



# 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 to the polling station
  - 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 a 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 JUNI 2010  
ELECTION DE 4 MEMBRES DE LA CHAMBRE DES REPRESENTANTS

5 <b>PS</b>		6 <b>MR</b>		8 <b>GDH</b>		12 <b>ecolo</b>		14 <b>R.W.F.</b>		16 <b>ptb+</b>		18 <b>FRONT DES GAUCHES</b>		20 <b>ME PLUS</b>		22 <b>PARTI POPULAIRE</b>		24 <b>WALLONIE d'abord!</b>		25 <b>BELG.UNIE</b>	
1	COURARD Philippe	1	COLLARD Philippe	1	LUTGEN Berolt	1	THIBAUT Cécile	1	SWIDERSKI Alain	1	DULIEU Myriam	1	CAYEN Nicole	1	CALIFANO Olivier	1	VANDERBIEST Didier	1	LIGOT Pascal	1	PONCELET Gérard
2	BORDI Véronique	2	PONCELET Isabelle	2	KIRSCH Christiane	2	GAUDRON Romain	2	LAURENT-HENROTTE Annick	2	RASSAA Rafik	2	DEZ Bernard	2	DESJULX DE MARIQNY PEYGER Wiliane	2	GUSSARD Christelle	2	BOVY Gilberte		
3	DAVREUX Anne	3	WEBER Marie-Claude	3	BODRON Annick	3	BOIRON Annick	3	GENDEBEN DESMET Jean Mathieu	3	PASQUIER Françoise	3	DEL DEBBO Victoria	3	CUYX Eric	3	CHARLET Luc	3	TROMPETTE Jean	3	de HEMPINNE Florence
4	STEFER Francis	4	JACQUET Michel	4	BOUCHAT André	4	FRON François	4	WEYER Angélique	4	LEXANE Christian	4	DONCEEL Michel	SUPPLEANTS		4	GERARD Edwige	4	LEVIEGIE Mélissa	4	BALUIS Jean-Marie
SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS		SUPPLEANTS	
1	PERPETE André	1	PEDROEUF Berolt	1	ARENS Jony	1	PETIT Jérôme	1	SWIDERSKI Alain	1	ZAMORA Daniel	1	BESSEN Bernard	1	CUYX Eric	1	VANDERBIEST Didier	1	GUSSARD Christelle	1	CONTER Jo
2	HEYDEN Stéphanie	2	RASSE Chantal	2	MAYY Thérèse	2	SERVAIS Isabelle	2	DE CLERCO Odette	2	ROEMANS Gertrude	2	BUSTAN Mireille	2	DEZ Frédéric	2	DESJULX DE MARIQNY PEYGER Wiliane	2	BIETHERES Gauthier	2	STRE Marie-Catherine
3	WEYDICH Olivier	3	BAURY Cédric	3	VAN DEN ENDE- CHAPELLER Annick	3	DE FRIEUREAU Paul	3	DEFAUT Francis	3	WELLENS Mathieu	3	WILLIAMS Mathieu	3	FRANCHOY Jean	3	DANIELS Arnaud	3	LEVIEGIE Mélissa	3	BEAUDOINT-DAVID Pasquella
4	SOINET Malika	4	ALBY Mélissa	4	BALTHAZARD Véronique	4	COFFIN Annie	4	BERTRAND Annick	4	VANDAMME Godolève	4	EVARD Jacqueline	4	DE ROECK Catherine	4	GERARD Edwige	4	TROMPETTE Jean	4	DELAUNOIS Vincent
5	NEUBERG Marie	5	NOEL Marionne	5	DEBURE Elio	5	STILMANT Nicolas	5	DELMOTTE Yvette	5	HERTOGEN Krislian	5	ANDRE Nelly	5	WARWON Audrey	5	CHARLET Luc	5	LAMAUT Stéphanie	5	NYSENS Hubert
6	PILOT Sebastian	6	EVARD Yves	6	FOURNY Dimitri	6	DEWANT Christina	6	HERMAN Roné	6	FILLEUX Guillaume	6	HOFFMAN Denis	6	SORRELOOS Annie	6	LIGOT Pascal	6	BOVY Gilberte		

