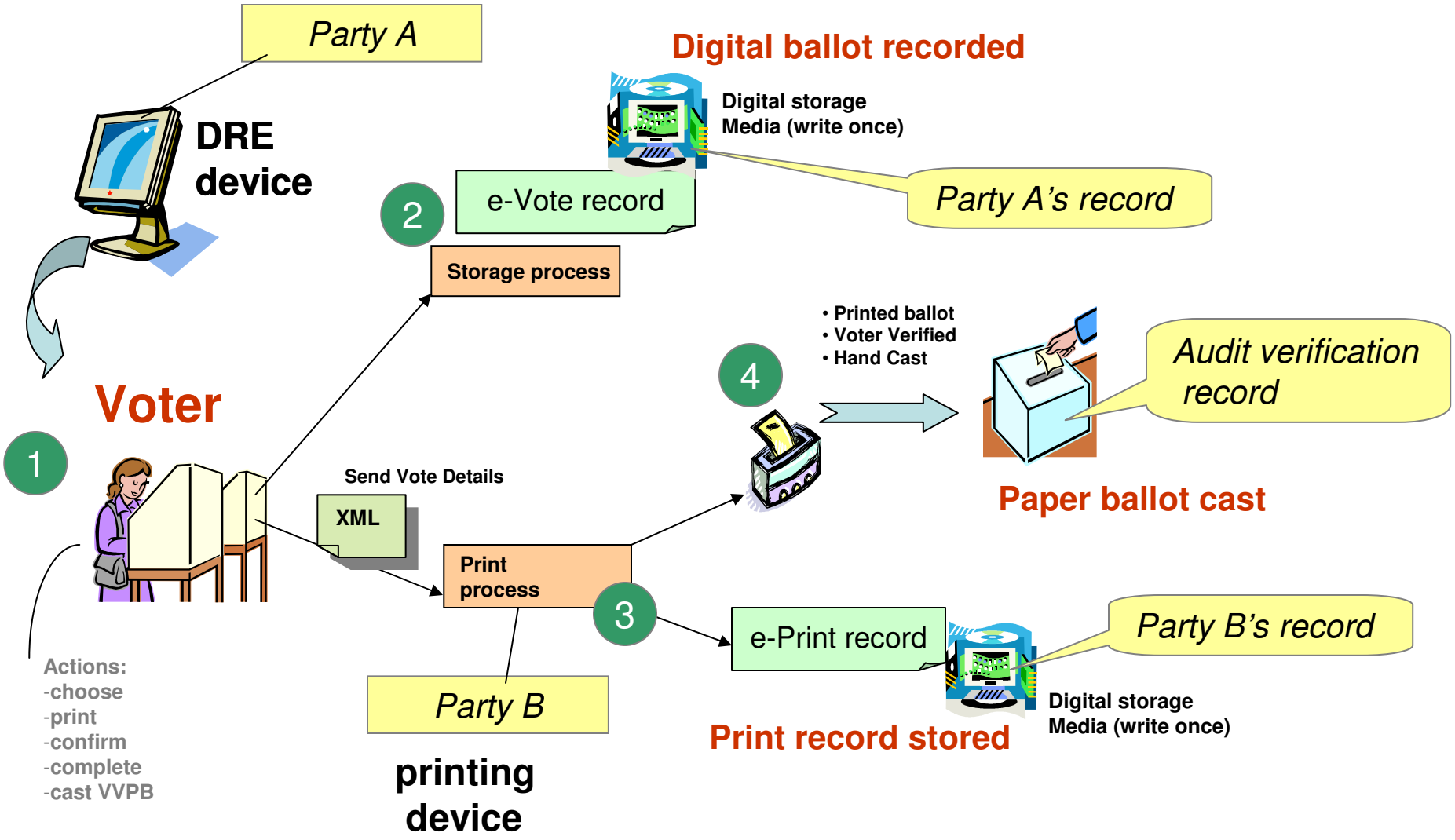
Trusted Logic Applied to Voting

- **First party creates record of the voters' choices**
- **Voter selection information transferred to second party**
- **Second party then confirms what the first party did and displays that information for the voter to confirm**
- **Confirmation uses write-once technology**
  - paper ballots (preferred medium today)
  - or "digital-paper" – liquid crystal plastic that machine "writes" to and human can read*
  - or write-once digital chips that insert into a computer slot (MIT "frogs")
- **Process completes with three records retained**
  - What the first party said they did
  - The copy they passed to the second party
  - What the second party displays to the voter (printed as paper ballot)
- **Auditor can compare all three records – to ensure they match**

*** too costly today – but maybe within fifteen years time will be as cheap and easy to handle as paper.**

OASIS

US Voting System Example



- Trusted Logic Voting in action -

OASIS

Core Trust Principles

- Verifiable paper ballots
- Matched e-Vote electronic records
- Electoral roll of voter participation
- Private and anonymous
- Secure 100% tallying and crosschecking
- Easy for citizens to understand

OASIS

Three Pillars of Trust

- Electoral Roll
  - managed by election officials and administered by voting staff
  - process designed to ensure anonymous vote
- Electronic voting records
  - generated by voter using voting system
  - digitally recorded and stored by voting system
- Matching Paper voting records
  - generated by voter using voting system
  - manually cast or mailed by voter

Fundamentals of Trust

- 100% audit and comparison every time of all three Trusted Pillar counts to produce a certified election result
- Separation required between each step of the process; the trusted logic process is applied between the electronic and paper vote handling
- No single system can control or access more than one of the Trusted Pillars processing – each has to be distinct
- Every paper vote record is scanned and counted; every matching electronic vote is stored and then separately tallied

