Electronic Voting Systems
Is Brazil ahead of its time?

Professor Pedro A. D. Rezende*
Dept. of Computer Science - University of Brasilia

1 Introduction

In May 2001, from the losing end of a fierce internal power dispute, the president of the Brazilian Senate publicly admitted to spying on secret voting on the Senate floor [1]. Through a back door in the voting system, protected by obfuscation, but according to the supplier "built exactly to specifications", as later revealed by an independent investigation. Since voting in elections for public offices in Brazil is mandatory for citizens over 18, and because such elections are also – and pioneerly – conducted by similar electronic devices, an ensuing Watergate-like affair resulted in his resignation.

But more important, the scandal set the climate for approval of legislation requiring such devices be made voter-verifiable. By the addition of an extra printer to the voting machines already in use for general public elections. These are machines of the type known as *Direct Recording Electronic* (which we will refer to using the acronym *DRE*). The most proeminent feature of a *DRE* voting machine is its inability to allow for recounts, for they do not record individual votes, only sums per candidate per precinct. A back-up system for printing individual votes would allow for detection of eventual errors in precinct sums caused by malicious tweaking with the sofware, not otherwise detectable with *DRE*s in use under ineffective auditing of its software.

Here, voter-verifiable means that any voter could eventually act as an official for recounting votes through individual paper ballots, with no special programming skills to audit software required. Pushed by those who did not believe in software auditing ever becoming efficient under the legal, technical and political circumstances, Law 10.408 was so enacted in January 2002, under the constitutional provision that elections for public offices in Brazil be regulated by federal legislation [2]. Law 10.408 set *voter verifiability* (which we will refer to using the acronym *vv*) in a manner that each voter was to see his or her choices printed on a slip of paper, behind a transparent window.

When confirmed, the vote slip would be inserted into a sealed bag, without voter interference, and the bag properly handled for later audit against electronic precinct tally by sampling, or for possible recount. According to the original bill, this print-show-collect add-on mechanism for turning *DRE*s into voter-verifiable systems, was to be added on to all em DRE machines in use, from the following election onward. The random choice of which machines were to be sampled, for regular auditing purposes, was to be made after the election time period, as would be in any meaningful audit measure of this sort. But what happens if a voter disagrees with the printed vote? Either because of error, or if a joker tries to spoil the process by falsely claiming a mismatch, protected by the secrecy of his would be vote?

This question was the basis of criticism by officials

and politicians against the measure. Such question is, indeed, a hurdle which is inseparable from any backup counting scheme for voting systems. Naturally, those against the *vv* measure went out to lobby aganist it. Led by the chief electoral official, they succeeded in slowing down the approval of the bill mandating it and, at the last minute, incorporating amendments which diffused its effectiveness and scope. For "technical reasons", which were never spelled out, the random choice of which slip bags to audit was not to be made after, but before election day, thereby extinguishing any auditing value without any benefit in cost or efficiency [3, 4]. And due to the filibustering and constitutional time constraints (electoral law takes effect one year after sanction), this measure would not apply to the upcoming 2002 election.

Another ammendment tried to "ammend" the possible impasse from voters being able to claim divergent sreen and slip outputs. If that happens, the vote is to be canceled by the precinct official, and the voter can vote again. If the alleged mismatch persists, the entire precinct has to switch, from then on, to manual vote. However, this solution exposed a double standard. For before the *vv* measure, if the voter complained of mismatch, claiming, falsely or not, that the vote shown on the screen for confirmation differed from the vote keyed in, repeatedly on several tries, he would have to accept whatever the screen says or give up on his vote, cancelling and leaving. The justificaton was that since vote is secret, no one was allowed to verfify his claim and/or suspend the use of the equipment upon such claim. The voting equipment, which has been implicitly assumed to be flawless by the electoral authorities, was no longer so with an extra printer attached, for printing votes to be seen dropping into a sealed bag.

