State of the Art Briefing on Open Source Voting Systems and Projects

Presented to the

City and County of San Francisco Elections Commission

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Contents

Executive Summary

In 2014, the San Francisco Board of Supervisors passed Resolution No. 460-14 "Supporting the Creation of Open Source Voting Systems (OSV)," which "commits the City and County of San Francisco (CCSF) to work with other jurisdictions and organizations to create new voting systems using open source software; and to study the feasibility of CCSF developing and using a new voting system; either whole or in part, through a collaborative model." A business case solicited by the San Francisco Department of Elections followed in 2017. A preliminary business case was developed in 2017 which estimated the costs associated the developing such at $24-34M and which identified a number of challenges that the City would need to overcome before it could create or adopt an OSV system.

This "State of the Art Briefing" provides a summary of research into the current state of OSV systems. This research was conducted in support of the City's goal of creating an open source elections systems.

Since the early 2000s, OSV systems have drawn attention from jurisdictions interested in more transparent, secure voting that allows for independent verification of election results. Also, the solutions available from the vendor community were considered by some to be outdated and expensive. Over the ensuing two decades, there has been only limited incremental progress toward this goal of an OSV system other than the Los Angeles County Voting Solutions for All People (VSAP) program. Although some progress has been made toward developing OSV software, such as non-profit OSET's "trust the vote" project, only Los Angeles County has adopted an OSV system or used such a system in a major election.

The federal government and the states have declined the opportunity to take on a significant role championing or funding Open Source Voting (OSV) efforts. At the same time, several voting system vendors have created modern versions of their products which address many of the technical concerns raised by the original OSV advocates.

It is worth noting that not all the projects analyzed for this report are open source systems. However, all are non-commercial. Open Source (OS) denotes software for which the original source code is made freely available (often under an OS licensing agreement) and may be redistributed and modified. Non-Commercial means that the organization funding the voting system development does not intend to sell the product for gain. Rather, the purpose of development is to improve the election process through one or many components which would be publicly licensed or otherwise shared.

While it is difficult to draw definitive conclusions from this research, the conclusion that the OSV solutions have not advanced at the same pace of the propriety solutions is hard to ignore. Also, as indicated in the detailed analysis later in this report, the level of technical activity across the various open source code repositories has not grown and in some cases has declined as some efforts have stalled.

The most notable exception to this is the development of the Voting Solutions for All People (VSAP) solution by Los Angeles County, which is currently undergoing certification by the California Secretary of State's office for use in the March 2020 Primary Election. VSAP is a non-commercial system where the solution and related intellectual property is publicly owned by the County of Los Angeles, and the County intends to determine an open source licensing approach in the future. Los Angeles County has also engaged a set of technology vendors to develop and support the various components of the system.

History

2003 The Condorcet Internet Voting System is published by the Cornell Computer Science Department.

2005 The discussion of more transparent, secure begins in public news articles and academic white papers. Travis County, TX announces it has begun research into improving the efficiency and security of its voting systems.

2007 CCSF Department of Elections signs a contract for an election voting system with Sequoia Voting Systems.

2008 CCSF creates the Voting Systems Task Force (VSTF) to provide the City with recommendations on voting systems and related matters.

2009 Public discussion of transparent, secure voting alternatives increases, and research projects begin across the country.

Code for America is founded to minimize the gap between public and private organizations use of technology and design.

The Los Angeles County Registrar-Recorder/County Clerk (RR/CC) forms the Voting Systems Assessment Project (VSAP) to gather baseline data that will shape the strategy for voting system modernization.

2010 Dominion Voting Systems acquires Sequoia Voting Systems and assumes CCSF's contract.

2011 CCSF VSTF issues its final report on "Recommendations on Voting Systems for the City and County of San Francisco."

Code for America Civic Commons and Open Plans launch USAspending.gov which is considered a major milestone for government transparency and open data efforts to date.

2013 Travis County partners publish "STAR- Vote: A Secure, Transparent, Auditable, and Reliable Voting System." Research into STAR-vote begins at election departments across the US.

2014 Open Source Election Technology Institute (OSET) publishes a voter-facing technology framework, including the VoteStream project, a 12-state collaboration. Their open source software is made available through the OSET Public License.

The federal government forms the 18F project to improve and modernize federal government technology, with a focus on using open source to promote transparency and collaboration between federal agencies. 18F takes the role of a technical consultancy within the federal government.

The San Francisco Board of Supervisors passes Resolution No. 460-14, "Supporting the Creation of Open Source Voting Systems - Studying New Models of Voting System Development," requesting the San Francisco Local Agency Formation Commission (LAFCo) conduct a feasibility study.

2015 CCSF LAFCo publishes its final report, "Study on Open Source Voting Systems."

CCSF Elections Commission passes an Open Source Voting Systems Resolution.

2016 Travis County puts the STAR-Vote project out to bid with an RFP. The RFP focuses on open source voting machine software, commercial off the shelf hardware, third party auditable security, and end-to-end election process transparency.

VSAP progresses to the design phase when the LA County RR/CC signs a Phase III contract with IDEO to create a voting system product design.

2017 CCSF Elections Commission creates the Open Source Voting System Technical Advisory Committee (OSVTAC) to "provide technical guidance, ideas, and support to the Elections Commission… on ways to improve and help ensure the success of the City and County of San Francisco's open source voting system project."

CCSF Department of Elections issues an RFP (REG RFP #2017 01) to "prepare a business case for developing an accessible, open source voting system."[1]

LA County RR/CC finalizes the VSAP design specifications and produces Ballot Marking Device design validation units.

Travis County Clerk ends the STAR-Vote project due to lack of viable open source-based commercial RFP bids.