OASIS

Ensuring Timely Results

- To be trusted elections must be able to produce timely answers and results
- 100% audit and comparison of three counting sources provides this “real time” analysis during voting and immediately after the balloting closes
- Avoids recrimination, legal challenges and uncertainty that is introduced by today’s partial audits only
- Identifies and traces operational issues (machine problems or operator errors) and resolves them
- Allows confidence in declared results of elections

OASIS

Balancing information capture

- A trusted logic process allows the minimum effective information collection to effect a secure voting process
- Too much information compromises anonymous voting in subtle ways
- Too little information prevents effective audit trails
- Example: stamping votes with machine IDs – good idea or bad idea?
- Next we look at how OASIS EML 4.0 instructs on the information exchange details…

OASIS

Quick Overview of EML

- History
  - Work begun in May 2001
  - Charter: 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
  - UK government has implementations:
    - UK Local Election pilots held in May 2003.
  - http://www.oasis-open.org/committees/election
- Council of Europe Endorsement
  - Council of Europe Ministers have endorsed the e-voting recommendations and with that the use of EML http://europa.eu.int/ida/en/document/3294/358
- EML 4.0 is a committee draft for review and comment, other countries in Europe now exploring use

Overview of EML and processing: http://www.idealliance.org/papers/xmle03/slides/spencer/spencer.ppt

Category Overview of EML

One or more XML schemas series are provided to support each general process area:

- Pre election
  - Election (100)
  - Candidates (200)
  - Options (600)
  - Voters (300)
- Election
  - Voting (400)
- Post election
  - Results (500)
  - Audit
  - Analysis

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

- Administration Interface
- Help Desk

OASIS

Selected EML 4.0 Transactions

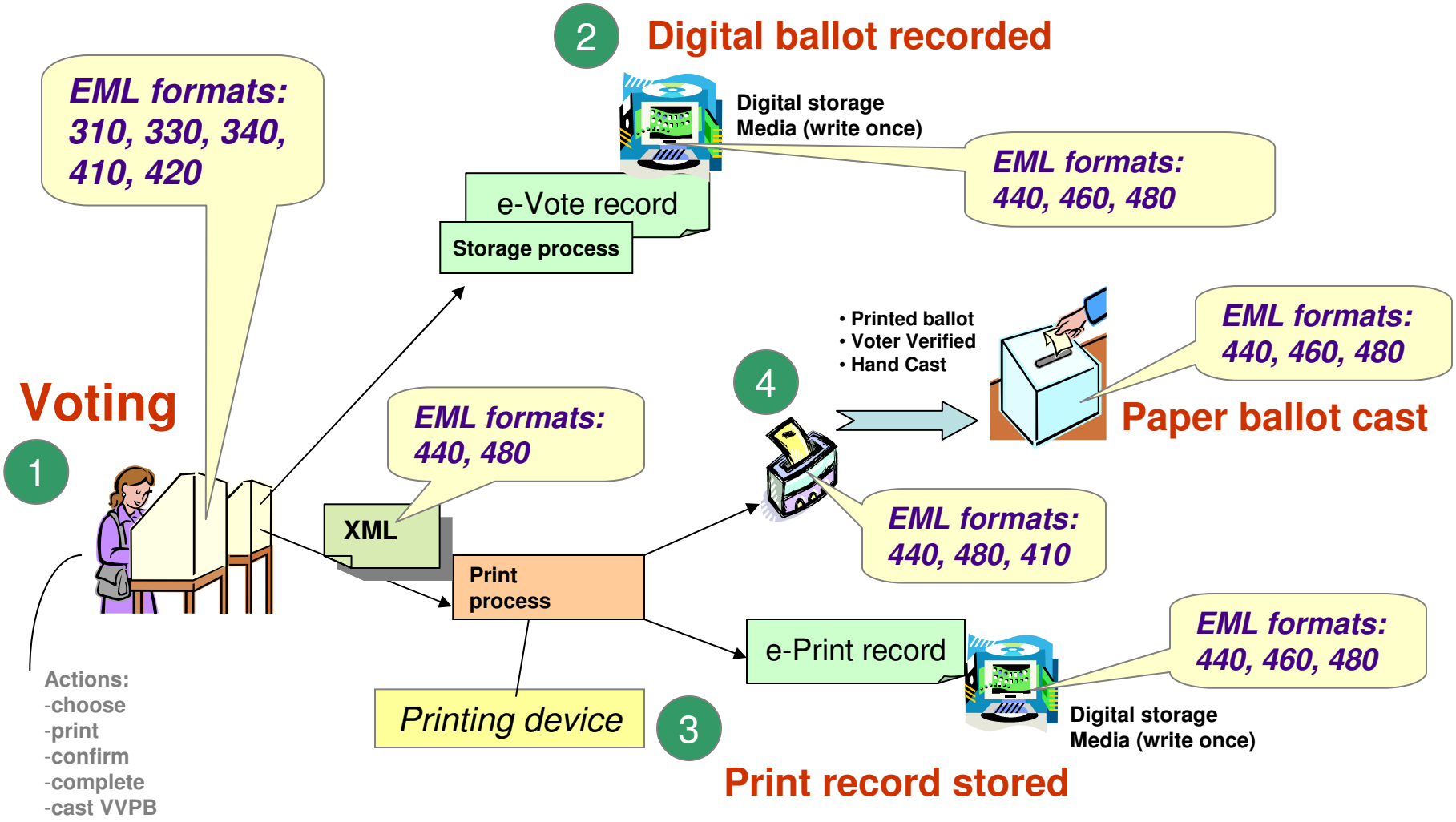
Schema Name	Purpose
EML 110 – election event	Information about an election or set of elections. It is usually used to communicate information from the election organizers
EML 210 – candidate nomination	Used to nominate candidates or parties, consenting or withdrawing
EML 230 – candidate list	Contest and candidates details
EML 310 – voter registration	Used to register voters for an election
EML 330 – voter election list	Details of actual voters for an election
EML 340 – polling information	Notification to voter of an election, their eligibility and how to vote
EML 410 – ballot	Describes the actual ballot to be used for an election
EML 420 – voter authentication	Used for voter authentication during a voting process
EML 440 – cast vote	Actual record of vote cast
EML 460 – votes group	Group of votes being transferred for counting
EML 480 – audit log	Documents access to voting records and reason
EML 510 - count	Results of election contest(s) and counts
EML 520 - result	Communicating specific result details on candidates and elections

