Electronic Voting Technology DRC: Security Vulnerabilities and Déjà Vu

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Civil society organizations and pro-democracy movements based in the Democratic Republic of Congo (Congo) and around the world cried foul when the Congolese government announced plans to introduce electronic voting technology for use in the country's upcoming elections scheduled for December 2018.[1] The combined volume of domestic and international attention toward the use of electronic voting machine technology in Congo ultimately reached Argentina, where it caught the attention of a network of technical experts and civil society activists familiar with the South Korean company at the heart of the controversy, Miru Systems Co. On the other side of the world, the Iraqi government ordered a recount of votes cast in May 2018 parliamentary elections, due at least in part to allegations of technical glitches in Miru-provided vote counting equipment.

Based on technical documents obtained by The Sentry, a review of publicly available images and videos, and lessons learned from Argentina's own experiences with electronic voting, technical experts and security researchers identified significant similarities between the electronic voting technology currently proposed for implementation in Congo and models previously planned – and ultimately declined – for use in Argentina's 2017 national elections. In addition, experts found specific security vulnerabilities in prototype machines Miru sold to Congo. These vulnerabilities include potential threats to ballot secrecy as well as results manipulation. Iraq's current electoral dispute shows how glitches in unfamiliar technology can trigger contested election results.

Electronic voting technology thus threatens electoral transparency as well as the overall credibility of Congo's electoral process.

Déjà Vu

In July 2016, a South Korean delegation composed of both government officials and representatives of well-known technology companies visited Argentina in order to promote South Korean e-government technology.[2] According to an official statement from South Korean officials following the visit, the delegation included Miru Systems Co.[3] The same statement also indicated that Argentina planned to introduce its own electronic voting system in August 2016.[4]

In June 2016, the Argentinian government introduced an electoral reform bill to parliament that included a provision to implement an electronic voting system during national elections.[5] At the time of Miru's visit, Argentina's Congress was still debating the bill and no consensus had been reached about the roll out of electronic voting on a national level. The Argentinian government also published a statement on an official website following the South Korean delegation's visit.[6] Although this statement was later deleted, the title of an archived version of the original post refers instead to agreements reached between the governments of Argentina and Mexico.[7]

In August 2016, respected electoral expert Delia Ferreira Rubio, who currently chairs Transparency International, alleged that the Argentina's Minister of Modernization Andrés Ibarra had already procured a prototype of a South Korean "electronic single ballot" machine, despite the fact that the electoral reform law had not yet passed Congress and therefore the technical specifications necessary to evaluate any prototype machines had not yet been defined.[8] In addition, independent researchers and technical experts expressed concerns with potential security vulnerabilities in the proposed electronic voting technology.[9]

While the electoral reform law introduced to Congress concerned national elections,[10] Argentinian law allows provinces to determine their own methods of voting, and "electronic single ballot" technology had already been used in 2015 municipal elections in Buenos Aires and in Salta province.[11] In both cases, voters cast their ballots through Vot.Ar ,[12] a system owned by Argentinian company Grupo MSA.[13] Vot.Ar used paper ballots embedded with Radio Frequency Identification (RFID) technology.[14] The technology — essentially an antenna and small computer chip — has widespread everyday uses, such as contactless key fobs, car keys or subway cards.[15] For Vot.Ar, Argentine voters used a touchscreen system to make their selection. Ballot selections were then printed and stored in a traditional ballot box while simultaneously transmitted to an embedded RFID chip that electronically counts the vote. [16]

During the 2015 elections in Buenos Aires, independent researchers and technical experts demonstrated how corrupt individuals could hack or manipulate Vot.Ar's electronic voting machines. They showed that private keys used to transfer polling station vote totals to a central counting server were publicly available online, exposing them to hackers who could potentially manipulate votes and election returns.[17] The researchers also demonstrated how hackers could exploit additional

vulnerabilities in the underlying source code to manipulate the data stored in embedded RFID technology in order to cast multiple votes using a single ballot.[18] J. Alex Halderman, who heads the University of Michigan's Center for Computer Security and Society[19] profiled the work of these independent researchers in a paper on security vulnerabilities in electronic voting worldwide.[20]

