Software vulnerabilities in the Brazilian voting machine

Diego F. Aranha, UNICAMP

dfaranha@ic.unicamp.br

@dfaranha

http://www.ic.unicamp.br/~dfaranha

Context

Brazilian elections:

- Massive (140M voters, 81% turnout)
- Held every 2 years
- Became electronic in 1996 (fully in 2000)
- Controlled/executed/judged by a single entity (SEC - Superior Electoral Court)

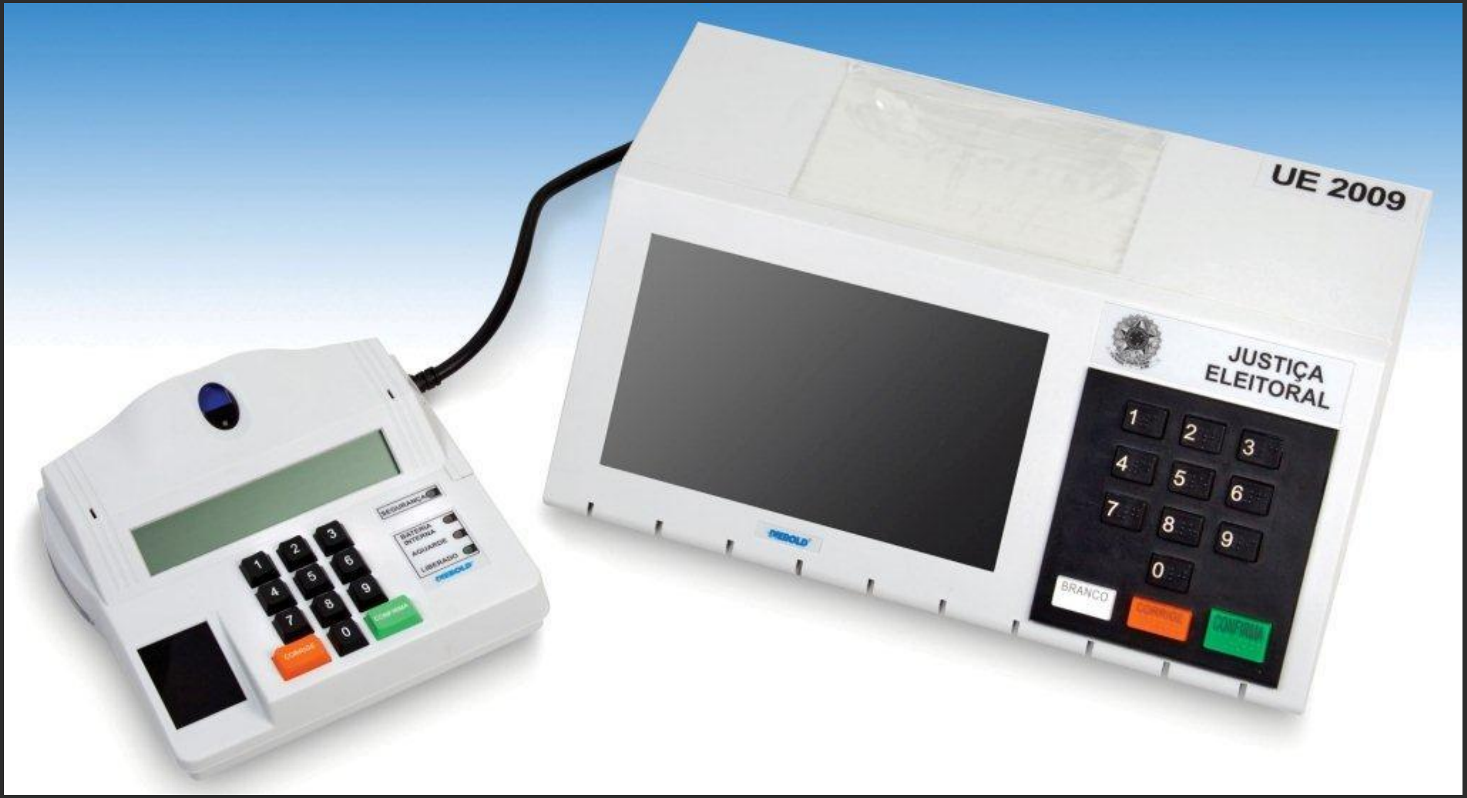
Context

Brazilian DRE voting machines:

- **Claimed** 100% secure (but only tested in 2012...)
- Hardware manufactured by **Diebold** (> 0.5M)
- Software written by SEC since 2006 (> 13M LOCs)
- Adopted GNU/Linux in 2008 (after **Windows CE**...)
- Experimented with **paper records** in 2002
- Identify 16% of the voters with **fingerprints** since 2011

