



Electronic Voting in Belgium Past and Future

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Slides available from <http://godot.be/slides>



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

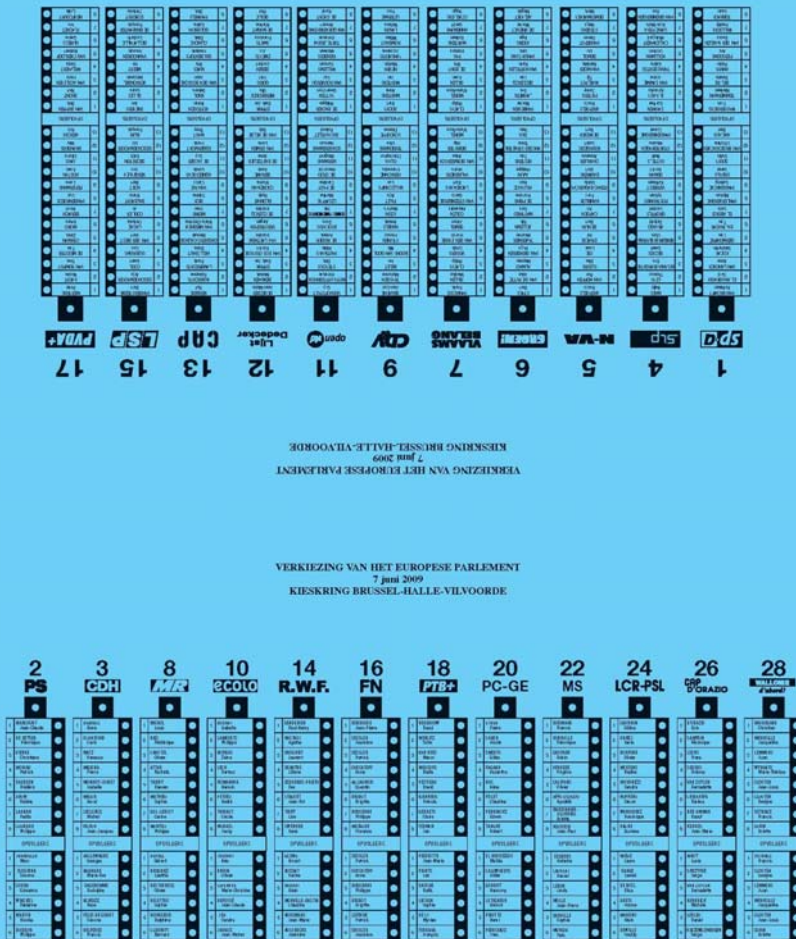
Real Voting Ballots

ELECTION DE LA CHAMBRE DES REPRESENTANTS
CIRCONSCRIPTION ELECTORALE DE LA PROVINCE DE LUXEMBOURG
13 JUIN 2010
ELECTION DE 4 MEMBRES DE LA CHAMBRE DES REPRESENTANTS