In November 2016, Javier Smaldone, a Buenos Aires-based computer programmer and tech blogger, and information security expert Alfredo Ortega showed the Argentinian Senate how a domestic radio receiver could intercept results transmission via RFID, threatening ballot secrecy.[21] Smaldone and Ortega's demonstration to lawmakers was widely circulated via social media networks, with #MurióElVotoElectrónico (electronic voting is dead) becoming a top trending topic on Twitter in Argentina in November 2016.[22]

Due at least in part to concerns over potential security vulnerabilities, the proposed modifications to Argentina's electoral law failed to garner sufficient votes to pass the Senate, and the legislative session concluded in December 2016 without bringing the issue to a vote, barring the use of electronic voting technology in the 2017 national parliamentary elections[23] and scuttling any potential deal with a South Korean company. After the legislation failed to pass, 19 Argentinian university professors and information security professionals signed a statement expressing their satisfaction with the bill's failure to pass and underscoring concerns with security vulnerabilities in electronic voting in general.[24]

Miru in the Congo

Miru's re-appearance in Congo last year piqued Smaldone's interest. He and several other independent researchers analyzed publicly available images of Miru's technology in the country and were struck by several apparent similarities between the "electronic single ballot" technology used in

(Left) Ballot used in Buenos Aires 2015 municipal elections. Photo: Javier Smaldone

(Right) CENI President Corneille Nangaa demonstrating a sample ballot. Photo: CENI DRC Twitter.

Argentina and Miru's prototype machines in Congo. In addition to similarities between the design of the paper ballot (see page 3 images), the RFID logo appeared on several of the prototype machines delivered by Miru to Congo.[25] Smaldone also noted that the amount of machines originally projected for use in Argentina — 120,000[26] — was very close to the number the CENI electoral commission said it would need for Congolese elections — 105,000.[27] Smaldone suggested the machines Miru was attempting to sell in Congo had been originally intended for use in Argentina, and that the machines were re-packaged and marketed to Congo after Argentina's e-voting law failed to pass.[28]

The Sentry has reviewed a document provided by Miru to CENI officials describing the technical specifications of Miru's touchscreen technology. Although the original document, is dated July 2017, document metadata indicates that it was last edited in August 2017 – one month before the CENI announced its intention to use electronic voting machines sourced from South Korea in the upcoming electoral cycle.[29] In addition, while the original document is in French, extracted images from the text obscured by overlaid text boxes and images include several Spanish words, references to well-known Argentine politicians, and vote-counting categories in Spanish. One extracted image shows the same ballot model used in "electronic single ballot" technology in Buenos Aires municipal elections and Salta provincial elections in 2015.

Sample of activation card generated at poll opening in 2015 Buenos Aires municipal and Salta provincial elections.
Photo: Tribunal Superior de Justicia Ciudad Autónoma de Buenos Aires

Extracted image from technical specifications document provided by Miru to the CENI.
Photo: The Sentry.

Acta de Apertura de Mesa

Please insert the open card to open the vote,
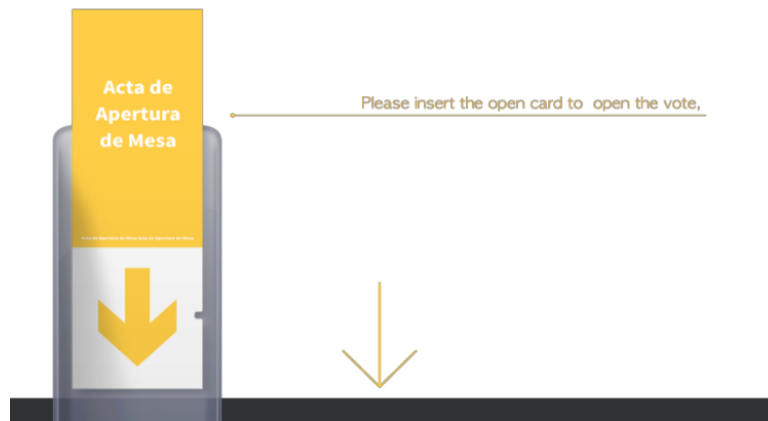
According to the same document, Miru's touchscreen measures 21.5 inches across. On November 17, 2016, Argentina's Secretary of Infrastructure, Technology and Digital Nation in the Ministry of Modernization Raúl Martínez stated that the touchscreens of the electronic voting machines being considered for use in Argentina measured the same size.[30]

A key difference between the machines Miru proposed for Congo and those used in Argentina in 2015 is the application of QR codes instead of RFID technology. The above-referenced technical document provided by Miru to the CENI includes pictures and information about ballots that use QR codes (and not RFID technology). QR codes are two-dimensional bar codes containing information that may be decoded using a QR scanner, most commonly via a smartphone application.[31] In Miru's technology, voters' selections are both physically recorded via paper ballot and electronically stored via QR code.