Source: Diebold

Context



Source: Diebold

Algorithm

1. Voting machines **loaded** with software
2. Zero tape **printed** (7-8 AM)
3. Voting session **opened**
4. Votes **cast**
5. Voting session **closed (5PM)** and poll tape **printed**
6. Media **written** with public products (PT, DRV, LOG)
7. Public products **transmitted** to central tabulator

Vulnerabilities from 2012

II Public Security Tests of Brazilian Voting System:

- **Restricted** security tests (no pen/paper)
- Limited to voting machines
- Serious vulnerability in **vote shuffling mechanism**
- Massive **sharing** and insecure **storage** of keys
- Voting software checks **itself**
- No **ballot secrecy** or **integrity** of software/results.

Digital Record of the Votes (DRV)

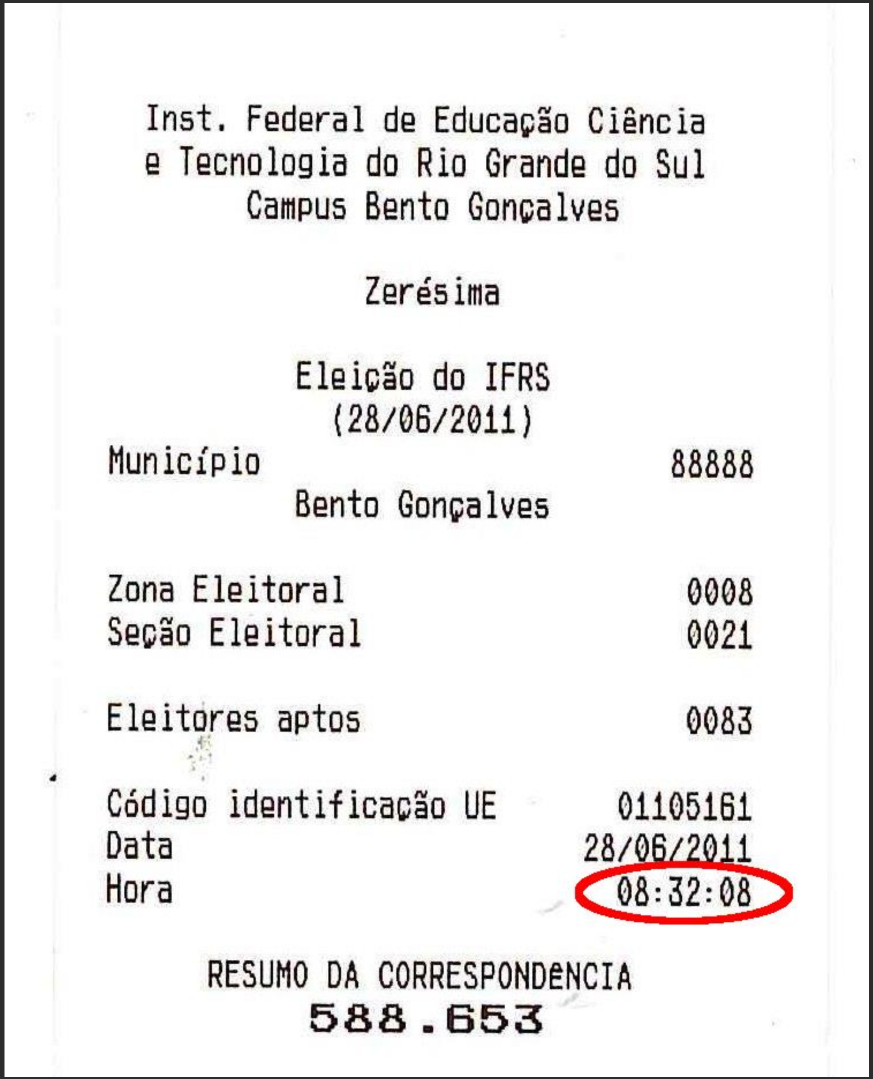
Governor	Senator	President
71	31	37
	BLANK	
13		
71	NULL	
		BLANK
		37

Warning: Advanced Cryptanalysis

```
grep -r rand *
```

Match in DRV.cpp! Seed?

```
srand(time(NULL))
```



```
    Inst. Federal de Educação Ciência
    e Tecnologia do Rio Grande do Sul
          Campus Bento Gonçalves

                 Zerésima

              Eleição do IFRS
               (28/06/2011)
Município                           88888
             Bento Gonçalves

Zona Eleitoral                       0008
Seção Eleitoral                      0021

Eleitores aptos                      0083

Código identificação UE          01105161
Data                           28/06/2011
Hora                             08:32:08

        RESUMO DA CORRESPONDENCIA
                588.653
```

Conclusions from 2012

- Trivial to recover votes in order
- LOG associates vote with timestamp
- Thus trivial to recover a specific vote

Eliminate the DRV and do not store metadata!