2 Hurdles with voter unverifiability

The chief electoral administration post in Brazil is held by a supreme (constitutional) court justice, then occupied by Mr. Nelson Jobim, an appointee of former president Cardoso. In his lobby at the Congress, justice Jobim offered, as compensation for delay, to "voluntarily test" the approved *vv* measure on 3% of the precincts in the upcoming election, including all precincts from two small states. And so it happened. On October 6, 2002, Brazilians voted for president, state governor, two Senate and two House seats, using mainly DREs.

Among the candidates, Luiz Inacio da Silva, known as Lula. From a remote backland, poor, raised by his mother who migrated to the industrial metropolis of São Paulo when he was 9, he became a metal worker and labor union leader, with limited formal instruction. This was his fourth run for the presidency, as the candidate from the political party he helped found in 1981 (the Workers Party), during the grueling times of right-wing dictatorship which ended in 1985. If elected, he would become the first outsider from traditional oligarchies to reach the post.

On election evening, less than four hours into the tallying had elapsed when the total of Lula's votes for president suddenly, and mysteriously, dropped from over a million to minus 41 thousand, on the main screen of the central tallying headquarters. After some screams, reboots to restore (in roughly five minutes) the 'normal' count, a swift police blockade of the place during that time, a laconic official explanation for the incident as "caused by a formatting error", it was at the end established, against projections by most polling surveys, that a run-off ballot was due. Three weeks later Mr. Lula was finally declared president of Brazil, from January 1 2003 through December 31 2006, with roughly 62% of the valid votes.

Lula thus became the first national leader ever elected solely through DREs (with 3% using 'experimental' *vv* add-on mechanism), and the second for the world record total of votes received in a presidential election, after Ronald Reagan in 1980 [5]. All very nice, given his origins, but, even before the run-off,

his momentary negative vote count received practically no press coverage. Only a brief real-time leak on a small TV network (Bandeirantes), and notes by two respected and non gullible newspaper columnists [6, 7].

The climate set by a general expectation of a landslide victory diverted attention from the possibility of fraud leading to the need for a run-off, with the favorite candidate not reaching 50% of valid popular votes in the first round. Some would even argue that had there been any fraud, Lula would not have been elected, which is a sophism, an exercise of self justification. Sophism is a rethorical art developed by an ancient greek school of philosopy, of which Jean Brun has a good summary: the art of self justification, of mixing any idea with any thing, of turning words into docile servers of any egotism.

On the other hand rumors have it that if Lula was in fact defrauded from winning in the first round, this would have been a show of force by the political power to be replaced, to pressure him into agreeing on maintaining the ongoing economic policy, as imposed by the IMF, before taking charge [8]. There were plenty of speculative moves in and by the markets on that, preceeding his election, for some feared the consequences of a leftist agenda on Brazil's delicate debtor status. And he ended up selecting the head of the Central Bank, the equivalent of US's Federal Reserve, a congressmen from the losing party (incumbent president Cardoso's party).

The fact that Lula's landslide victory could not carry along any important state gubernatorial seats (mostly won by Cardoso's party) neither meriting further analysis, what the mainstream media did cover instead, and profusely, were the long lines at polling places, worse in those with *vv* add-on printers. The problems blamed on the extra printers, with the most likely reasons for the delays, as one may agree from what follows, never mentioned [9].

3 The public perception game

No mention given to the fact that election officials in charge of setting up the machines were not instructed to remove a 'security' seal blocking the exit path of the slips of paper from the small add-on printer, before sealing the bag onto it, causing those with sealed path to jam during operation. A seal which was specified in the printer supplier's contract.

No mention given, either, to the fact that voters were not told about the need for, after having confimed his or her choice on the last race under vote, pushing the confirm key once more in order to make the vote printer cut up his ballot slip (shown under a sealed glass printer cover) from the paper reel and inject the slip into the sealed bag attached. Failing to do so caused the voting machines to time out after two minutes, which then required the machine to be reset. By a tortuous menu path, with entry of a password by the precinct official, for that ballot to be cancelled electronically, the uncut paper slip to be printed over with the message "canceled", and then cut up and injected into the sealed bag.