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



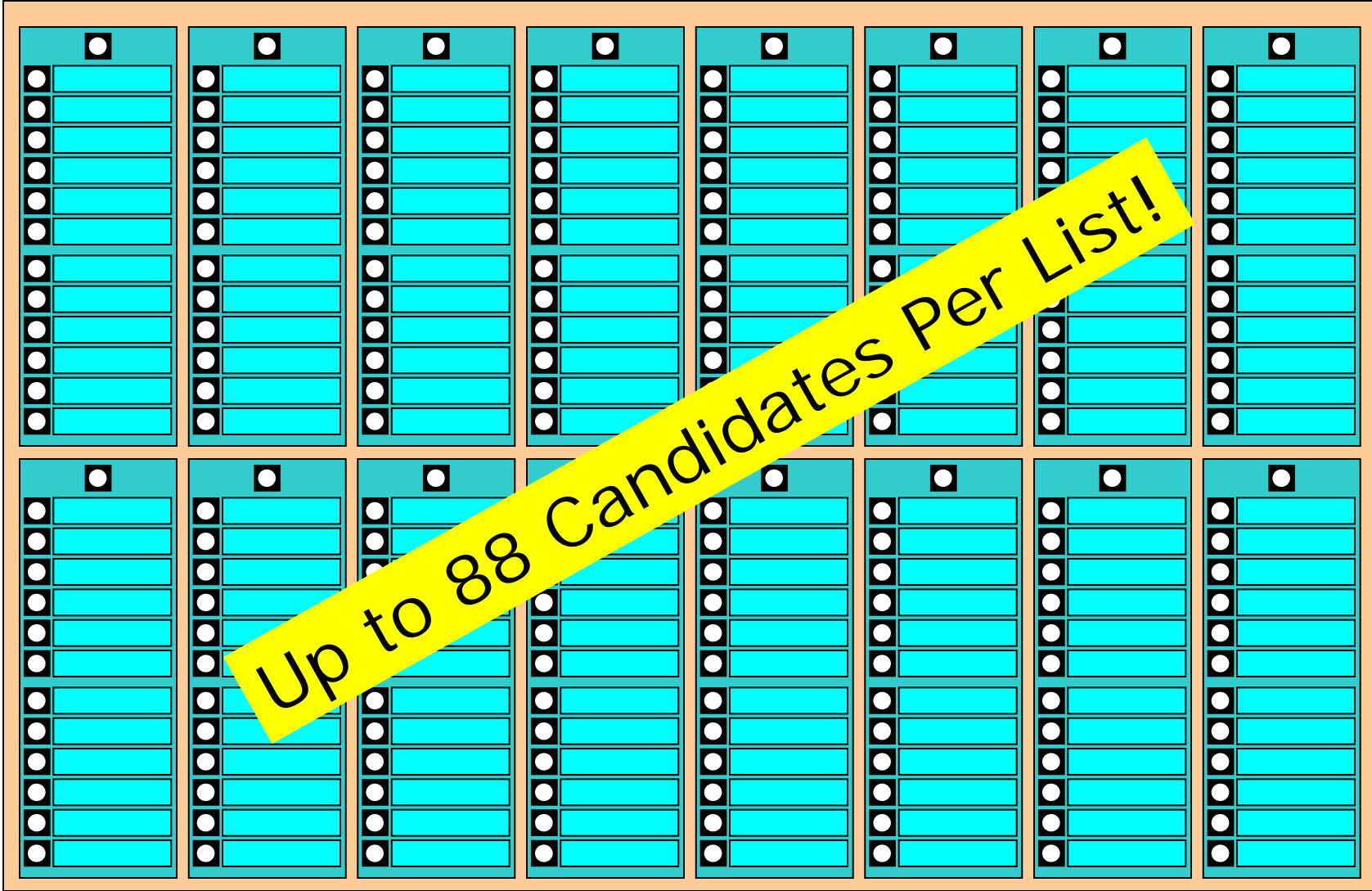




# 1 Voting Ballot per Election (Chamber, Senate, Regional, European Parliament,...)

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

<input type="radio"/>	
<input type="radio"/>	1.
<input type="radio"/>	2.
<input type="radio"/>	3.
<input type="radio"/>	...
<input type="radio"/>	
<input type="radio"/>	
<input type="radio"/>	...
<input type="radio"/>	25.
<input type="radio"/>	26.
<input type="radio"/>	27.
<input type="radio"/>	28.
<input type="radio"/>	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
- Large voting ballot is represented electronically in two menus:
  - Party menu
    - Voter selects his/her party
  - Candidates Menu per party
    - Number of candidates determines the number of columns
    - Voter selects candidates or list
- Note:
  - It is impossible to cast an invalid electronic voting ballot
  - 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
  - All procedures are simple, publicly available and 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

# Issues – 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



# Components of Classic Electronic Polling Station

- 589 municipalities
  - 44% of these use voting computers
- Each municipality has one or more polling stations
- Each polling station has one or more voting offices
- Each polling office using electronic voting is equipped with
  - 5 or 6 voting booths, each with one voting computer
  - 1 electronic urn to collect magnetic stripe ballots
  - 1 computer associated with the president of the voting office
- About 20.000 voting computers in total
  - On average 300 voters per voting computer