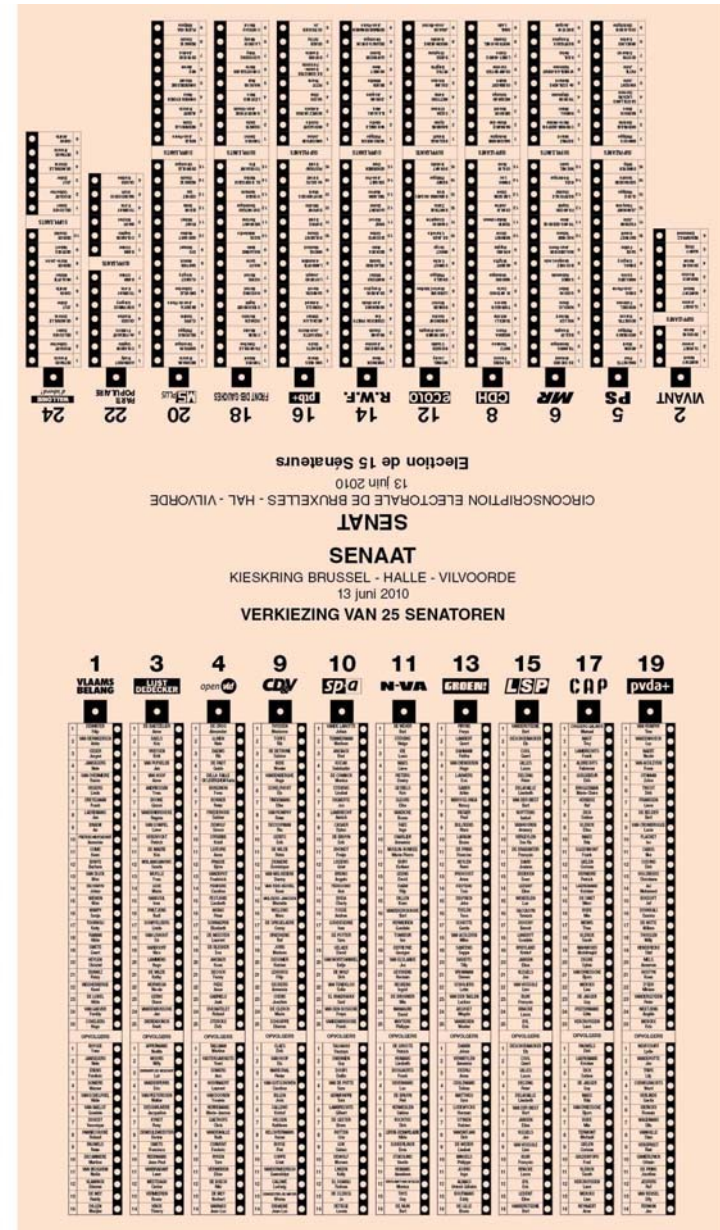
5 PS	6 MR	8 GDH	12 eCOLO	14 R.W.F.	16 ptb+	18 FRONT DES GAUCHES	20 ME PLUS	22 PARTI POPULAIRE	24 WALLONIE d'abord!	25 BELG.UNIE
1 COURARD Philippe ●	1 COLLARD Philippe ●	1 LUTGEN Benoît ●	1 THIBAUT Cécile ●	1 SWIDERSKI Alain ●	1 DULIEU Myriam ●	1 CAHEN Nicole ●	1 CALFANO Olivier ●	1 VANDERBIEST Didier ●	1 LISOT Pascal ●	1 PONCELET Gérard ●
2 BORDI Wronoque ●	2 LAFFIT Anne ●	2 PONCELET Isabelle ●	2 GAUDRON Romain ●	2 LAURENT-HENROTTE Annick ●	2 RASSAA Rafik ●	2 DIEZ Bernard ●	2 LIBOUL Claire ●	2 DESAUX DE MARGNY-PEYCKER Viviane ●	2 GUSSARD Christelle ●	2 BOVY Gilberte ●
3 DAVREUX Anne ●	3 WEBER Marie-Claude ●	3 KRISCH Christiane ●	3 BOIRON Annick ●	3 GENDREBEN DESMET Jean Mathieu ●	3 PASQUIER Françoise ●	3 DEL DEBBIO Vittoria ●	3 CLYX Eric ●	3 CHARLET Luc ●	3 TROMPETTE Jean ●	3 de HEMPTINNE Florence ●
4 STEIFER Francis ●	4 JACQUET Michel ●	4 BOUCHAT André ●	4 FION François ●	4 WEYER Angélique ●	4 LEXANE Christian ●	4 DONCEEL Michel ●	SUPPLEANTS	4 GERARD Edwige ●	4 LEVEQUE Mélissa ●	4 BALTUS Jean-Marie ●
SUPPLEANTS	SUPPLEANTS	SUPPLEANTS	SUPPLEANTS	SUPPLEANTS	SUPPLEANTS	SUPPLEANTS	1 LIBOUL Claire ●	SUPPLEANTS	SUPPLEANTS	SUPPLEANTS