Potential Security Vulnerabilities

The Sentry shared with the Washington DC-based Center for Democracy & Technology chief technologist Joseph Lorenzo Hall a copy of Miru's technical specifications provided to the CENI. Based on this document and Hall's prior experience with QR code technology, Hall identified the technology's potential vulnerabilities, including potential threats to ballot secrecy and vulnerabilities to hacking.

According to Hall, QR codes may store more information than simply a voter's ballot selections, potentially including the time a person voted, their place in line and other voter-specific or ballot-specific identifiers. This information can be used to correlate the contents of a ballot to a specific voter's identity, violating ballot secrecy. According to Hall, electoral authorities must take steps to ensure that ballots cannot be recorded, photographed or viewed by anyone other than the voter. Without proper controls, nefarious actors could exploit actual or perceived threats to ballot secrecy to intimidate or discourage voters. For example, a political party leader could tell voters they will take note of who cast a ballot for which candidate, threatening consequences for dissenting voices. Even perceived threats to ballot secrecy could thus result in a chilling effect, suppressing voter turnout.[32]

The technical specification document Miru provided to the CENI also includes several explanatory graphics and more detailed information about the company's software. The images show various ports on the side of the device for USB flash drives, used to activate machines, as well as ports for ethernet networks and an SD-card memory slot. The document further references 2G and 3G wireless cellular connections, and specifies reliance on an outdated version of an Android mobile operating system from 2014.

Without taking precautions to carefully monitor, control and clearly distinguish Miru's USB flash drives, an outside actor could enter a polling location and easily switch out one or more USB flash drives, potentially changing results or otherwise introducing malicious software, according to Hall. He also emphasized that relying on 2G and 3G wireless cellular connections could leave information stored on Miru's system open to tampering via hacking. There are also concerns about using an

outdated Android operating system (Android 5.0.2) without security patches to account for serious security vulnerabilities discovered in this software after its 2014 release.

On June 1, 13 Argentine information security specialists and two civil society groups, including Poder Ciudadano, the Argentinian chapter of Transparency International, published a statement expressing concern with potential vulnerabilities in electronic voting technology in general, including potential threats to ballot secrecy as well as potential barriers to transparency. [33] The letter concluded that paper ballots are the most secure method of voting and expressed solidarity with civil society groups in Congo advocating against the use of electronic voting technology in the upcoming election.

In addition to these technical concerns, Fred Bauma, a member of pro-democracy youth movement Lucha expressed concern that officials could exploit unfamiliarity with the technology to influence votes. "In many remote areas, the majority is illiterate and therefore unable to use it (the technology). The CENI suggests that there will be people who can show them how to find the candidate they want to vote for, therefore there is risk they could influence the vote of the people," Bauma said.

Miru in Iraq

In addition to its activity in Argentina and Congo, Miru signed a contract with the Iraqi government in April 2017 to provide electronic vote counting machines in that year's September local elections. [34] Iraq's electoral commission then decided to use the machines for May 2018 parliamentary elections.[35] On June 6, 2018, Al Jazeera reported that Iraq's parliament had ordered a full recount of election results.[36] Iraqi Prime Minister Haider al-Abadi was cited as stating that the vote counting machines had not been properly inspected before use. Tests of the machines produced disparate results, Al Jazeera added.