# Classic Electronic Voting Booth



# Observations wrt Magnetic Stripe Cards System

- How to convince a voter that the magnetic stripe card corresponds with the voter's choice?
  - Voting computer may have stored a different ballot
- How to convince a voter that his/her vote is read from the magnetic stripe?
  - Voting urn may have overwritten the 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

# Future eVoting Booth Components 😊



printer



Braque Election	Chambre Election	European Election	Provincie Election	Region Election	Local Election
1. Braque Election	11. Chamber Election	21. European Election	31. Provincie Election	41. Region Election	51. Local Election
2. Braque Election	12. Chamber Election	22. European Election	32. Provincie Election	42. Region Election	52. Local Election
3. Braque Election	13. Chamber Election	23. European Election	33. Provincie Election	43. Region Election	53. Local Election
4. Braque Election	14. Chamber Election	24. European Election	34. Provincie Election	44. Region Election	54. Local Election
5. Braque Election	15. Chamber Election	25. European Election	35. Provincie Election	45. Region Election	55. Local Election
6. Braque Election	16. Chamber Election	26. European Election	36. Provincie Election	46. Region Election	56. Local Election
7. Braque Election	17. Chamber Election	27. European Election	37. Provincie Election	47. Region Election	57. Local Election
8. Braque Election	18. Chamber Election	28. European Election	38. Provincie Election	48. Region Election	58. Local Election
9. Braque Election	19. Chamber Election	29. European Election	39. Provincie Election	49. Region Election	59. Local Election
10. Braque Election	20. Chamber Election	30. European Election	40. Provincie Election	50. Region Election	60. Local Election



chip card reader

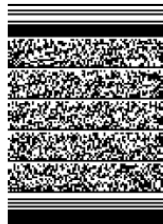


optional interface for visually challenged



mini PC

# 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

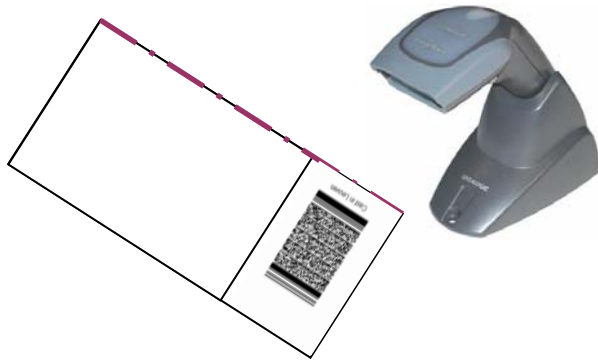
**Local Election**  
*Selected Party*

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

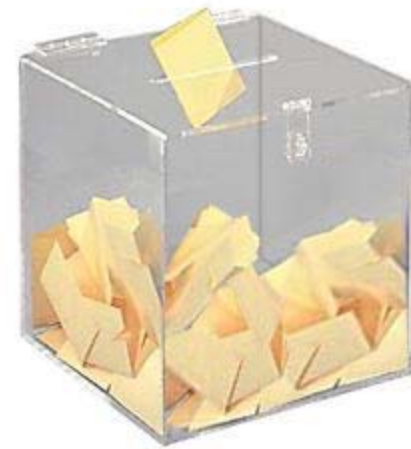


Cast in Leuven

# Future Voting Office's Equipment



Ballot Verifier



Ballot Box

© George Patton Associates, Inc.

