Outline

- Classic Electronic Voting System
- Interesting Things to Know
- Different Voting Channels
- Real Voting Ballots
- Requirements for (Belgian) Voting Systems
- Voting using Magnetic Stripe Cards
- Improved Paper-based Voting System
- Requirements for Belgian Elections
- Organizing Elections
Classic **Electronic Voting**…

- Introduced in 1991, pilots in 1994, large scale deployment in 1999, currently 44% coverage
- Standalone voting computers – not networked
  - Impossible to cast invalid vote – only valid or blank
  - Open-source software
- Voter uses light pen to select candidates
- Voting ballot encoded on magnetic stripe card
  - Ballot secrecy & integrity through cryptography
Interesting Things to Know (ITK)

- Voting is mandatory in Belgium
  - Everyone strictly older than 17 **must** go cast a vote
  - Sanctions & Fines with respect to ignored voting duty:
    - Police court rules, no appeal possible
    - First offender: 50 Euro
    - Second offense: 125 Euro
    - 4 offenses in less than 15 years: 10 years revocation of
      - Voting rights
      - Right to become a civil servant
      - Possibility to get promotion or distinction as a civil servant

- 7 Election types → 7 Paper ballot forms 😊
  - European, Federal (Chamber + Senate), Provincial, Regional, Communal, Local Council
Different Voting Channels

- **Uncontrolled environment**
  - Pencil + paper
    - Postal vote – Belgian citizens living abroad
  - Electronically
    - Internet voting – Nobody

- **Controlled environment**
  - Pencil + paper
    - Voting booths
      - 56%: mostly in Wallonia
  - Electronically
    - Voting booths with offline voting machines
      - 44%: Brussels, Flanders
    - Networked voting machines – Nobody
Real Voting Ballots

46cm wide, 24.19cm high
18.11” x 9.45”
# Real Voting Ballots

**SENAAT**

**VLAAMSE KIESKRING**

13 JUNI 2010

**VERKIEZING VAN 25 SENATOREN**

- 44.54cm wide, 52.61cm high
- 17.4” x 20.55”

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**KIESKRING ANTWERPEN**

7 JUNI 2009

**VERKIEZING VAN 33 LEDEN VAN HET VLAAMS PARLEMENT**

- 50.41cm wide, 68.56cm high
- 19.69” x 26.78”
Real Voting Ballots

49.54cm wide, 64.07cm high
19.35” x 25.03”

61.3cm wide, 86.68cm high
23.94” x 33.86”
1 Voting Ballot per Election (Chamber, Senate, Regional, European Parliament, …)

Easily 1 meter

Easily 0.5 meter

Up to 88 Candidates Per List!
ITK – Casting a Valid Vote

- Number of elected seats equals number of List votes + number of votes of main candidates + number of votes of successors
- Number of list votes influences the number of elected candidates per list
- A ballot is rendered invalid if a voter ticks candidates of more than one list

Voter can tick List Vote

Voter can also tick any number of main candidates

Voter can also tick any number of successors
Electronic Representation of a Voting Ballot

- Candidates are numbered
- Menu to represent large voting ballot:
  - Party menu
    - Voter selects his/her party
  - Candidates Menu per party
    - Number of candidates sets the number of columns
      - Voter selects candidates or list
- Note:
  - One cannot cast an invalid electronic vote
  - Voter can vote blank by choosing the “Blank party”
Requirements for (Belgian) Voting Systems

- Universal
  - Everybody can cast a vote
- Equal
  - Everybody has just one vote
- Freedom
  - Everybody can cast his/her vote of his/her choice
- Secrecy
  - Only the voter knows who he has voted for
- Transparency
  - Everything must be simple, publicly available/known
- Verifiability
  - Voting and counting systems are verifiable
Correctness…

- **Transparency**
  - Voter can/cannot check voting ballot correctness
  - Observer can/cannot check voting ballot correctness

- **Auditability**
  - Voter can/cannot audit election
  - Observer can/cannot audit election
Trustworthiness

- Voting system = Technology + **People** + Processes

- Paranoia:
  - Does the technology function correctly?
  - Did the voting officials validate the configuration?
  - Is the vote correctly recorded?
  - Is the vote correctly counted?
  - Is the election result correct?
  - Did independent auditors validate the elections?

- Pop quiz:
  - Why would a voting system reflect the voter’s choice?
Comparing (e)Voting Systems

- Paper + Pencil
  - Well known, highly trusted

- Current System (Magnetic Stripe Cards)
  - Good compromise to deal with complex voting rules
  - Mostly trusted

- Improved Paper-based Voting
  - Best compromise, verifiable trustworthiness
Paper + Pencil

- Cheap
- Simple
  - Everybody understands how it works
  - Not everybody understand potential problems...