OASIS EML 4.0 transaction use

- Electoral Roll **(EML 310, 330, 340)**
  - managed by election officials and administered by voting staff
  - process designed to ensure anonymous vote
- Electronic voting records **(EML 440, 460, 480, 510)**
  - generated by voter using voting system
  - digitally recorded and stored by voting system **(EML 510)**
- Matching Paper voting records **(EML 440, 480)**
  - generated by voter using voting system
  - manually cast or mailed by voter
  - scanned electronically **(EML 440, 480, 510)**

OASIS

EML and US Voting Example



- Using EML formats in action -

OASIS

Reality of real-world voting

- Good solutions have to be adaptive and survive in a complex unpredictable world; they have to administer well
- Today's paper-based voting have a culture around them and years of operational lessons learned
- Need to have formalized documented procedures
  - Council of Europe Ministers have endorsed the comprehensive steps for e-voting recommendations and with that the use of EML http://europa.eu.int/ida/en/document/3294/358
- Expecting 100% perfection is unrealistic; trusted system has to be a best case – that allows people to be able to diagnose events and occurrences, e.g.:
  - someone forgot a voting card left in a voting machine
  - the machine jammed; the disk is unreadable
  - someone keyed in the wrong setup code
  - the computer hardware failed

OASIS

EU Procedures* (Processing Layers)

Items covered:

- Electoral roll and voter registration
- Voting process
- Counting process
- Verification and Certification
- Equipment deployment, setup and control

*see: http://www.coe.int/T/e/integrated_projects/democracy/02_Activities/02_e-voting/01_Recommendation/default.asp#TopOfPage

OASIS

EU Procedures – clarifying items (1)

These trusted logic items should be added:

1. Explicit reference to the importance of using write-once media for vote recording - either paper or digital
2. Need for voters to be able to physically verify their vote directly - via paper ballot or equivalent physical representation of an actual ballot - not an electronic ephemeral representation, and to cast that physical representation by hand
3. Need to separate the layers of the process - so the same component provider is not doing all vote creating, printing, and counting the total votes (no single solution provider)
4. Need to use trusted logic principle so that the voter can verify that the digital voting choice recorded matches the physical voting choice they selected

OASIS

EU Procedures – clarifying items (2)

These ballot processing items should be added:

5. Need to compare 100% of all counts - electronic and physical ballot counts and electoral record counts to ensure they tally*
6. Explicit call-out of the need to avoid sequential processing information compromising vote privacy and anonymity
7. Explicitly call-out that overall election counts should be tallied independently for each of the sources - electoral roll, digital votes, and voter verified (paper) ballot counts (after scanning - EBI - Electronic Ballot Imaging**).

*** More in-depth technical operation level discussions here:**
http://gnosis.cx/publish/voting/privacy-electronic-voting.pdf

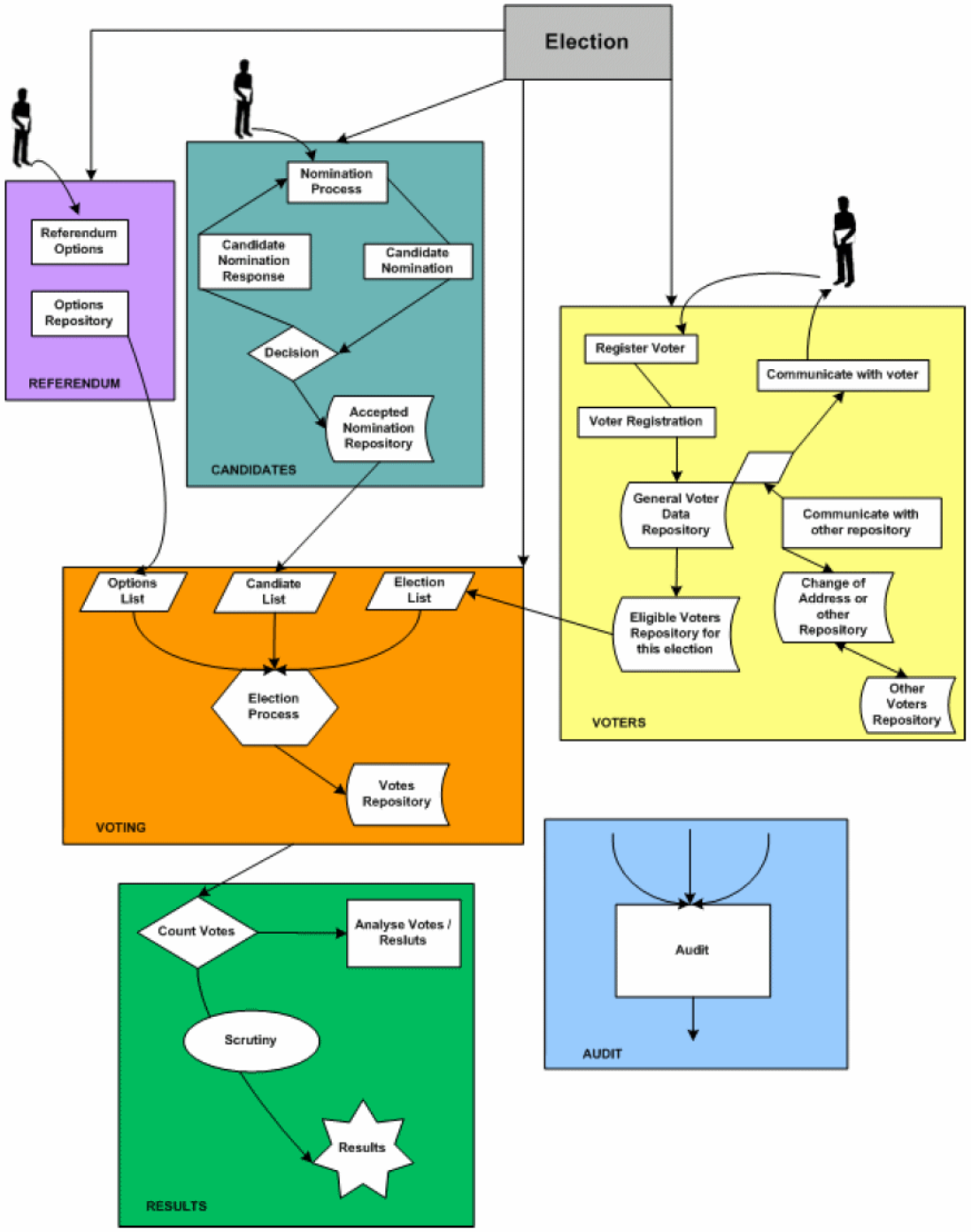
**** Electronic Ballot Imaging -** http://www-128.ibm.com/developerworks/xml/library/x-matters36.html