# 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

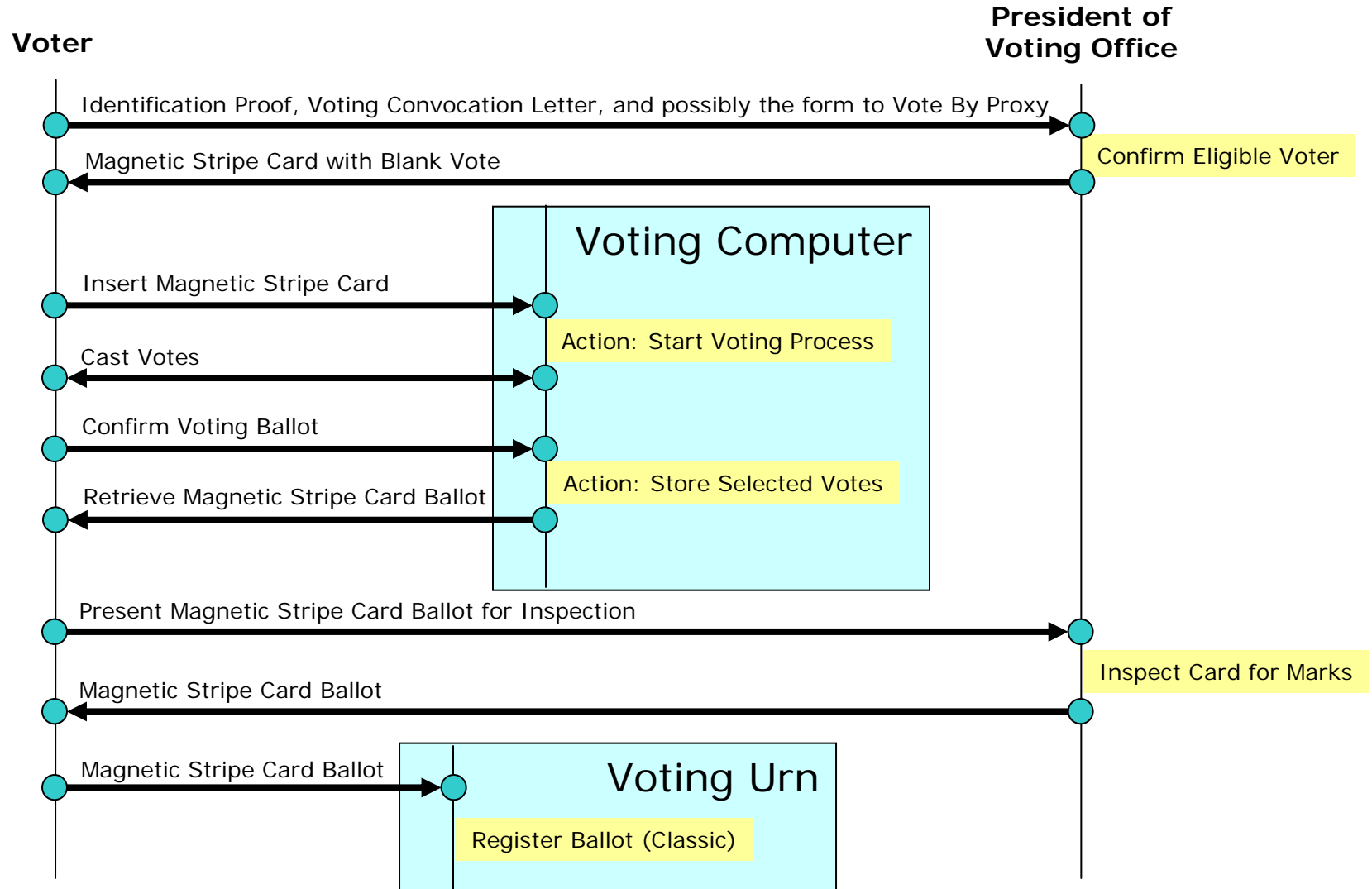


# Voting in Practice – Voters cast their vote at a Polling Place

## 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

# Voting Procedure – Magnetic Stripe Ballots



# Voting in Practice – Voters cast their Magnetic Stripe Ballot at a Polling Place

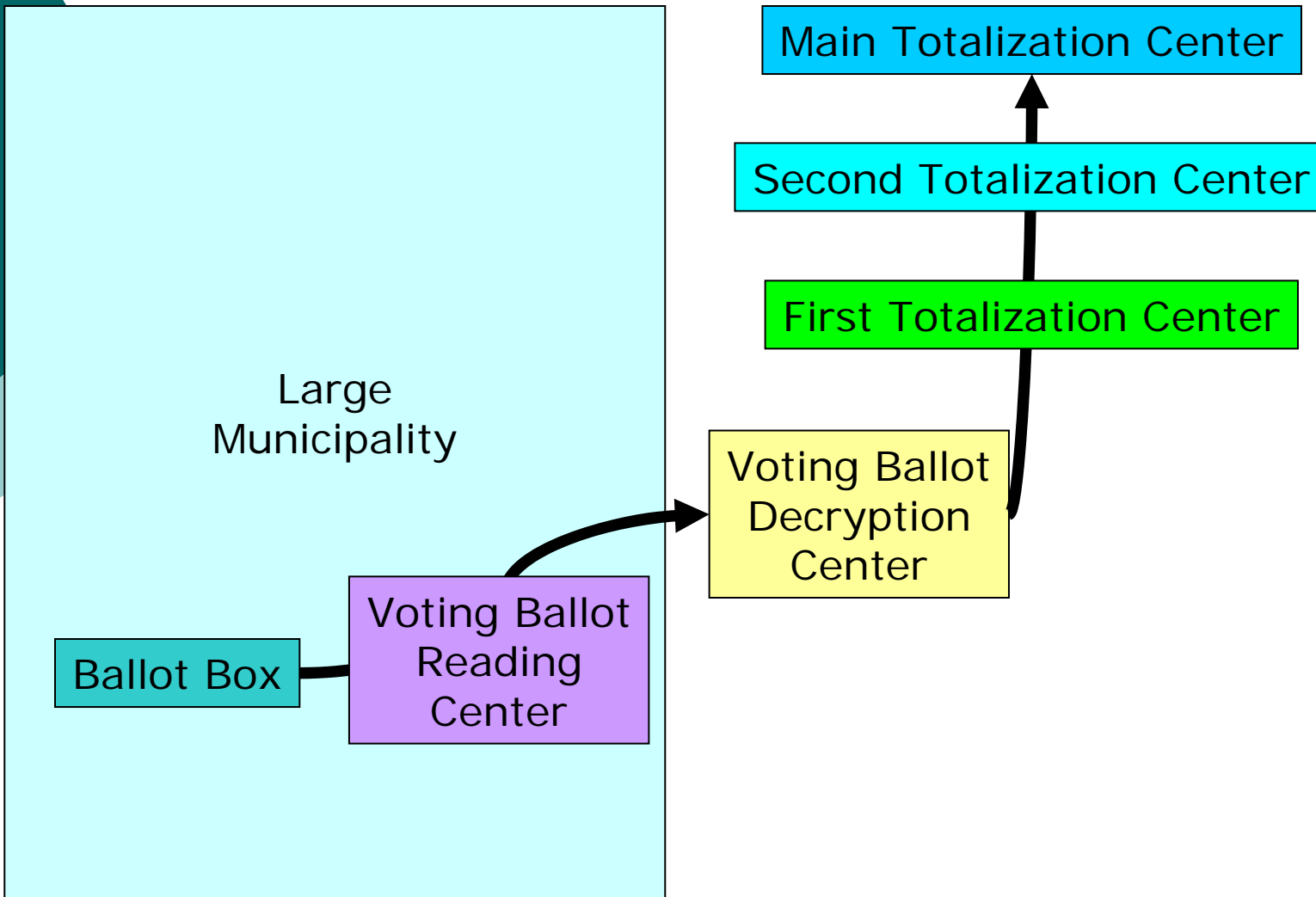
## Procedure:

1. Voting officials seal an empty voting urn before first voter arrives
2. Administration broadcasts invitation cards by paper mail to all Belgian citizens who are 18 or older on the Election Day
3. Voter hands over the identity card and invitation card to the voting officials
  - Officials verify identity of the voter
  - Officials check whether the voter is listed on their list with eligible voters
4. Voter receives voting ballot or magnetic stripe card from voting officials
5. Voter casts his/her vote in the voting booth
  - If voter makes a mistake, the president of the voting office may decide to give the voter a second chance
6. Voting official verifies whether the voter did not put a mark on the ballot or magnetic stripe card
  - Marked ballots are invalid
7. Voter inserts the ballot or magnetic stripe card in the voting urn
8. Voting officials stamp the invitation letter to confirm that the voter completed his/her duty
9. Voting officials return identity card and invitation card to voter