1 PERPETE André ●	1 PEDROELF Benoît ●	1 ARENS Jony ●	1 PETIT Jérôme ●	1 SWIDERSKI Alain ●	1 ZAMORA Daniel ●	1 BISEN Bernard ●	2 CLYX Eric ●	1 VANDERBIEST Didier ●	1 GUSSARD Christelle ●	1 CONTER Jo ●
2 HEYDEN Stéphanie ●	2 RASSE Chantal ●	2 MANN Thérèse ●	2 SERVUS Isabelle ●	2 DE CLERCO Odette ●	2 ROEMANS Gertraude ●	2 BLISTAN Mireille ●	3 CALFANO Olivier ●	2 DESAUX DE MARGNY-PEYCKER Viviane ●	2 BIETHERES Geoffrey ●	2 STRE Marie-Catherine ●
3 WEYRICH Olivier ●	3 BARRY Cédric ●	3 VAN DEN ENDE-CHAPPELLER Annick ●	3 DE FRIEUREAU Paul ●	3 DEFAUT Francis ●	3 WILLENS Mathieu ●	3 DIEZ Frédéric ●	4 FRANCHOLOY Jean ●	3 DARRIELS Arnaud ●	3 LEVEQUE Mélissa ●	3 BEAUDOINT-DAVID Pasalitte ●
4 SONNET Malika ●	4 ALBYR Mélissa ●	4 BALTHAZARD Vitorique ●	4 GOFFIN Annie ●	4 BERTRAND Annick ●	4 VANDAMME Godelieve ●	4 EVIARD Jacqueline ●	5 DE ROECK Catharina ●	4 GERARD Edwige ●	4 TROMPETTE Jean ●	4 DELAUNOIS Vincent ●
5 NEUBERG Marie ●	5 NOEL Mariville ●	5 DERLPE Elin ●	5 STILMANT Nicolas ●	5 DELAMITTE Verthe ●	5 HERTOGEN Kristiaan ●	5 ANDRE Nelly ●	6 WARINON Audrey ●	5 CHARLET Luc ●	5 LAMAUT Stéphanie ●	5 NYSSENS Hubert ●
6 PILOT Sébastien ●	6 EVIARD Yves ●	6 FOURNY Damien ●	6 DEWANT Christina ●	6 HERMAN René ●	6 FILLEUX Guillemine ●	6 HORMAN Denis ●		6 SORGELOS Annie ●	6 LISOT Pascal ●	6 BOVY Gilberte ●