No mention given, either, to the fact that the number of voters registered by the electoral administration to vote at most *vv*-enabled precincts were increased, beyond historic top levels. For reasons unrelated to the number of add-on printers delivered and ready for use, half of which were left as backup. And that, on top of all this, six different races concurred under compulsory voting.

Intriguingly, there were several advance warnings, by several high- ranking officials of the electoral administration, in the months before the 2002 election in the mainstream media, about the risks posed by such a "clumsy" device (print-show-collect mechanism for vote paper audit). Its function – to provide voter verifiability – disparaged as an "unnecessary" and "stupid" security measure, which could taint the success of an

otherwise flawless election [10]. And when an official slip vote bag, still attached to the add-on printer, showed up at the roof of a bus stop just in time for breaking early morning post-election news in the Federal District, the official word from electoral officials went to blame the audit measure itself, excusing themselves from any responsibility for safegarding election material under their custody. "After all", they would demean, "that stuff was only for a stupid test".

After leading the demonization of the *vv* measure "under test", those officials would later pass out the chance to corroborate (or disprove) their presumptions about it, in a formal appeal for manual recount of a tumultuous but fully *vv*-enabled state gubernatorial run-off election. For an election in which all the precincts yielded slip paper record of individual votes in sealed bags under official custody, and in which the final result was by a margin smaller than 0.2% (the Federal District), the appeal for recount by the losing candidate, from Lula's party, was unanimously dismissed. By the local "electoral tribunal", headed by an early critic of the later-to-be-enforced *vv* measure [10], on the grounds that a manual recount from a non-mandatory mechanism "could put under suspicion [the electronic] elections nationwide" [14]. After all, they would argue, no one has yet been able to prove there has been any fraud at electronic votings in Brazil. The main question, obfuscated: a system is secure because no one can show fraud, or no one can show fraud because it is secure?

Another intringuing phenomenon, which has been building up since 1996 (when the incremental use of *DRE* machines in official elections began), kept its momentum in 2002: disparity among election polls. Specially in states where races have been historically close, simultaneous polls begin to diverge wildly, far beyond their own declared "margin of error", as election day approaches. In the Federal District, for instance, this phenomenon happened in two last gubernatorial elections, in 1998 and 2002. This phenomenon is perhaps better explained by a semilogical analisys. Semiology is the study of communication systems in their broadest sense, taking into account the interplay between common linguistic capacities of agents, signal carrying characteristics of channels, and linguistc features of the codes involved in a communication, specially the possible semantic maps between linguistic compenteces through these channels. The wisdom of the semiological approach here is enforced by the fact that, while its approach to computer security in general leads to the inevitability of some trust presumption in any computer sercurity protocol or mechanism, these presumptions look inevitable in the case under focus.

If one considers the hypothesis that a matching between a poll and an election result would reinforce each other's legitimacy, even if both tilt in tandem by a disguised rig, one would conclude that the lack of auditability would tend to raise the probabilty, by lowering the risks to insiders, of insider fraud. This trend would tend coopt the polling institutions into complicity, forcing them to bet, willingly or not, their reputation on "invisible fraud wars". This hypotesys is able to explain, for example, why the Gallup Institute, a global survey enterprise zealous of its reputation, does election polls, does polls in Brazil, but does not poll elections in Brazil. And the best one I can find, absent a convincing explanation from Gallup itself.

Since the introduction of the *vv* paper audict trail measure through Federal Law 10.408/01 [2] (which we will refer by the achronym *vvpat*), high-ranking electoral administration officials have not only been disparaging *vv* measures, but also relentlessly pursuing and advocating for a series of alternative measures. As each one has been proven ineffective, in principle, at securing the integrity of election outcomes, they have moved on to lobby for the next one. Before reading about them, the reader may notice that roughly half of Brazil's media advertising revenue comes from government sources, where criticisms of Brazil's pioneer electronic voting system is almost always disparaged as unpatriotic, and that all high-ranking electoral

administration posts in Brazil have to be filled by active judges.