OASIS

How OASIS EML views process steps and separations

Election:

- Candidates
- Ballot / Referendum
- Voters
- Voting
- Results
- Audit

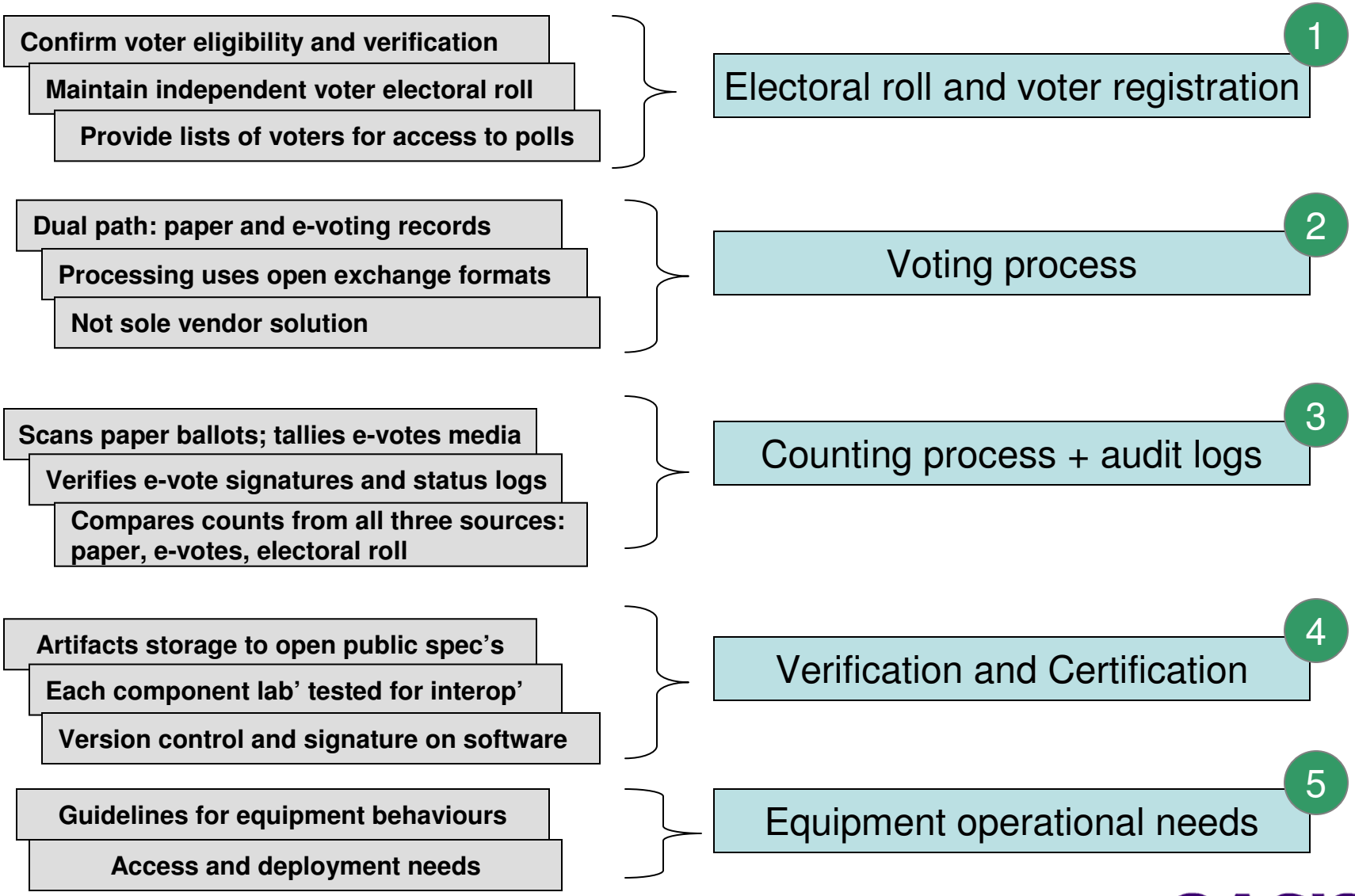


Procedural requirements

- One implementer cannot supply solutions across more than one layer or process
- Each layer must be autonomous and passes information to next layer in open formats that can be inspected and verified
- Software involved must be published to open source
- Physical separation of layers and devices associated with them