46cm wide, 24.19cm high
18.11" x 9.45"

Real Voting Ballots



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

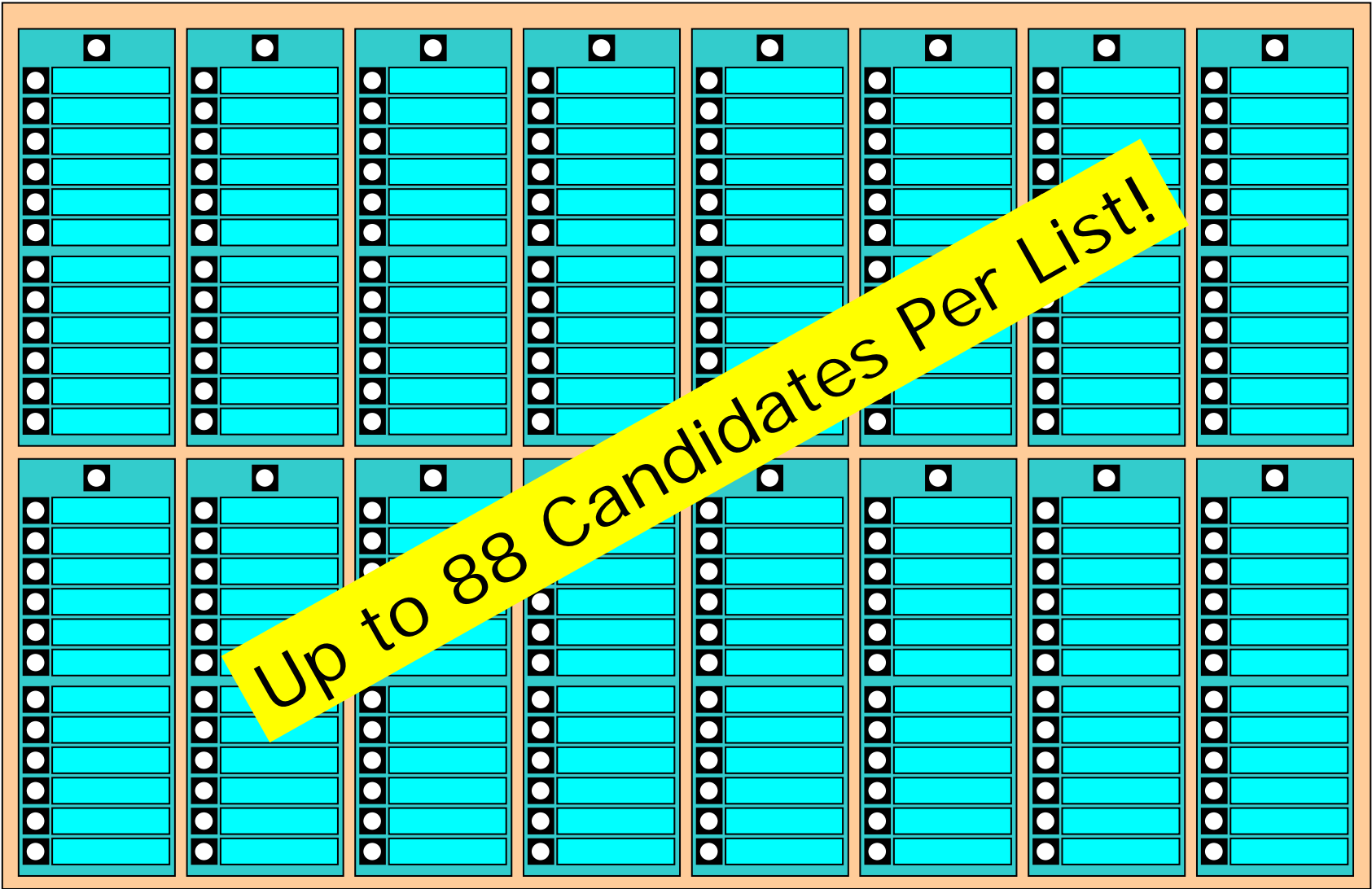


61.3cm wide, 86.68cm high
23.94" x 33.86"

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

The ballot interface consists of a teal header with a large white circle in a black square. Below this is a list of candidates, each with a white circle in a black square to its left. The candidates are numbered 1, 2, 3, followed by an ellipsis, then two more candidates, another ellipsis, and finally candidates 25, 26, 27, 28, and 29.

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



Ballot Section	Charter Election	Regional Election	Provincial Election	Regional Election	Local Election
1. First Name	11. First Name	21. First Name	31. First Name	41. First Name	51. First Name
2. Second Name	12. Second Name	22. Second Name	32. Second Name	42. Second Name	52. Second Name
3. Third Name	13. Third Name	23. Third Name	33. Third Name	43. Third Name	53. Third Name
4. Fourth Name	14. Fourth Name	24. Fourth Name	34. Fourth Name	44. Fourth Name	54. Fourth Name
5. Fifth Name	15. Fifth Name	25. Fifth Name	35. Fifth Name	45. Fifth Name	55. Fifth Name
6. Sixth Name	16. Sixth Name	26. Sixth Name	36. Sixth Name	46. Sixth Name	56. Sixth Name
7. Seventh Name	17. Seventh Name	27. Seventh Name	37. Seventh Name	47. Seventh Name	57. Seventh Name
8. Eighth Name	18. Eighth Name	28. Eighth Name	38. Eighth Name	48. Eighth Name	58. Eighth Name
9. Ninth Name	19. Ninth Name	29. Ninth Name	39. Ninth Name	49. Ninth Name	59. Ninth Name
10. Tenth Name	20. Tenth Name	30. Tenth Name	40. Tenth Name	50. Tenth Name	60. Tenth Name
11. Eleventh Name	21. Eleventh Name	31. Eleventh Name	41. Eleventh Name	51. Eleventh Name	61. Eleventh Name
12. Twelfth Name	22. Twelfth Name	32. Twelfth Name	42. Twelfth Name	52. Twelfth Name	62. Twelfth Name
13. Thirteenth Name	23. Thirteenth Name	33. Thirteenth Name	43. Thirteenth Name	53. Thirteenth Name	63. Thirteenth Name
14. Fourteenth Name	24. Fourteenth Name	34. Fourteenth Name	44. Fourteenth Name	54. Fourteenth Name	64. Fourteenth Name
15. Fifteenth Name	25. Fifteenth Name	35. Fifteenth Name	45. Fifteenth Name	55. Fifteenth Name	65. Fifteenth Name