4 Seeking alternatives to vvpat

Alternative one is called ‘parallel voting’. This measure consists of selecting some voting machines among those set up for an election, which are then substituted by backups, to be used in a test run by election officials, on election day, to ‘ensure’ that machines are working correctly. Votes drawn from a hat filled with samples are to be keyed in, in full view of observers, representing the interested parties. This is called a “simulated” vote. If the manual count of the simulated votes, seen to be keyed in, matches the count issued by the electronic report, generated by the machine under test, when the simulation is closed at the end of the official voting period, that sampled machine passes the test.

What does this test prove? At most, it proves that the machine under test does not swindle when collecting that many votes. How many? A number bound by the ratio between the official voting time, which is 11 hours (from 8 am to 5 pm), and the mean time a simulate a vote lasts. A real vote, explained in detail by a script simulator at the web site of Brazil’s Federal Electoral Administration [15], can be clocked as follows: after the voter is identified, the prescinct official at a terminal releases the voting machine to register a vote. This start the clock. After the voter enters the booth, votes, and confirms his vote, the machine register the vote and blocks itself. The voter has to go back to the official to get a receipt for having voted, since vote is mandatory. After that, the next voter can step up to identify himself for the official. After he is idenfified, the clock resets.

A simutated vote, on the other hand, has to be carried out in all the laborious and pedantic details drawn up by electoral officials in rulings [16]. In 2002, when this was first done, simulated votes were clocked by observers in four different states. The average time for a vote to be so simulated turned out to be more than five minutes, and thus, more than four times the known average for real voting.

However, for this kind of test to have any auditing value, the machine’s program can not know it is being tested when it is. And it happens that in this case it can obviously know, for the average vote time during such simulation test exceeds by fourfold that of real elections. Besides, the spreadsheet accessed by the precinct official, through a terminal connected to the *DRE* by a 10” cable, for identifying voters allocated to vote in that precinct, is stored at the the *DRE* itself, the same machine where the vote is recorded. The possibility of a voter’s vote being identified later by someone else hindges only on officials’ word that there will be no software installed to do that, once we figure the effectiveness of the alternative measures later added to this so called ‘parallel voting’.

Alternative two, which by law should have been in place since 1997, proposes software ‘auditing’. Some (but not all as the 1997 law stipulated) source code to be used in election equipment is thrown to inspection by the political parties, under the most rigid non-disclosure agreement possible (not even made public [16]. Since some of the code is not opened for inspection, due to alleged ‘copyright protection’, and since the time allotted for inspection has not been enough (would normally take months of study), this has been a silly exercise. Worse: despite no independent way ever been offered, or permitted, to ensure that the code inspected is actually the code used, this exercise has nonetheless been held, by chief electoral officials and mainstream gullible media, as homologation of electoral equipment by the interested parties [17]. Whereas even if permitted, it would still be worthless under incomplete code inspection and build.

Finally, the third alternative is to throw in additional electronics and/or software, to produce and verify dig-

ital signatures on all manner of things. Interested parties would be able to add, during the software 'auditing' phase of the electoral process, their digital signatures to files loadable into *DRE*s, after 'seeing' some code compile. These files, plus parties' signature verification softwares, would then be loaded into some 450 thousand *DRE*s, distributed to different local election headquarters. During the loading process, local supervisors could then check, by sample, their party's signature on those files, using their respective public keys. But under the control, however, of the to-be-verified software proper [17].

That means an interested party can only verify his or her signature on the files loaded into a *DRE* machine which has been set up for election by running a supposed copy of his verification software installed in the *DRE* machine itself. Even if such copy is intact, the *DRE*'s operating system can be tweaked to defeat the alleged objective of the measure: by presenting the original file to have its original signature verified, and later replacing it by a hidden and rigged equivalent. The very operating system which has been left out of the inspection set up by measure two, as the reader may recall, so that the tweaking mechanism can be prepared in advance and by few, while its activation steps is kept secret.