Questions Moving Forward

Despite the broad array of concerns voiced by domestic and international observers, the CENI still publicly expresses support for using the technology in the 2018 election. In an April 3 statement, CENI representatives confirmed that Miru had already delivered the first 200 machines[37] out of an estimated 105,000.[38] On May 31, the CENI stated that a delegation of officials, including CENI Vice President Norbert Basengezi, visited South Korea in order to inspect 1,000 machines to be used for training and voter outreach purposes.[39] [40]

The similarities in electronic voting technology pitched for Argentina's 2016 national elections and Miru's prototype machines debuted in Congo raise several important questions. Were the machines originally intended for Argentina modified for use in Congo? How can electronic voting technology that failed review in Argentina be safe for use in Congo's arguably more logistically-demanding electoral environment? What steps has the CENI taken to mitigate security vulnerabilities and ensure ballot secrecy?

Although the bulk of international attention on elections in the Congo is focused on ensuring a peaceful transition of power at the presidential level, the 2018 election cycle includes legislative, regional, local and presidential elections. Although the technology used in Iraq's May 2018 parliamentary elections and the technology proposed for use in the DRC are different, Iraq's experience vividly illustrates how actual or perceived vulnerabilities in technology can trigger hotly contested results. In Congo's politically charged environment, lack of popular confidence in the technology could clearly also suppress voter turnout. As a result, Miru's technology may seriously threaten electoral credibility in Congo.

Recommendations

The proposed use of electronic voting technology in Congo's upcoming election raises a red flag that could hamper the credibility of the results. The Congolese government is denying freedom of assembly to civil society and opposition groups ahead of elections[41] and pressing politically motivated charges against activists.[42] Congolese security forces arrest and intimidate pro-democracy groups[43] and President Joseph Kabila has yet to deny his candidacy in the upcoming presidential election.[44]

The United States and the European Union should:
- Immediately exert financial pressure to help prevent Kabila from running for re-election and ensure a credible democratic transition of power, including sanctions designations and anti-money laundering measures against senior members of his inner circle and their corporate networks. This pressure should increase if the Kabila government fails to take meaningful steps to hold a credible, peaceful democratic transition of power. Key benchmarks should include: abandoning the use of electronic voting technology in favor of paper ballots, ensuring that civil society and opposition groups can peacefully demonstrate and exercise their rights to freedom of assembly, dropping politically motivated charges against opposition and civil society leaders, releasing political prisoners, allowing all candidates to register and public confirmation that Kabila will not stand for re-election.
- Ensure enforcement of existing sanctions and take steps to monitor and guard against evasion by already-sanctioned individuals.

The US, African Union, Southern African Development Community and EU should:
- Coordinate public messaging on the Kabila government's failure or success to meet the benchmarks outlined above, preferably via joint statements.

The donor community should:
- Increase assistance to civil society efforts to observe the electoral process. Increase and sustain assistance to democracy and governance strengthening initiatives.

[1] For a comprehensive overview of observer concerns with electronic voting technology in the DRC see: "Congo Research Group Election Brief N°1: The Electronic Voting Controversy in the Congo." Congo Research Group. April 2018. Congoresearchgroup.org/wp-content/uploads/2018/04/Electronic-Voting-Controversy-1.pdf; see also "Red Flags in DR Congo's Electoral Process: Time for Consequences." Enough Project. March 8, 2018. https://enoughproject.org/blog/red-flags-dr-congos-electoral-process-time-consequences

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[3] *Idem.*

[4] *Idem.*

[5] A copy of the draft law can be accessed via diputatdos.gov/ar/export/hcdn/secparl/dsecretaria/s_t_parlamentariao/2016/pdfs/0018-PE-2016.pdf

[6] Smaldone, Javier. "Boleta única electrónica, invento argentino que debuta en la cuestionada democracia del Congo." April 23, 2018. http://borderperiodismo.com/2018/04/23/la-boleta-unica-electronica-un-invento-argentino-que-debuta-en-la-dictadura-del-congo/

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[9] See endnotes xvi – xxi

[10] A copy of draft law can be accessed via diputatdos.gov/ar/export/hcdn/secparl/dsecretaria/s_t_parlamentariao/2016/pdfs/0018-PE-2016.pdf

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[12] Vot.Ar website: https://votar.com.ar/

[13] Grupo MSA website. https://www.msa.com.ar/

[14] Halderman, J Alex. "Practical Attacks on Real World E-Voting." In: Hao, Fang; Ryan, Peter Y A. *Real World Electronic Voting: Design, Analysis, and Development.* CRC Press. Boca Raton, Florida. 2017.