Smartcard Reader to activate Voting process



Optional interface for visually challenged



Simplest Computer Possible

Eventually – eVoting Booth Components



Smartcard
Reader to activate
Voting process

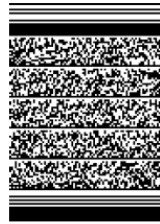


Simplest
Computer Possible



Printer

Future Voting Ballot



Cast in Leuven

**Check and
fold this
ballot**

Senate Election
Selected Party

1. First Name
2. Second Name
3. Third Name
4. Fourth Name
5. Fifth Name
6. Sixth Name
7. Seventh Name
8. Eighth Name
9. Ninth Name
10. Tenth Name
11. Eleventh Name
12. Twelfth Name
13. Thirteenth Name
14. Fourteenth Name
15. Fifteenth Name
16. Sixteenth Name

Chamber Election
Selected Party

17. First Name
18. Second Name
19. Third Name
20. Fourth Name
21. Fifth Name
22. Sixth Name
23. Seventh Name
24. Eighth Name
25. Ninth Name
26. Tenth Name
27. Eleventh Name
28. Twelfth Name
29. Thirteenth Name
30. Fourteenth Name
31. Fifteenth Name
32. Sixteenth Name

European Election
Selected Party

33. First Name
34. Second Name
35. Third Name
36. Fourth Name
37. Fifth Name
38. Sixth Name
39. Seventh Name
40. Eighth Name
41. Ninth Name
42. Tenth Name
43. Eleventh Name
44. Twelfth Name
45. Thirteenth Name
46. Fourteenth Name
47. Fifteenth Name
48. Sixteenth Name

Province Election
Selected Party

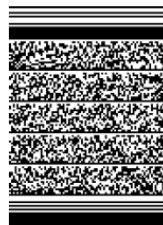
49. First Name
50. Second Name
51. Third Name
52. Fourth Name
53. Fifth Name
54. Sixth Name
55. Seventh Name
56. Eighth Name
57. Ninth Name
58. Tenth Name
59. Eleventh Name
60. Twelfth Name
61. Thirteenth Name
62. Fourteenth Name
63. Fifteenth Name
64. Sixteenth Name

Region Election
Selected Party

65. First Name
66. Second Name
67. Third Name
68. Fourth Name
69. Fifth Name
70. Sixth Name
71. Seventh Name
72. Eighth Name
73. Ninth Name
74. Tenth Name
75. Eleventh Name
76. Twelfth Name
77. Thirteenth Name
78. Fourteenth Name
79. Fifteenth Name
80. Sixteenth Name