In other words, if the short-circuited nature of this verification would not be enough to invalidate alternative three, the software to be verified has always included binaries from source untraceable by the 'auditing' offered in alternative two, yielding a cumulative process without any basis of trust on which to build. Essentially smoke and mirrors, only this time more technically sophisticated in its third layer. It is difficult to predict what the next proposals will be like. Little is known about how Brazil's chief electoral administrator's plan to evolve the system they seemingly believe to own.

The flaws and associated risks which are raised in this session, and which have been pointed out repeatedly to officials in charge, point also to a poignant question. Whether all these procedural and architetural decisions are influenced by incompetence or malice. This is the one million dollar question which the author shall not attempt to address. The bibliography can show a wide range of oppinions for an answer, including the a negation of the question's binary character. What I can address, though, is the political background where the question stands, begging for an answer, and what we can learn from both short of an answer.

5 Interests for alternatives to vvpat

Inspecting the system's code has proved to be a charade, with repeated promises – or rulings – to "open all the code" failing to materialize at the last moment, election after election [16, 17]. It is difficult to discover the origin of the money spent to develop and deploy it, let alone eventual strings that may come attached. Interested parties have not been able to either validate the workings of deployed *DRE* machines, nor to inspect contracts in due time. Some of these contracts have never been made public beyond their summary or first outsourcing link, despite deemed public. The electoral administration was constitutionally set out in a way as to be its own judge, whereas the vast majority of voters and officials seem satisfied with the belief that technology works as panacea for negative human traits.

The chief IT officer of the electoral administration, Mr. Paulo Camarão, indicates in a book about the system [11] that roughly half of its seed money would have come from the IADB (Inter American Development Bank), but IADB public documents do not acknowledge any such project [12]. Mr. Camarão, for his part, was fired from that post one year before publishing his book, by then chief electoral official justice Marco Aurélio de Mello, due to mishandlings with the federal voter registration database [21],

only to be promptly re-hired by his successor, Mr. Jobim. Cryptographic software has been deployed in the system by the Brazilian federal intelligence and surveillance agency, whose resources, specially financial, have been allegedly supplemented by untraceable US government funds, according to Carlos Costa, a former US government employee and FBI chief delegate whom has spoken up on this matter to Brazilian media [20]. To those who are, or should be, aware of the footprints of US secret services in political ploys throughout Latin America, from as early as Guatemala in 1954, there will be dots that can or can not be connected.

Then, in 2003, under those circumstances and with strong lobbying by the electoral administration, a bill introducing alternative three was put before the Congress. It was to replace the *vvpat* measure enforceable after 2004. The *vvpat* measure conquered in 2001, through a hard-fought civil struggle fueled by indignation with political hypocrisy, got quickly and quietly killed two years later, before ever going into effect. With one lone chance to get first demonized, and no public hearing on technical merits pros and cons [13], despite efforts by scientists, scholars and civil activists, author included, who signed a manifesto calling for hearings [22]. Not only that, but with the parties rights, from the 1997 electoral Law, to inspect all software source for the system, diluted by ambiguous verbosity to match the official practices. Killed in such undignified way, but not without a paradoxical irony. The House's internal electronic tracking system had to get rigged for the 2001 /em vvpat measure to go away with no public hearings, though with the rig provable – and proved [18] – by a paper verifiability trail, as follows.

After passing the Senate with no hearings, said bill went to the House. The House's Science and Technology Committee received the scientists' manifesto, and filed a request to get the records and report on it, before its final vote. Request granted by the House president, while leaders of two other branches of government grew impatient for its quick approval. They wanted the bill approved in the exact terms under which it had passed the Senate, and before October 3rd, for its effect to reach the upcoming elections, to be held October 6, 2004. They pressured the president of the House on that, and he eventually reversed himself on allowing the bill to go through hearings at the Science and Technology Committee. Sort of. A "flaw" in its electronic tracking system ensued, while the bill records disappeared overnight from Science and Technology Committee premises. Only to resurface by dawn at the House floor, both physically and according to a then inconsistent electronic tracking control [18], as we proceed to explain.