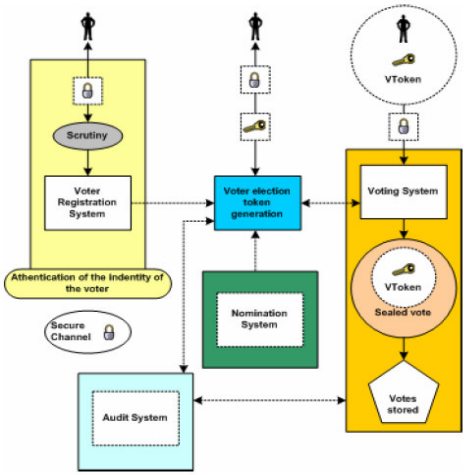
OASIS

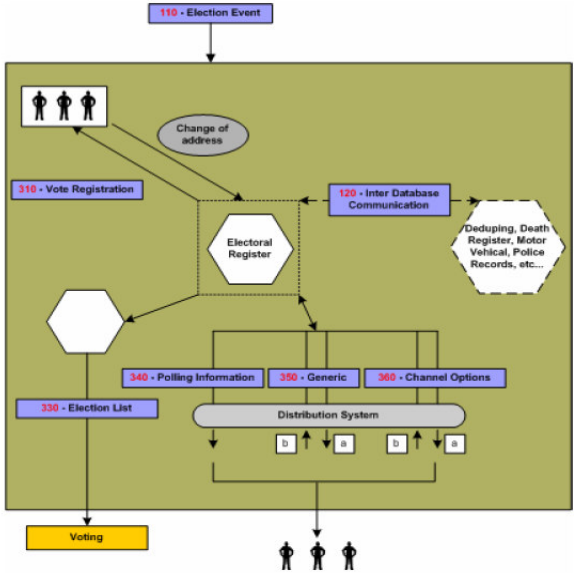
Process Overview

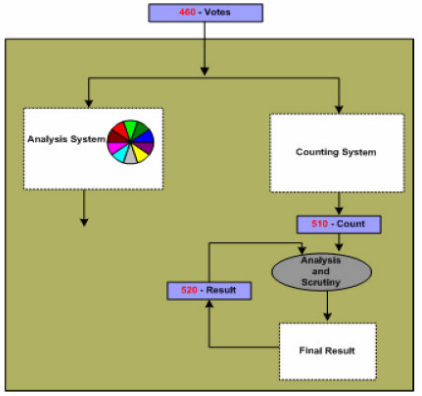


OASIS EML process details

- The OASIS EML provides details for each part of voting process (see specification for exact details)
- Next few slides show how these can be applied to a trusted logic voting process