"Fixed" by using **/dev/urandom**, although voting machine has **two hardware RNGs**

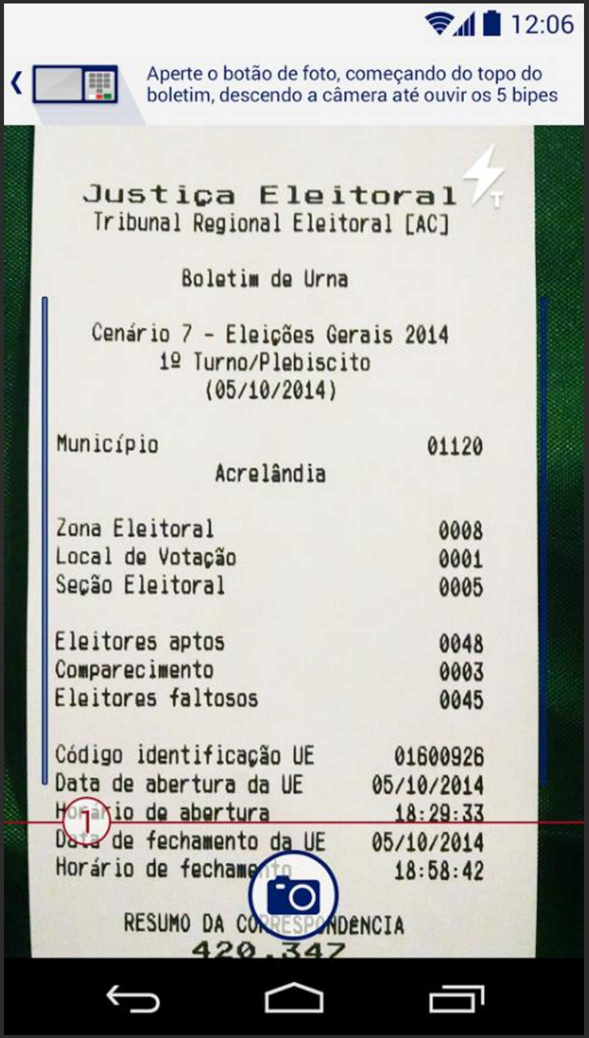
Current problems

1. Software is **secret** for almost 20 years
2. Software is demonstrably **insecure**
3. No paper record for **recount**
4. No effective means to **audit** the system
5. **Conflicts of interest** everywhere
6. **Insider attacks** completely disregarded

YouInspect in 2014

Audit transmission of **results** by matching **pictures** of poll tapes taken from mobile app with **electronic records.**

VOCÊ FISCAL



12:06

Aperte o botão de foto, começando do topo do boletim, descendo a câmera até ouvir os 5 bipes

Justiça Eleitoral
Tribunal Regional Eleitoral [AC]

Boletim de Urna

Cenário 7 - Eleições Gerais 2014
1º Turno/Plebiscito
(05/10/2014)

Município	01120
Acrelândia	
Zona Eleitoral	0008
Local de Votação	0001
Seção Eleitoral	0005
Eleitores aptos	0048
Comparecimento	0003
Eleitores faltosos	0045
Código identificação UE	01600926
Data de abertura da UE	05/10/2014
Horário de abertura	18:29:33
Data de fechamento da UE	05/10/2014
Horário de fechamento	18:58:42

RESUMO DA CORRESPONDÊNCIA
420.347

Results from YouInspect

- Around 8,000 poll tapes in the two rounds
- Approximately **100 GB** in pictures
- Image processing -> OCR -> final check
- Verified **transmission** for 4.1% of the votes
- **Quality of the sample?**

MIT Technology Review

INNOVATORS UNDER 35 BRAZIL

Challenge for 2016

How to **design** sampling process for large-scale elections?

Source: SEC

Future

1. Voter-Verified Paper Audit Trail for **security**
2. Auditable software for **transparency**
3. Social control mechanisms for **participation**

Elections need not only to **appear** fair, but **provide** real means for **independent verification**.

Thanks! Questions?

Diego F. Aranha, UNICAMP
dfaranha@ic.unicamp.br
@dfaranha
http://www.ic.unicamp.br/~dfaranha

References:

[1] Software vulnerabilities in the Brazilian voting machine.
In: Design, Development, and Use of Secure Electronic Voting Systems (2014)

[2] Crowdsourced integrity verification of election results. Under review (2015)