The tracking system went from saying, one day, that the bill record's last move, its n-th move at the House, had been from the Judiciary Committee to the Science and Technology Committee, to saying the following day, after the bill's physical record had disappeared from where it should have been, that the bill's last move, the same n-th move, had been from the Judiciary Committee to the House floor, where it was found. At this time the tracking system was showing that the bill had followed a discontinuous path, jumping from the Judiciary to the Science and Technology Committes without moving. Concerned citizens managed to collect paper records of the electronic tracking system while under such inconsistent state, and passed them on to some congressmen, but most were not amused by such 'double flop'. Maybe it was just a formatting error, later 'corrected' to include the electronic extra missing link.

Once found at the floor, the bill got quickly voted. Into Law 10.740/03, on October 1st, amidst false arguments and isolated protests [23, 24]. In a speech defending the bill, congressman Moroni Torgan argued that the *vvpat* measure being banned is dangerous, for the alleged reason that a voter could take the receipt of his vote and show it to a candidate to sell his vote. There is no such receipt of what the voter voted for. Neither as established by the *vvpat* measure under fo-

cus, in the old law being reformed by the bill, nor in the ”voluntary test” conducted by authorities. Only a receipt that the voter has showed up at the precinct and voted, mandated by old law and maintained by the bill.

The irony here is that a simple (but risky) way to sell votes remain. Since the *DRE* voting software shows, in the *DRE*'s LCD screen, the name and a picture of the chosen candidate before the voter confirms his vote for the office he or she is running for, and since this picture is from a file provided by the candidate to official authorities in charge of setting up the software, a candidate can later show a voter a collection of different pictures of him or herself, one of wich from the same file given to the electoral officials, the one shown by the *DRE* when his candidate number is selected. He can then offer to pay for the voter who can pinpoint the correct picture shown at the *DRE* screen, but not without risk: a savvy voter can choose his number only to see his picture and collect later, canceling the choice after seeing it and choosing again someone else. The senatorial scandal of 2001 had faded into oblivion.

6 An unusual case study

Fading not enough. About a week later Mr. Jobim, no longer the chief electoral official but the former who had lobbied against the *vvpat* measure and, as supreme court justice, for a new law to kill it, allowed himself to unveil, once alleviated by the success of his lobby, perhaps a long kept secret. In an interview to a major newspaper, as the justice who is to preside over Brazil's supreme court after June 2004, he confessed that, as congressmen in legislature elected to draft and approve a new constitution for Brazil, he had quietly inserted two unvoted items into the bill's final draft, later signed on paper by his peers and himself, thus sanctioned as the present Constitution, in 1988.

He refused to specify which items were those, but offered two explanations. First, he had done so as secretary of the drafting process, under authorization from the president of Congress for that legislature, who has already passed away. Second, “If all framers signed what they later had on paper, this means they all agreed” [19]. Brazil's Constitution is long and verbose, with more that 200 articles. The framers of 1988 had tediously voted on each article, one by one, for months. They seem to have acted, at least by the end, under two principles of faith which can damage freedom and democracy when combined: priorization of convenience, and blind trust in authority.

The rig, the one in Brazil's present Constitution if indeed happened, went unnoticed and can not be verified because those congressmen devalued their need for a voter-verifiable procedure to accomplish their mission. Giving up their duty to verify on paper what they have voted for at the floors of Congress, they turned it into illegitimate power for the vote organizers. As congressmen in the 2003 legislature who, feeling empowered to do likewise regarding general elections, did so with somber irony, in the name of all Brazilians. Meanwhile, the mainstream media have begun reporting that Brazil's e-voting system – now stripped of voter verification mechanisms – is being promoted as a model.

News indicate that Paraguay, Argentina, Mexico, and other countries where corruption and election fraud are not just abstract concepts, may soon borrow or rent Brazil's system. At the same time, the same media gulliblely, if not by some complicity, ignore important messages from Mr. Jobim's justifications for constitutional piracy. First, that unverifiability means uncertainty, which yields impunity, which invites abuse of power, specially of the illegitimate kind. Second, that voters who devalue their need to verify the correct accounting of their own decisions, do so at their own risk.