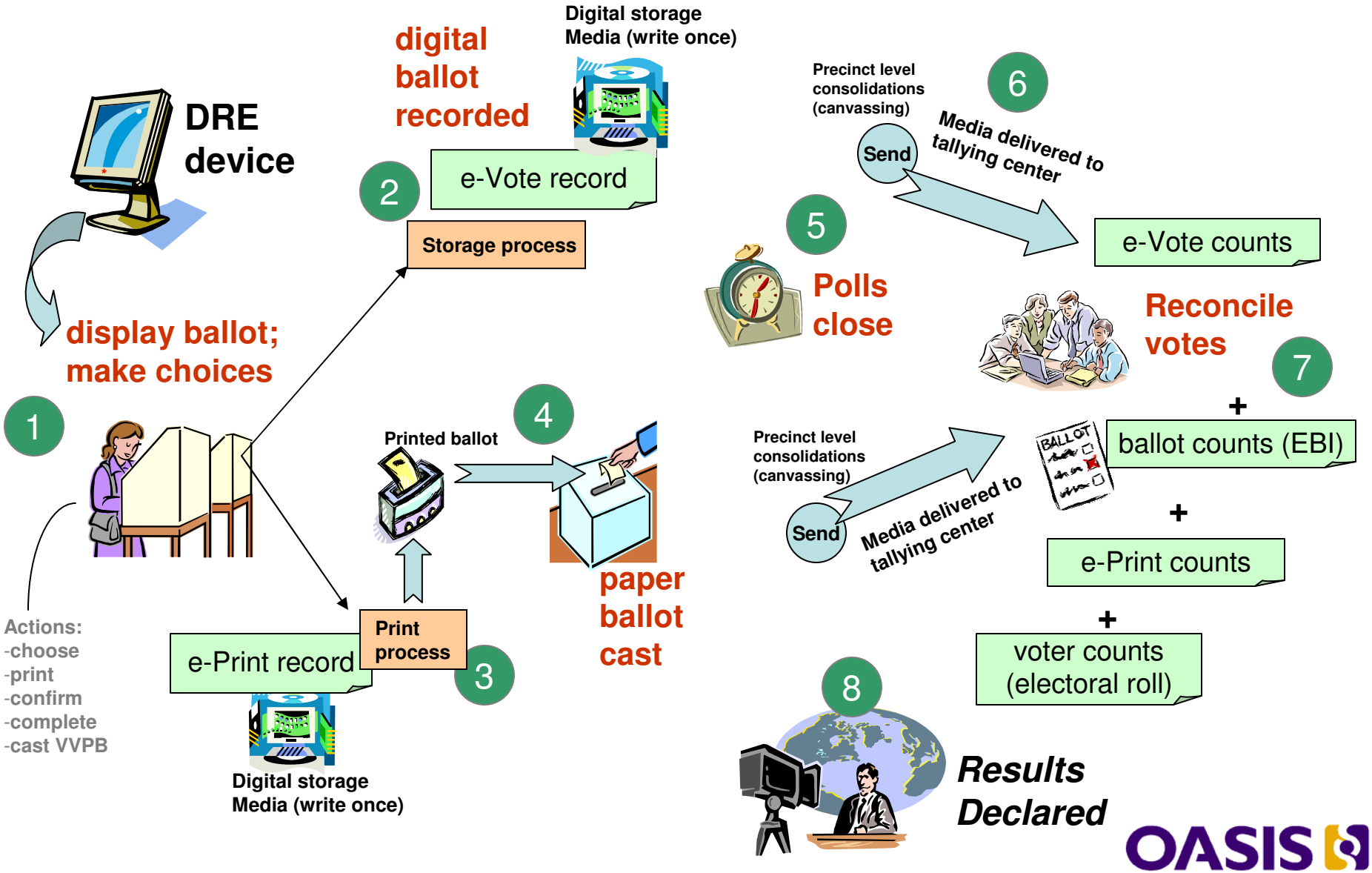




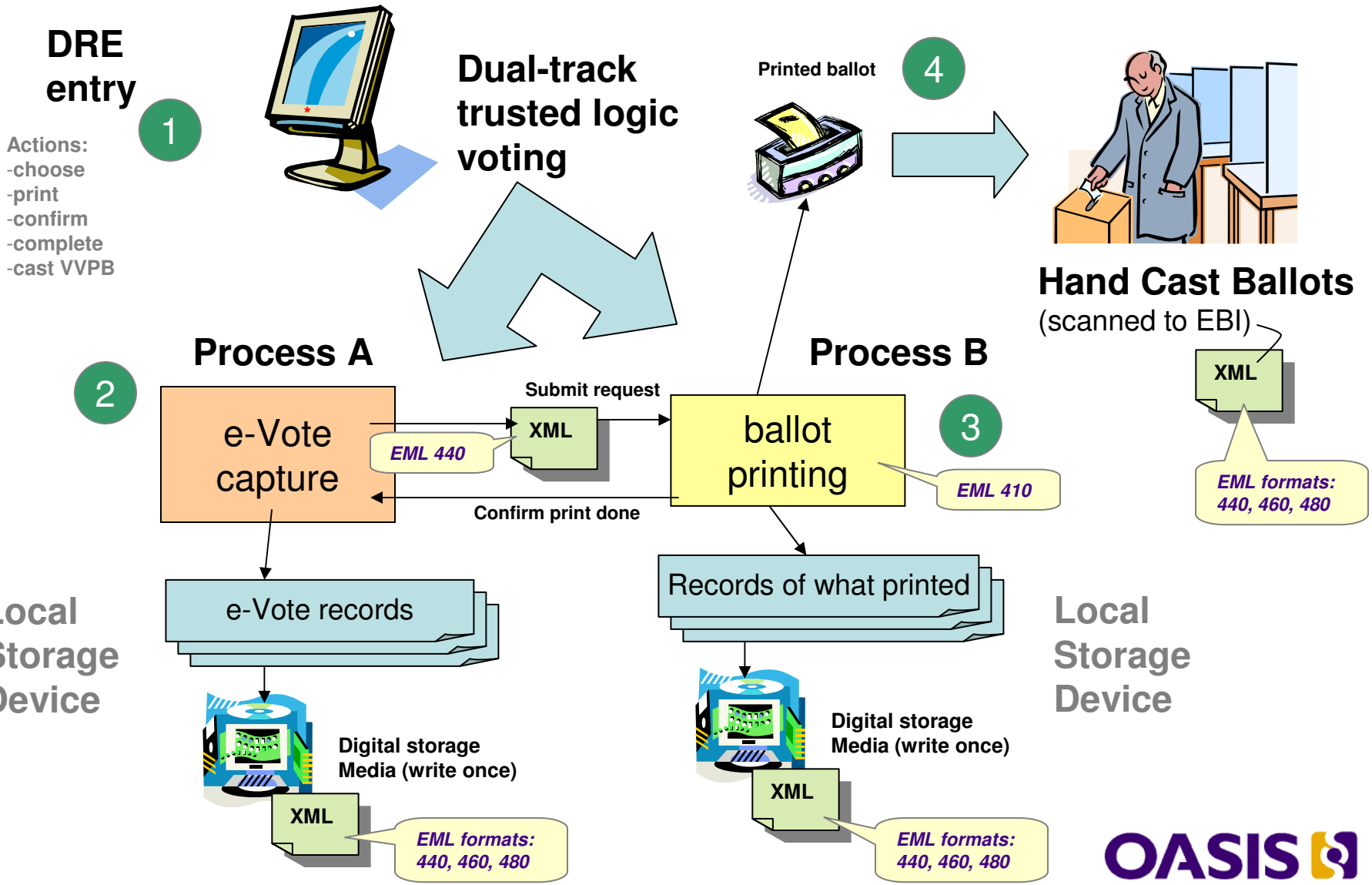
more process details – NIST / HAVA: http://vote.nist.gov/TGDC/Process%20Model%2020050223.pdf