[15] "Radio Frequency Identification (RFID): What is it?" US Department of Homeland Security. https://www.dhs.gov/radio-frequency-identification-rfid-what-it

[16] Halderman, J Alex. "Practical Attacks on Real World E-Voting." In: Hao, Fang; Ryan, Peter Y A. *Real World Electronic Voting: Design, Analysis, and Development.* CRC Press. Boca Raton, Florida. 2017.

[17] *Idem.*

[18] *Idem.*

[19] J. Alex Halderman's professional website. https://jhalderm.com/

[20] Halderman, J Alex. "Practical Attacks on Real World E-Voting." In: Hao, Fang; Ryan, Peter Y A. *Real World Electronic Voting: Design, Analysis, and Development.* CRC Press. Boca Raton, Florida. 2017.

[21] Presentation to the Argentinian Senate by Javier Smaldone and Alfredo Ortega. November 17, 2016. https://www.youtube.com/watch?v=aFYoJkbaPrU

[22] Screenshot of List of top trending topics on Twitter. November 24, 2016. https://twitter.com/mis2centavos2/status/801940327418490880; see also #VotoElectronicoYa (Enough Already Electronic Voting) https://trendogate.com/placebydate/23424747/2016-11-25

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[26] Idem.

[27] "Africa Director Rushdi Nackerdien Briefs the UN Security Council on the DRC." International Foundation for Electoral Systems. February 21, 2018. www.ifes.org/news/africa-director-rushdi-nackerdien-briefs-un-security-council-drc.

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[29] According to a May 2018 report commissioned by USAID, "In September 2017, the CENI announced its intention to use electronic voting machines sourced from Congo in the upcoming elections." "DRC 2018 Elections Rapid Response Assessment Report February 28 – March 9, 2018." Produced for review by the United States Agency for International Development. Prepared by the Consortium for Elections and Political Process Strengthening. May 1, 2018. http://www.iri.org/sites/default/files/cepps_drc_2018_electoral_preparation_assessment_06-01-18-french.pdf

[30] Argentine Infrastructure, Technology and Digital Nation Minister Raúl Martinez speaking at the Senate about the screen size of the voting machines. November 17, 2016. https://www.youtube.com/watch?v=eMoi0RyL7zM&feature=youtu.be

[31] www.princeton.edu/frist/qrcodes.html

[32] See also Javier Smaldone's commentary on potential vulnerabilities posed by QR code technology: Liffran, Olivier. "RDC: l'utilisation de la machine à voter vivement critiquée par des ONG argentines." Jeune Afrique. June 1, 2018. www.jeuneafrique.com/564559/politique/rdc-lutilisation-de-la-machine-a-voter-vivement-critiquee-par-des-ong-argentines

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See also: Liffran, Olivier. "RDC: l'utilisation de la machine à voter vivement critiquée par des ONG Argentines." June 1, 2018. Jeune Afrique. http://jeuneafrique.com/564559/politique/rdc-lutiliation-de-la-machine-a-voter-vivement-critiquee-par-des-ong-argentines

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[35] Sattar, Omar. "Electronic vote counting sparks controversy ahead of Iraqi polls." Al-Monitor. April 18, 2018. https://www.al-monitor.com/pulse/originals/2018/04/iraq-election-electronic-votes-counting.html

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[39] CENI official Twitter handle. May 31. https://twitter.com/cenirdc/status/1002442450143760385

[40] According to a May 2018 report prepared by the Consortium for Elections and Political Process Strengthening, Miru's model requires voters to insert a paper ballot into a voting machine and then use touch screen technology to select a candidate. After the voter confirms the selection, the machine prints the voter's choice on a paper ballot, which the voter then places in a physical ballot box, while the voter's selection is simultaneously

electronically recorded. While the paper ballots are intended to serve as the primary basis for final results determination, electronic results could be used to offer more rapid provisional results tallies.

"DRC 2018 Elections Rapid Response Assessment Report February 28 – March 9, 2018." Produced for review by the United States Agency for International Development. Prepared by the Consortium for Elections and Political Process Strengthening. May 1, 2018. http://www.iri.org/sites/default/files/cepps_drc_2018_electoral_preparation_assessment_06-01-18-french.pdf

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