7 Conclusion

Is Brazil, after all, ahead of its time regarding voting technology? Maybe.

It is understandable that voter verifiability measures tend to raise, besides complexity, the risk of malicious interference by underdogs upholding rights to supervise election procedures. Such rights, if abused, can spoil electoral organizations. But this shall not be held as reason to simply discard such measures from the outset. Rather, it shall be held as motivation to better research e-voting systems, given that verifiability is a technical price to pay for automation. Brazil's pioneer experience with e-voting evidences the flawed nature of such simplistic reasoning, while giving yet a bundle of pointers to the fact that election security is a matter of balancing risks and responsibilities.

Nevertheless, when dots are connected, one can find the same global enterprises and traces of interest dominating the electronic voting market, the related services' and regulatory lobbying practices worldwide, trying to uphold and advance such flawed reasoning. Brazil may have been chosen, due to historical, judicial and geopolitical circumstances, as a guinea techno-pig. For social engineering strategies aimed at advancing new power roles for IT players and their obscure alliances, eventually held or so potentialized, under the ideological reign of market fundamentalism, if we allow ourselves the benefit of the conspiratorial doubt.

The longest running democracy of our times is now debating the convenience and possible effects of legal measures enforcing voter verifiability in electronic systems. If we can trace parallels between official arguments put forth here and there, particularly those with feedback effects, the links so formed would be carrying signals. Signals indicating, to informed and cautious readers, that conspiratorial hypothesis are not so far fetched at the e-voting scenario. And that Brazil is, indeed, ahead of its time. Able to prove to the world the seriousness this debate merits, and the perils within.

References

[1] National newspaper special report: "*Crise no Senado, Tempestade no Planalto*" O Estado de São Paulo, May 2001 http://www.estadao.com.br/ext/especiais/tempestade/tempestade.htm, accessed July 27, 2003.

[2] The 2002 Law implementing voter-verifiable measure: "*Lei 10.408/02*" *D.O.U. de 11.01.2002, http://www.brunazo.eng.br/voto-e/textos/lei10408.htm*, accessed July 27, 2003.

[3] Interview with Brazil's chief electoral official: "*Ilmar Franco entrevista Nelson Jobim*" O Globo, Rio de Janeiro, October 15, 2001 http://oglobo.globo.com/pais/1659118.htm

[4] Note in National newspaper: "*CCJ aprova impressão do voto eletrônico*" Folha de São Paulo, pp. A9, October 29, 2001.

[5] Electoral statistics: "*Comitê Nacional Lula 2002*" http://www.lula.org.br/index1.asp, accessed July 27, 2003.

[6] National syndicated newspaper column: "*Coluna Jânio de Freitas*", Folha de São Paulo, October 8, 2002, São Paulo, SP.

[7] National syndicated newspaper column: "*Coluna Carlos Chagas*", Tribuna da Imprensa, October 10, 2002, Rio de Janeiro, RJ.

[8] Laerte Braga: "*A agência errada, o golpe é aqui, no Brasil*" http://www.crestani.hpg.com.br/2002C/laertebraga.htm, accessed June 19, 2004.

[9] Local newspaper main stories on elections: "*Confusão Eletrônica*" pp.21, "*No Limite da Paciência*", pp.22, Correio Braziliense, October 7, 2002, Brasília, DF

[10] Interview with chief electoral official in Federal District: "*Fabrício Azevedo entrevista Lécio Rezende da Silva: Garantimos a lisura das eleições*" Jornal da Comunidade, August 4, 2002, pp.4, Brasília, DF.

[11] Camarão, P. C. B.: "*Voto informatizado: legitimidade democrática*" pp. 196-203 Ed. das Artes, São Paulo, 1997.