OASIS

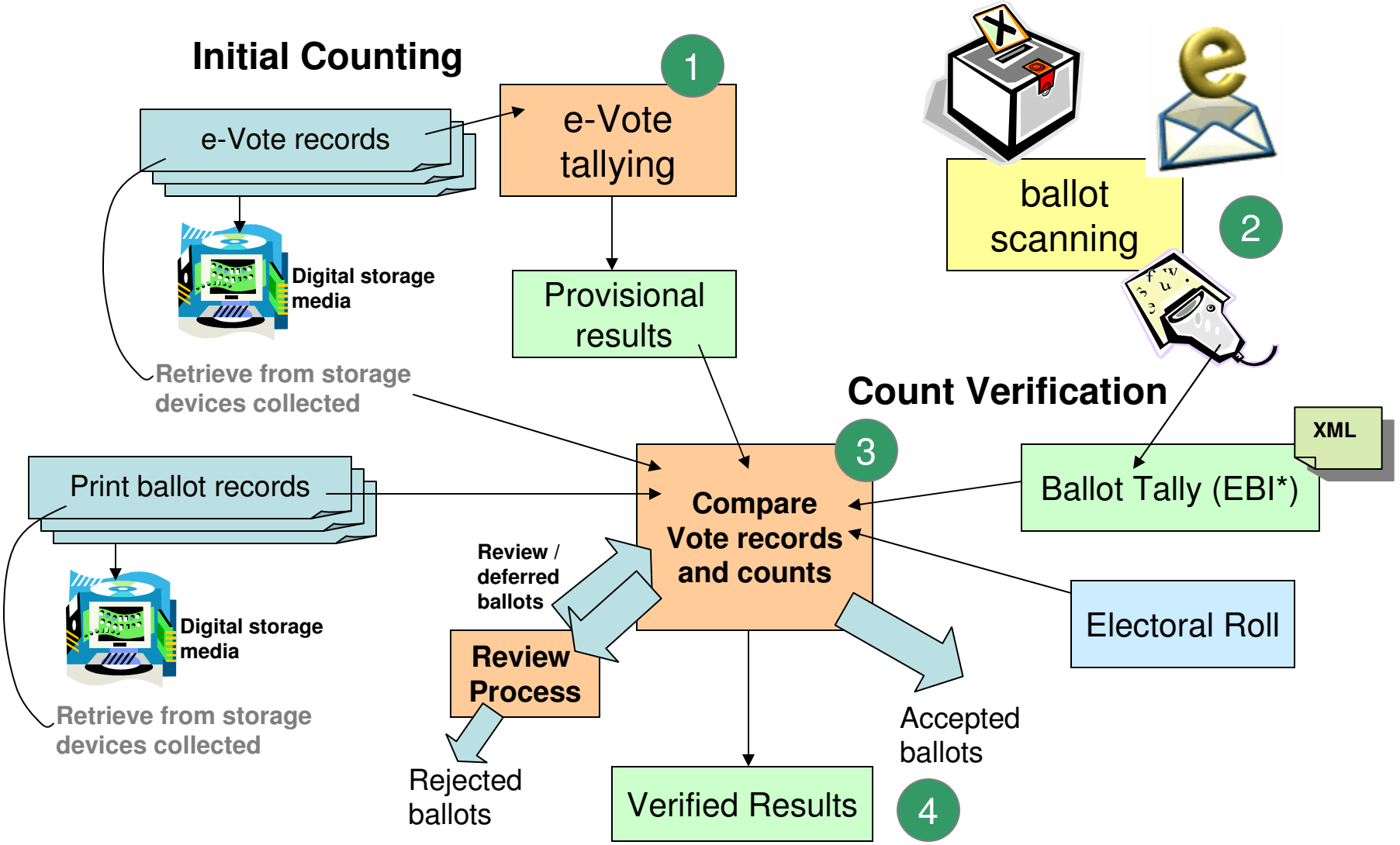
Projected US implementation flow



Action Process : Voting



Action Process : Counting



*Electronic Ballot Imaging - http://www-128.ibm.com/developerworks/xml/library/x-matters36.html

OASIS

Action Process : Voter Verification

1

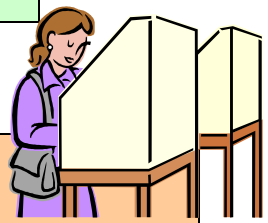
Electoral Roll

Token enabling device

Provide random voting token

2

Recycle voting token



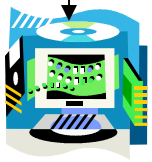
3

Proceed to Voting booth

4

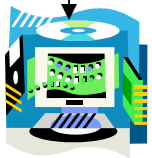
Deposit ballot

Electoral records



Digital storage media

Digital voting records



Digital storage media

KEY FACTOR: Avoid inadvertent sequential local information imprinting!

OASIS

Creating an open marketplace

- Open *trusted logic voting (TLV)* that underpins voting in the digital age
- A healthy and open marketplace where a broad range of service providers can deliver solutions to citizens, using off-the-shelf cost-effective components, that support and enhance the voting system and experience
- Based on open specifications that have free use licensing and not encumbered by any specific proprietary technology
- Inform and guide legislators and administrators

OASIS

TLV Implementation Components

1. Voter registration and ballot day sign-in - separate system, with separate counts and reporting at end of day. Providers voters with access to voting system to cast their ballot; uses OASIS EML formats
2. Separate Voting system that voters access to select choices, make vote, passes choices to VVPAT printing system, creates electronic record of vote (uses simple ballot-ID to provide crosscheck and real-time auditing). Supports disabled access and multilingual access.
3. Ballot printing system - creates paper record, and printing audit electronic record. Voter confirms paper ballot detail, and casts vote into ballot box. Ballot-ID printed on ballot; ballot is scanned into EBI*.
4. Real-time counting - after polls close – provides 100% crosscheck via ballot-ID between counts from 1), 2) and 3). Takes OASIS EML records and counts them. Counting software is open source. Using 3 separate count systems – gives banking system level of robust auditing and trust.
5. The goal is to provide the underlying functions as OSI - and then allow solution providers to provide localization and value-add above that.