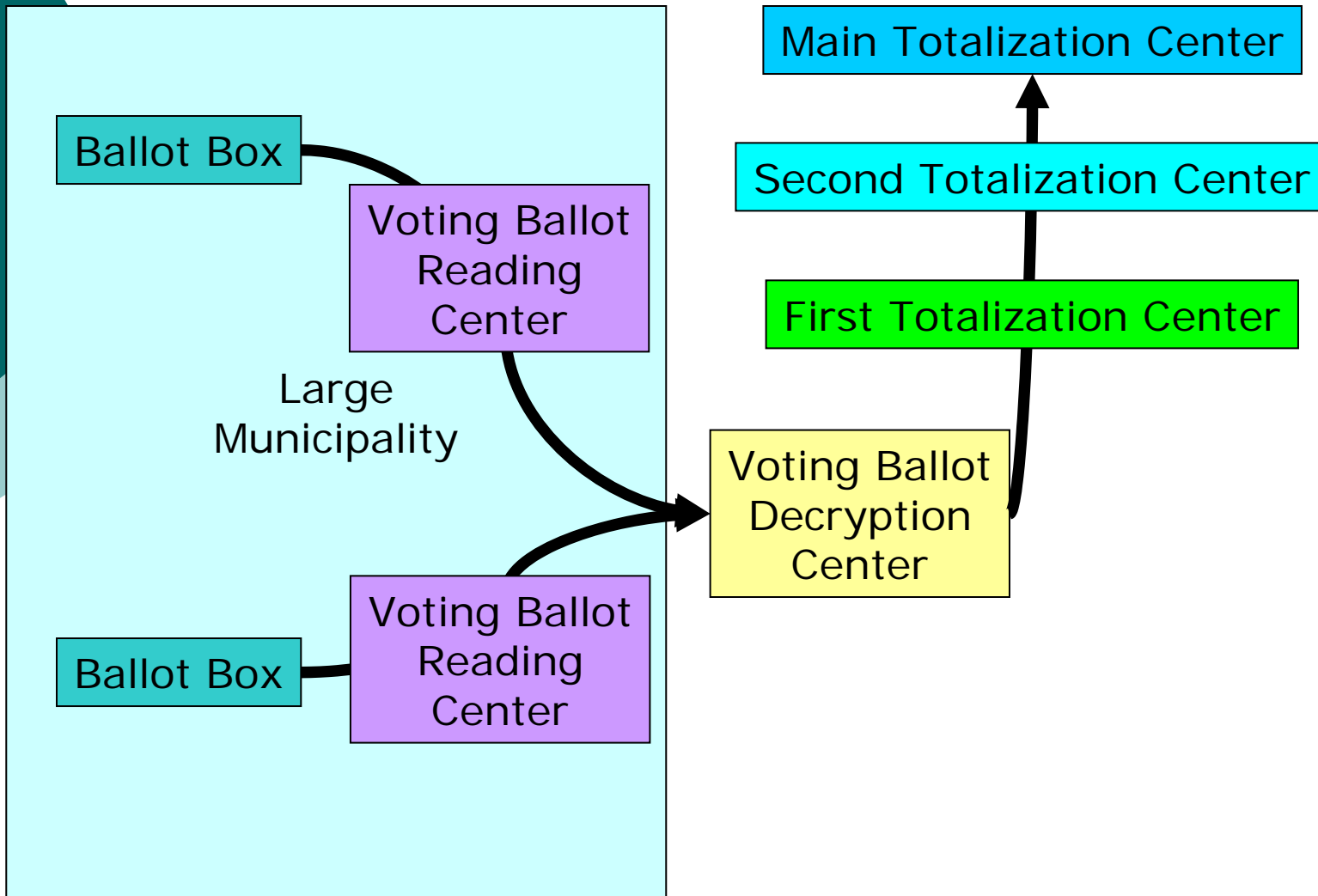
# Counting the Magnetic Stripe Ballots

- Paper ballots
  - Seal of the voting urn is removed at the end of the Election Day, e.g., around 14.00
  - Talliers keep tallying at voting office-level until they count twice the same result
- Magnetic stripe cards
  - Voting urn reads magnetic stripe card ballot immediately
    - PC controlling voting urn keeps the score on a floppy
    - All floppies of voting offices are aggregated per municipality at the end of the Election Day
  - Seal of the voting urn with magnetic stripe cards is only removed when recounting is necessary