- But
  - Easy to invalidate voting ballots
  - Sometimes hard to distinguish voting ballot marks
  - Not really anonymous
    - Physical traces on paper: fingerprints, scratches, stains,...
  - Voting ballots can grow large in some cantons
  - Costly preparation, printing and distribution of ballots
  - Counting is cumbersome and slow
Classic Electronic Polling Station Components

- 589 municipalities
  - 44% of these use voting computers
- One or more polling stations per municipality
- One or more voting offices per polling station
- Each voting office using electronic voting has:
  - 5 or 6 voting booths
  - 1 voting computer per voting booth
  - 1 electronic urn to collect magnetic stripe ballots
  - 1 computer for the president of the voting office
- About 20,000 voting computers in total
  - On average 300 voters per voting computer
Classic Electronic Voting Booth
Issues with Magnetic Stripe Cards Voting

- Lack of transparency
  - Magnetic stripe card = voter’s choice?
  - Voting computer may have stored different ballot

- Lack of verifiability
  - Is magnetic stripe ballot also counted?
    - Voting urn may overwrite magnetic stripe

Organizational and procedural measures neutralize these potential issues
Key Arguments to Introduce New System

- Hardware of “current” system is outdated
  - Supply issues
- Countering issues with magnetic stripe cards
- Dependable and verifiable marking of candidates
  - Voter can verify voting ballot
- Secure transport of voting ballots
  - Protection against eavesdropping and modification of ballot storage and transmission
- Counting votes: accurate and fast
  - No need for manual counting
  - Support for recounting
  - Manual audit
Suggested eVoting Booth Components

- Printer
- Touch screen with inductive pen
- Smartcard Reader to activate Voting process
- Optional interface for visually challenged
- Simplest Computer Possible

17 June 2011
Eventually – eVoting Booth Components

- Touch screen
- Smartcard Reader to activate Voting process
- Simplest Computer Possible
- Printer
## Future Voting Ballot

<table>
<thead>
<tr>
<th>Senate Election</th>
<th>Chamber Election</th>
<th>European Election</th>
<th>Province Election</th>
<th>Region Election</th>
<th>Local Election</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selected Party</td>
<td>Selected Party</td>
<td>Selected Party</td>
<td>Selected Party</td>
<td>Selected Party</td>
<td>Selected Party</td>
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<tr>
<td>1. First Name</td>
<td>17. First Name</td>
<td>33. First Name</td>
<td>49. First Name</td>
<td>65. First Name</td>
<td>81. First Name</td>
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<tr>
<td>2. Second Name</td>
<td>18. Second Name</td>
<td>34. Second Name</td>
<td>50. Second Name</td>
<td>66. Second Name</td>
<td>82. Second Name</td>
</tr>
<tr>
<td>3. Third Name</td>
<td>19. Third Name</td>
<td>35. Third Name</td>
<td>51. Third Name</td>
<td>67. Third Name</td>
<td>83. Third Name</td>
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<tr>
<td>4. Fourth Name</td>
<td>20. Fourth Name</td>
<td>36. Fourth Name</td>
<td>52. Fourth Name</td>
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<tr>
<td>5. Fifth Name</td>
<td>21. Fifth Name</td>
<td>37. Fifth Name</td>
<td>53. Fifth Name</td>
<td>69. Fifth Name</td>
<td>85. Fifth Name</td>
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<tr>
<td>6. Sixth Name</td>
<td>22. Sixth Name</td>
<td>38. Sixth Name</td>
<td>54. Sixth Name</td>
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<td>23. Seventh Name</td>
<td>39. Seventh Name</td>
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<td>71. Seventh Name</td>
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<tr>
<td>8. Eighth Name</td>
<td>24. Eighth Name</td>
<td>40. Eighth Name</td>
<td>56. Eighth Name</td>
<td>72. Eighth Name</td>
<td>88. Eighth Name</td>
</tr>
<tr>
<td>9. Ninth Name</td>
<td>25. Ninth Name</td>
<td>41. Ninth Name</td>
<td>57. Ninth Name</td>
<td>73. Ninth Name</td>
<td>89. Ninth Name</td>
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<td>10. Tenth Name</td>
<td>26. Tenth Name</td>
<td>42. Tenth Name</td>
<td>58. Tenth Name</td>
<td>74. Tenth Name</td>
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<td>11. Eleventh Name</td>
<td>27. Eleventh Name</td>
<td>43. Eleventh Name</td>
<td>59. Eleventh Name</td>
<td>75. Eleventh Name</td>
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<td>12. Twelfth Name</td>
<td>28. Twelfth Name</td>
<td>44. Twelfth Name</td>
<td>60. Twelfth Name</td>
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<td>29. Thirteenth Name</td>
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<td>61. Thirteenth Name</td>
<td>77. Thirteenth Name</td>
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<td>14. Fourteenth Name</td>
<td>30. Fourteenth Name</td>
<td>46. Fourteenth Name</td>
<td>62. Fourteenth Name</td>
<td>78. Fourteenth Name</td>
<td>94. Fourteenth Name</td>
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<tr>
<td>15. Fifteenth Name</td>
<td>31. Fifteenth Name</td>
<td>47. Fifteenth Name</td>
<td>63. Fifteenth Name</td>
<td>79. Fifteenth Name</td>
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</tr>
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<td>16. Sixteenth Name</td>
<td>32. Sixteenth Name</td>
<td>48. Sixteenth Name</td>
<td>64. Sixteenth Name</td>
<td>80. Sixteenth Name</td>
<td>96. Sixteenth Name</td>
</tr>
</tbody>
</table>
Future Voting Office’s Equipment