Summary – What EML supports

- Allows implementation of *trusted logic process* combining paper and digital ballots
- Details of the core elements and their interactions, safeguards and cornerstones
- Mechanisms and separations to secure process and provide audit crosschecks
- XML required to run all the exchanges
- Open international public specifications

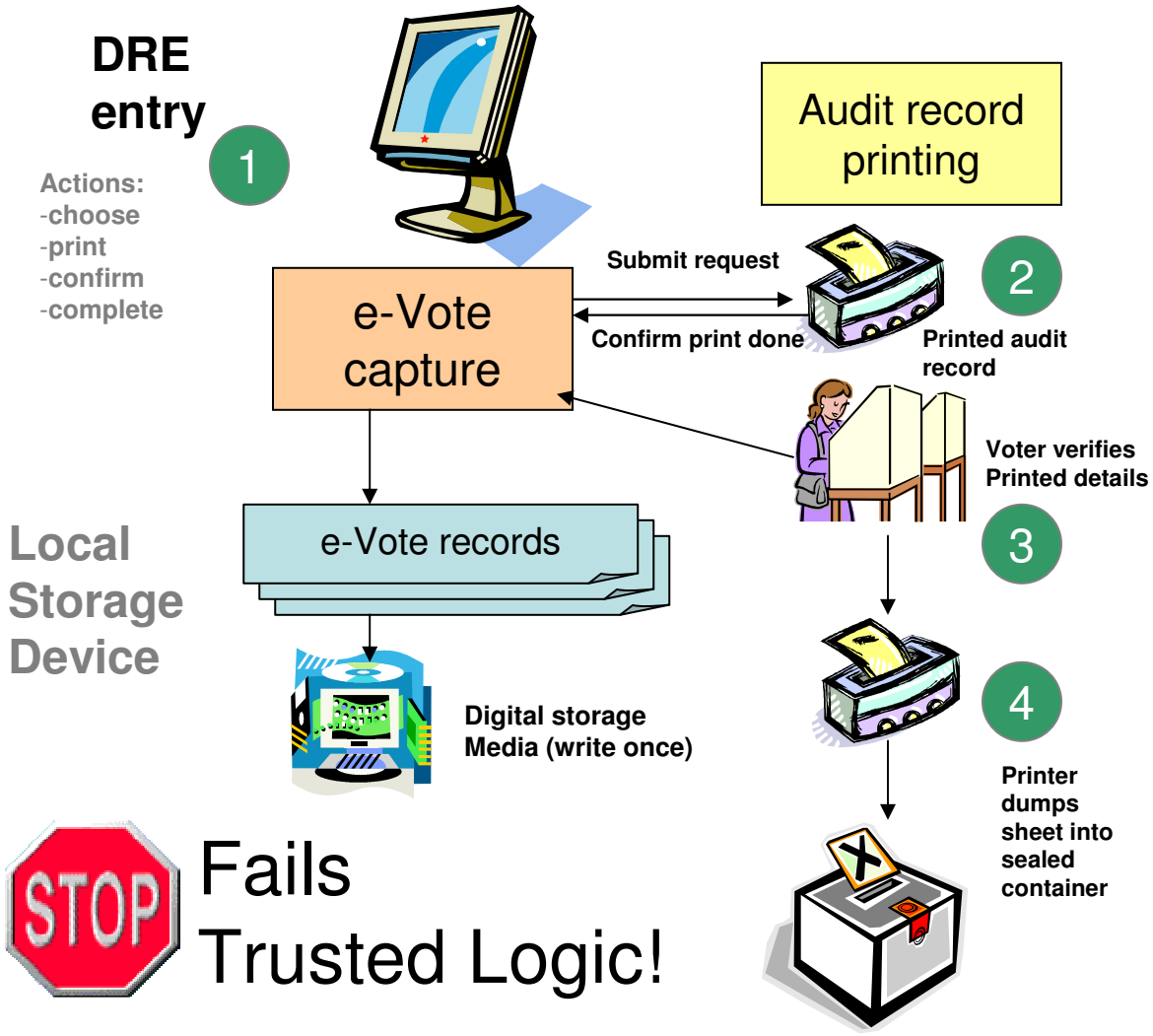
OASIS

Useful Resources

- Website of Professor Rebecca Mercuri - http://www.notablesoftware.com/evote.html
- Brookings Institute Report - Agenda for Election Reform - http://www.brook.edu/comm/policybriefs/pb82.htm
- CalTech site on ensuring voting integrity - http://vote.caltech.edu/reports
- NYVV - Advantages of ballot scanners over DREs - http://www.nyvv.org/paperballotVsDRE.htm
- Analysis of counting irregularities in US elections - http://ideamouth.com/voterfraud.htm
- MIT Study on accuracy of voting systems - http://vevo.verifiedvoting.org/vendors/studies/20040601_Ansolabeherepaper.pdf
- Verified Voting site http://www.verifiedvoting.org
- West Virginia procedures for optical scanning ballots - http://www.wvsos.com/elections/eday/procedureselectronic.htm
- Administration and Cost of Elections (ACE) - http://www.aceproject.org/main/english/index.htm
- Anecdotal reporting on 2004 US elections - http://www.lionsgrip.com/voting2004.html
- NIST Glossary of Terms document – http://vote.nist.gov/TGDC/voting glossaryv2Feb28.doc
- IEEE P1622 - http://grouper.ieee.org/groups/scc38/1622/p1622_documents.htm
- Overview of EML: http://www.idealliance.org/papers/xmle03/slides/spencer/spencer.ppt
- Technical aspects vote processing: http://gnosis.cx/publish/voting/privacy-electronic-voting.pdf
- Trusted Logic Voting: http://drrw.net/backup/Trusted-Ballot-Processing-Nutshell.pdf

OASIS

DRE + VVPAT "Sealed" Printer Analysis



TRUST ISSUES

- **A** Voter unable to directly verify what the printer dumps into the container
- **B** Sequence of paper in container may not be random enough compared to single central ballot box
- **C** Printer could print information that is not verified by voter (not anonymous)
- **D** Single vendor for voting and printing devices
- **E** Requires special printer instead of familiar everyday printer
- **F** More difficult for visually impaired voters to verify printed ballot behind plexi-glass shield
- **G** Use of special embossed paper in printer would increase voter trust
- **H** Equipment reliability and failures
- **I** DRE can manipulate vote and printing without needing voter intervention, or by ignoring / misleading voter
- **J** Voter cannot be assured that spoiled or incomplete ballots really are ignored
- **K** Missing use of standard XML to configure Ballot forms and manage printing

OASIS