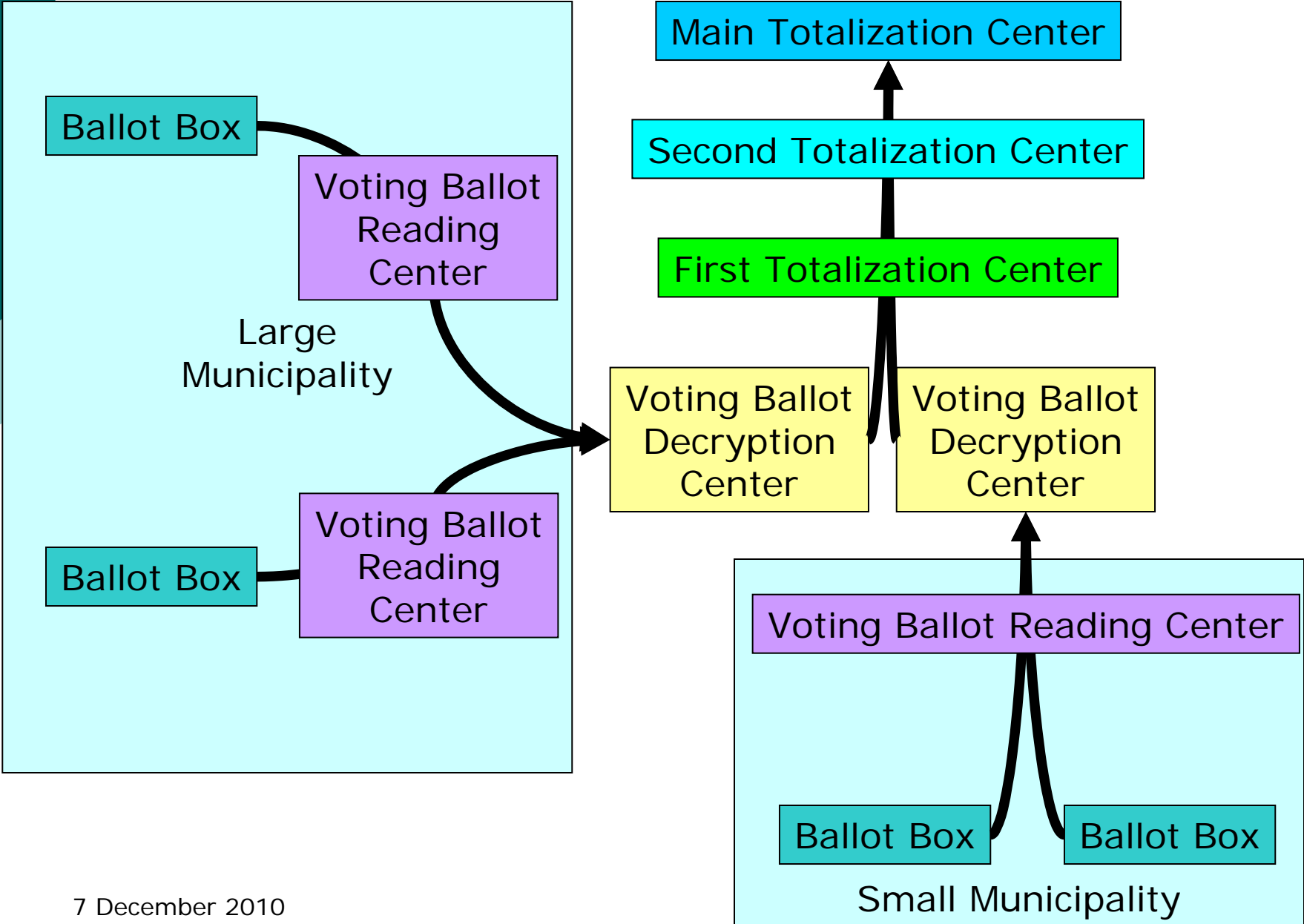
# Counting New Voting Ballots



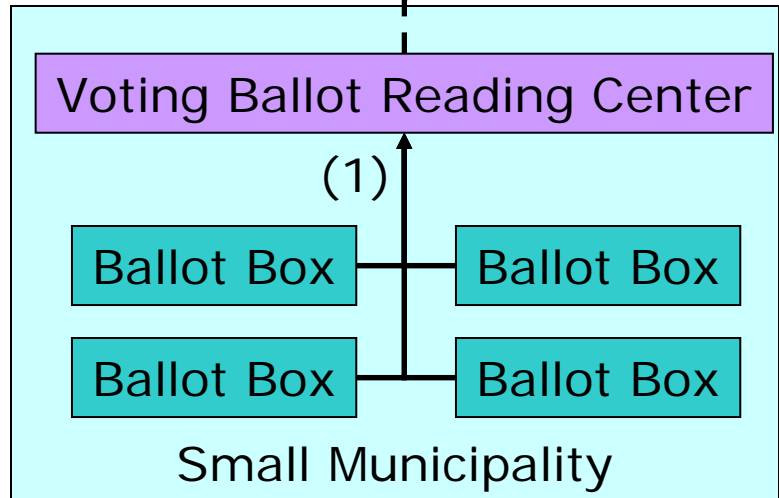
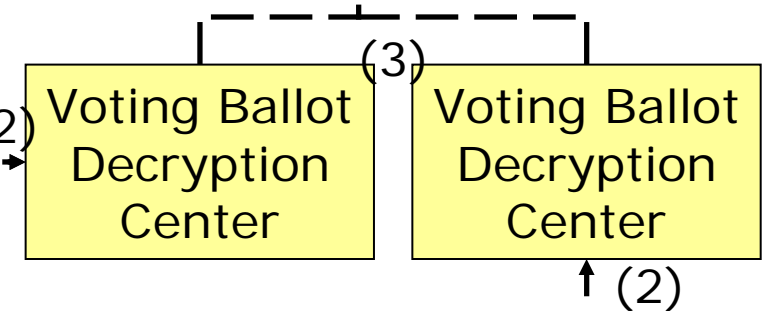
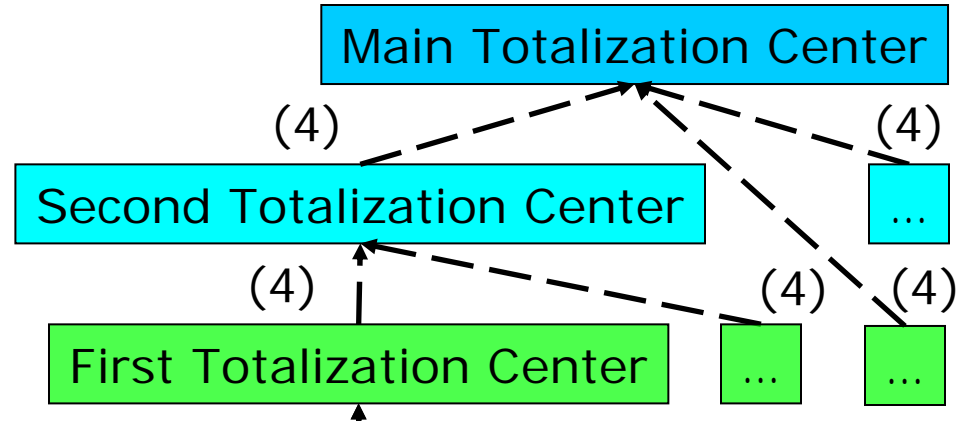
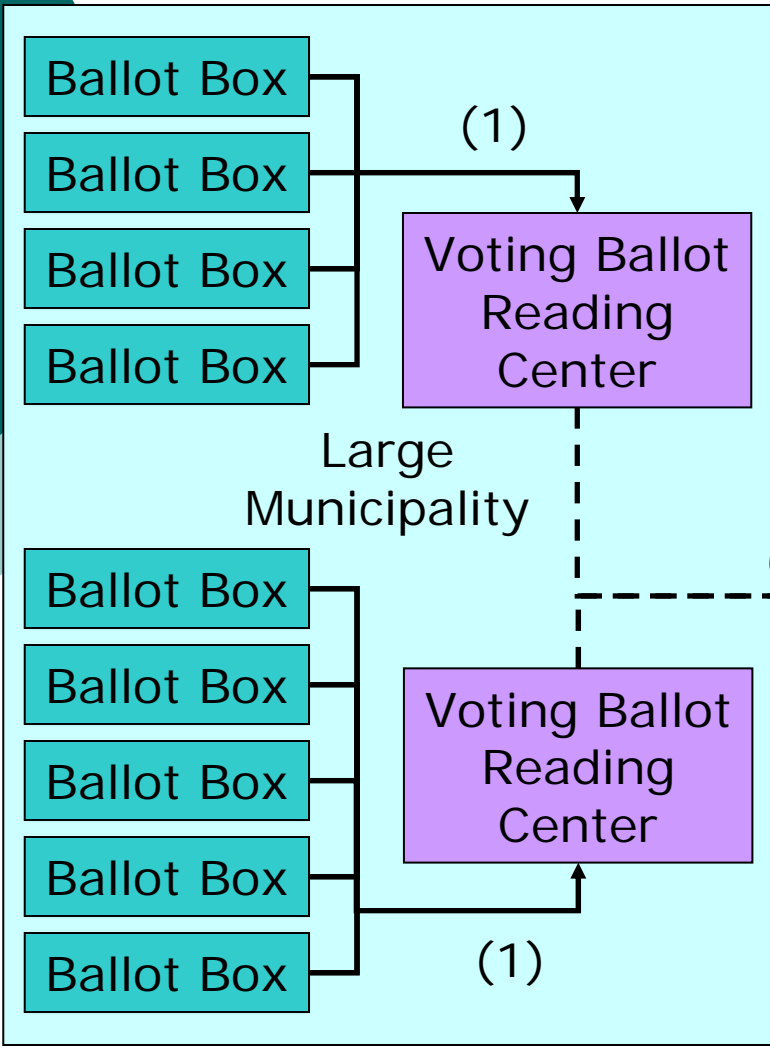
# Counting New Voting Ballots



# Counting New Voting Ballots



# Counting New Voting Ballots



Legend:  
 —▶ Local transport of Ballot Boxes  
 - -▶ Sending ballot information  
 —▶ Digital transport of partial voting results



# 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

# Questions?

- Email:

- [Danny.DeCock@esat.kuleuven.be](mailto:Danny.DeCock@esat.kuleuven.be)
- [godot@godot.be](mailto:godot@godot.be)

- Homepage:

- <http://godot.be>

- Slides:

- <http://godot.be/slides>

# 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

2. use touch screen to mark candidates

3. print voting ballot

touch screen with inductive pen

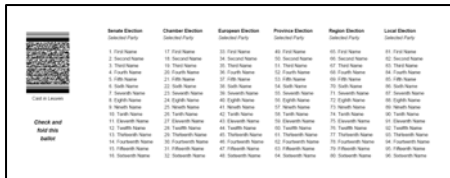
1. use chip card to activate voting computer



mini PC



chip card reader



optional interface for visually challenged