[12] Inter American Development Bank. "*Approved Projects - Brazil*" http://www.iadb.org-/exr/doc98/apr/lcbraz.htm, accessed July 27, 2003.

[13] The 2003 electoral law bill: "*Câmara dos Deputados do Brasil - Proposição PL-1503/03, do Senado Federal*" Brazil's House of Representatives, National Congress http://www.camara.gov.br/sileg/Prop_Detalhe.asp?id=124899, accessed July 27, 2003.

[14] Editorial page from mainstream newspaper: "*Magela Recorre ao TSE para recontagem dos votos*" O Estado de São Paulo, November 19, 2002, São Paulo, SP http://www.estado.estadao.com.br/editorias/20-02/11/19/pol025.html, accessed July 30, 2003.

[15] Official web simulation of Brazil's electronic voting: http://www1.tse.gov.br/eleicoes/urna_eletronica/simulacao_votacao/urna.html accessed June 19, 2004.

[16] Official web site for Brazil's voting regulations: http://www1.tse.gov.br/servicos/resolucaoEm-Destaque/pesquisa.jsp accessed June 19, 2004.

[17] Brazil's Electoral Administration web newsroom: http://www1.tse.gov.br/servicos/informativo/-index.jsp accessed June 19, 2004.

[18] Report tracking Law 10.740/03's approval: "*Lei do voto virtual às cegas*" Forum do voto seguro, http://www.brunazo.eng.br/voto-e/textos/PLazeredo.htm, accessed May 10, 2004. Links doc.1 through doc.10 in report point to scanned versions of paper documents showing: a) trail the corresponding bill would have followed in Congress; b) its logical inconsistency.

[19] Maganize story: "*A prova dos abusos*" Revista Época, October 13, 2003, pp.75. Editora Globo, Rio de Janeiro.

[20] Fernandes, Bob: "*A hora da Autópsia*". magazine Carta Capital n.283, March 24, 2004, pp.35. Editora Confiança, São Paulo.

[21] Rutkowski, Lauro: "*Erros derrubam o secretário de informática do TSE*". Newspaper Zero Hora , August 6, 1996, pp.6. Porto Alegre.

[22] Public manifesto: "*Alerta contra a insegurança do sistema eleitoral informatizado*" Forum do voto seguro, http://www.votoseguro.com/alertaprofessores, accessed May 10, 2004, with 878 signataries.

[23] *Transcripts of House evening session of October 1st, 2003*: Brazil's House of Representatives, National Congress http://www.camara.gov.br/Internet/plenario/notas/ordinari/v011003.pdf, accessed May 10, 2004, pp.333-334: speech by the leader of Workers Democratic Party (PDT), Rep. Alceu Colares, denouncing: a) false representations by Rep. Moroni Torgan about the 2001 vv measure, which the bill there and then under vote would ban; b) the rigging of the House's internal electronic tracking system, on the path taken by said bill.

[24] Excerpt from *official video transcripts of Brazil's House of Representatives evening session of October 1st, 2003*. Forum do voto seguro www.brunazo.eng.br/voto-e/arquivos/collares1.rm [codec Real video 3.0, aprox. 3 min, 4.5Mb]:

Speech by PDT Leader (referenced in [23]), who frantically waves paper trail documents (scanned and linked in [18]) which show a rig at the House's internal electronic tracking system, on the path taken by the bill there and then under vote, to an unamused and unresponsive House president (Rep. João Paulo Cunha) conducting the session.

www.brunazo.eng.br/voto-e/arquivos/collares2.rm [codec Real video 3.0, aprox. 7 min, 8.5Mb]: Complete speech.

*** The author**

Pedro Antonio Dourado de Rezende is a tenured professor at Computer Science Department, University of Brasilia (UnB). ATC PhD in Applied Mathematics from University of California at Berkeley in 1983, heads the UnB Cryptography and Info Security Extension Program since 1997. Author of over one hundred articles on related topics, is a member of Brazil's Public Key Infrastructure Steering Committee since 2003, by appointment of President Lula da Silva to represent civil society.

**** Author's note**

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