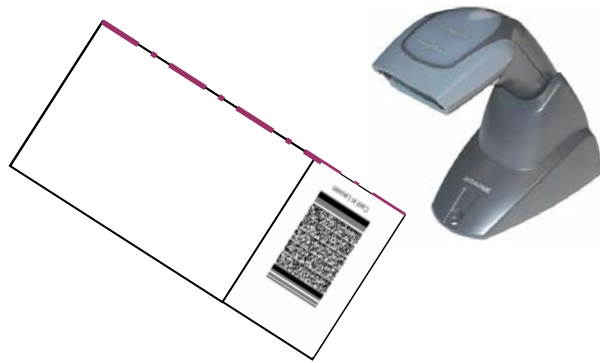
Local Election
Selected Party

81. First Name
82. Second Name
83. Third Name
84. Fourth Name
85. Fifth Name
86. Sixth Name
87. Seventh Name
88. Eighth Name
89. Ninth Name
90. Tenth Name
91. Eleventh Name
92. Twelfth Name
93. Thirteenth Name
94. Fourteenth Name
95. Fifteenth Name
96. Sixteenth Name

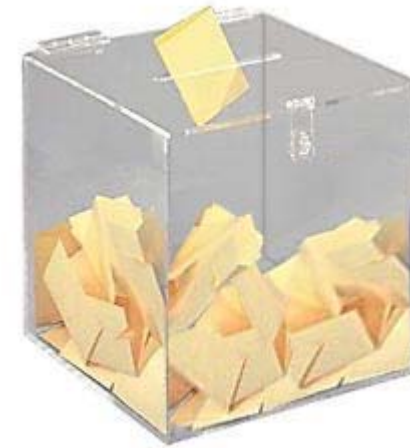


Cast in Leuven

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?

- Email:

- Danny.DeCock@esat.kuleuven.be
- 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

3. print voting ballot



2. use touch screen to mark candidates



1. use chip card to activate voting computer



chip card reader



mini PC



optional interface for visually challenged

State Election General	County Election General	City Election General	Primary Election General	Regional Election General	Local Election General
1. State Election General	1. County Election General	1. City Election General	1. Primary Election General	1. Regional Election General	1. Local Election General
2. State Election General	2. County Election General	2. City Election General	2. Primary Election General	2. Regional Election General	2. Local Election General
3. State Election General	3. County Election General	3. City Election General	3. Primary Election General	3. Regional Election General	3. Local Election General
4. State Election General	4. County Election General	4. City Election General	4. Primary Election General	4. Regional Election General	4. Local Election General
5. State Election General	5. County Election General	5. City Election General	5. Primary Election General	5. Regional Election General	5. Local Election General
6. State Election General	6. County Election General	6. City Election General	6. Primary Election General	6. Regional Election General	6. Local Election General
7. State Election General	7. County Election General	7. City Election General	7. Primary Election General	7. Regional Election General	7. Local Election General
8. State Election General	8. County Election General	8. City Election General	8. Primary Election General	8. Regional Election General	8. Local Election General
9. State Election General	9. County Election General	9. City Election General	9. Primary Election General	9. Regional Election General	9. Local Election General
10. State Election General	10. County Election General	10. City Election General	10. Primary Election General	10. Regional Election General	10. Local Election General
11. State Election General	11. County Election General	11. City Election General	11. Primary Election General	11. Regional Election General	11. Local Election General
12. State Election General	12. County Election General	12. City Election General	12. Primary Election General	12. Regional Election General	12. Local Election General
13. State Election General	13. County Election General	13. City Election General	13. Primary Election General	13. Regional Election General	13. Local Election General
14. State Election General	14. County Election General	14. City Election General	14. Primary Election General	14. Regional Election General	14. Local Election General
15. State Election General	15. County Election General	15. City Election General	15. Primary Election General	15. Regional Election General	15. Local Election General
16. State Election General	16. County Election General	16. City Election General	16. Primary Election General	16. Regional Election General	16. Local Election General
17. State Election General	17. County Election General	17. City Election General	17. Primary Election General	17. Regional Election General	17. Local Election General
18. State Election General	18. County Election General	18. City Election General	18. Primary Election General	18. Regional Election General	18. Local Election General
19. State Election General	19. County Election General	19. City Election General	19. Primary Election General	19. Regional Election General	19. Local Election General
20. State Election General	20. County Election General	20. City Election General	20. Primary Election General	20. Regional Election General	20. Local Election General