Ballot Verifier

Ballot Box

© George Patton Associates, Inc.
Improved Paper-based Voting Ballots Properties

- Barcode represents same information as human readable part
- Barcode digitally signed by voting computer
  - Signature not linkable to voter
- Barcode encrypted under public key of election administration
  - Photo of barcode does not compromise voter secrecy
- Extension of this system can be fully verifiable
  - Voter gets a copy of the hash of barcode
  - Ballot has been counted if hash value is listed online
System Validated by Council of Europe

- Requirements for Free and Fair Elections
  - Universal
    - Everybody can cast a vote
  - Equal
    - Everybody has just one vote
  - Freedom
    - Everybody can cast his/her vote of his/her choice
  - Secrecy
    - Only the voter knows who he has voted for
  - Transparency
    - All procedures are simple, publicly available and known
  - Verifiability
    - Voting and counting systems are verifiable
- Only recommendation
  - Voters and external observers must check correctness of voting ballots
Questions?

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  - godot@godot.be

- **Homepage:**
  - http://godot.be

- **Slides:**
  - http://godot.be/slides
Voter’s Secrecy

- Belgian election system is ‘vulnerable’ to pattern-based voting
  - Avoid manual processing of ballots
- Voter’s fingerprints or marks on paper based ballots
- Cameras in mobile phones, cf. vote selling
- Miniaturized cameras in voting office or booth
- Electromagnetic radiation (TEMPEST)
  - Perfect protection is complicated and expensive
  - Adequate protection is feasible
Casting Votes at a Polling Place

Facts:

1. Voters living in a municipality cast their vote in a voting office
2. Each voting office has a list with eligible voters
3. Each voting office has one voting urn to collect completed voting ballots
4. A voting ballot consists either of a paper ballot or of a magnetic stripe card
5. Election period = 1 Sunday, starting at 9.00
   1. Offices using paper ballots close at 13.00
   2. Offices using magnetic stripe cards close at 15.00
Processing Election Results

- If a candidate dies before the Election Day
  - The deceased is treated as if he/she never existed
  - Votes for the deceased are taken into account to determine the number of voters for the candidate’s list
- If a candidate dies on the Election Day or after the Election Day but before the official announcement of the Election Result
  - The deceased may be elected, but the first successor takes his seat
- If a candidate dies after the official announcement of the Election Result
  - The deceased is replaced by the first successor
- If a candidate dies after closing the candidate list but before printing the paper ballots
  - The list does not include the name of the deceased
Requirements for Belgian eVoting Systems

- Be combinable with classic paper voting system
- Be usable in the Belgian context
  - Cf. 7 election types, complex ballots...
- Not too expensive
- Available at all times
- Modular & flexible
  - Different voting systems may be used in one canton
  - Installable in voting offices and voting booths
- Customizable
  - List of elections, candidates & parties varies per election
- Easy to verify
  - Correct casting of votes, 1 voter = 1 ballot
  - Correct counting of votes
  - Secrecy of the vote
- Encourage the automated processing of votes
  - Automated casting of votes is less important
- Be very easy to use (user friendliness, simple,...)
- Be very accessible/attractive to
  - Non-computer literate people, elderly, disabled people,...
Operational Aspects

- D-80: Preparation of lists with eligible voters
- D-40: Independent experts can start auditing the Election procedure
- D-33: Publication of banned acronyms in Belgian Gazette
- D-30: Lottery to rank parties on voting ballots
- D-26: Publication of parties and their numbers in Belgian Gazette
- D-28: Deadline to submit election candidates
- D-24: Fixing lists with election candidates
- D-15: Publishing names of election witnesses, Mail broadcast of election convocation letters
- D-12: Appointing presidents and assistants of voting offices
- D-10: Mail broadcast of lists with eligible voters per voting office
- D- 5: Appointing election witnesses of voting & counting offices
- D- 3: Deadline of voting computer boot floppy delivery to president of cantonal headquarters
- D- 1: President of voting office receives voting ballots, distribution of computer boot floppies to presidents of voting offices
- D: Election day, processing voting ballots after closing election period
- D+15: End of the audit possibility of independent experts
- D+45: Publication of election results
- D+75: Finalization of election-related expenses
Voting Booth + Barcode voting ballots

1. Use chip card to activate voting computer
2. Use touch screen to mark candidates
3. Print voting ballot

Touch screen with inductive pen
chip card reader
mini PC
Optional interface for visually challenged