2018 LA County RR/CC's central vote tabulator, VSAP Tally, is certified for use in elections by the California Secretary of State.

Slalom publishes the Open Source Voting Business Case for CCSF.

LA County RR/CC signs a contract for VSAP Phase IV-V with Smartmatic USA Corporation for the hardware manufacturing and software development of the VSAP Ballot Marking Device (BMD), the VSAP BMD Manager (BMG), and the VSAP Interactive Sample Ballot (ISB) as well as Systems Integration and Coordination services. Full implementation is planned for the 2020 election cycle.

Travis County Clerk approves a voting systems contract with Election Systems & Software (ES&S).

[1] "Request for Proposals for Preparing a Business Case for Developing an Accessible, Open Source Voting System," City and County of San Francisco, 22 May 2017, https://osvtac.github.io/project/files/DOE/REG_RFP_2017-01_Business_Case.pdf

2019 DARPA partners with Galois to build an open source, secure, election system[2]

Microsoft announces Electionguard, an opensource SDK[3].

Galois partners with Microsoft to enable verifiable elections with Electionguard[4].

US Senate Intelligence Committee recommends the use of risk-limiting audits to secure elections in its report on Russian Interference[5].

DHS Cybersecurity and Infrastructure Security Agency (CISA) partners with VotingWorks to release an Open Source risk-limiting auditing tool[6].

CCSF performs a successful pilot of a risk-limiting audit on a RCV contest. Pilot built on Open-Source project "ShangRLA" and was sponsored by CCSF[7].

The Open Source Digital Voting (OSDV) Foundation (a.k.a "Trust the vote") announces availability of its prototype Open Source election system[8].

State of California passes AB-1784. This bill, the Secure the VOTE Act, would authorize the Secretary of State to award up to $16,000,000 in matching funds, upon appropriation by the Legislature, to counties for the development of open-source paper ballot voting systems[9].

LA County VSAP conducts a Mock Election to engage and educate the public on the VSAP Solution. Similarly, it piloted the BMDs in the November 2019 election and is underway with rotating Demonstration Centers to further engage the public to learn about and interact with the BMDs.

[2] https://www.vice.com/en_us/article/yw84q7/darpa-is-building-a-dollar10-million-open-source-secure-voting-system
[3] https://blogs.microsoft.com/on-the-issues/2019/05/06/protecting-democratic-elections-through-secure-verifiable-voting/
[4] https://galois.com/news/galois-partners-with-microsoft-to-enable-verifiable-elections-with-electionguard/
[5] https://www.intelligence.senate.gov/sites/default/files/documents/Report_Volume1.pdf
[6] https://www.zdnet.com/article/cisa-and-votingworks-release-open-source-post-election-auditing-tool/
[7] https://arxiv.org/pdf/1911.10035.pdf
[8] https://www.wired.com/2009/10/open-source/
[9] https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB1784

Background

CCSF serves over 500,000 registered voters and provides voting materials in four languages—English, Chinese, Spanish, and Filipino. The needs of the City's voter base are complex. Learning from implemented open source voting systems is crucial to the creation of a system that can serve San Francisco.

The following voting systems are examined in this document:

1. **Voting Solutions for All People (VSAP) – Los Angeles County Registrar-Recorder/County Clerk**

   The VSAP project is a complete replacement of Los Angeles County's existing voting system, including custom-designed hardware and open source software. It will be fully implemented for the March 2020 Presidential Primary Elections.

2. **Free & Fair – Galois**

   Free & Fair is a spin-off of Galois focused on secure election technologies, including two open source projects launched in 2016 and 2017.

3. **Sovereign – democracy.earth**

   Sovereign is a bitcoin-based open source "liquid democracy" platform that seeks to increase faith in the political process and ultimately decentralize elections.

4. **Condorcet Internet Voting System (CIVS) – Cornell Department of Computer Science**

   CIVS is an online, open source polling tool, used to create public and private polls based on the Condorcet method.

5. **TrustTheVote – Open Source Election Technology Foundation**

   TrustTheVote seeks to develop a complete suite of open-source software for the election process, called ElectOS, planned for implementation in November 2020.

6. **Voting Works – Ben Adida and Matt Pasternack**

   A new organization working with Center for Democracy & Technology. Based on the Helios Voting system it which was not intended for pubic elections.

7. **FollowMyVote**

   Completed a Blockchain proof of concept at several events. Minimal public information available nor implementions.

8. **ElectionGuard – Microsoft**

   Launched in May 2019, the tools provide an open source SDK which was built in partnership with Galios. The software supports Risk Limiting Audits and end to end verification processes.

9. **STAR-Vote – Travis County Clerk**

   STAR-Vote is an election system designed by the Travis County Clerk, centered on open source software and commercial off-the-shelf hardware. This effort has been discontinued.

Methods and Analysis Used to Identify Open Source, Non-Commercial Voting System Projects

Transparency, collaboration, and momentum are good indicators of the viability of an open source project. Most open source projects use the public repository service, GitHub, to store code, making a survey of GitHub's listed statistics is one way to measure the feasibility of using the project. This can be quantified by noting the number of major code contributions, or pull requests. Each pull request represents a contributor requesting to merge a changed piece of code into the main code base, which requires a documented conversation of what the change represents, why it should be merged, and the project leader's interest in the change. For this reason, the number of pull requests was considered a indicator of a project's health.

In general, the presence of any or all of the following attributes are indicators of a viable project:

- Multiple individual and commercial contributors
- Public project strategy
- Public discussions on code changes
- Public milestones along with project revisions
- Public software pipeline
- Public technical leadership
- Public community engagement, where questions can be asked and discussions on topics can happen

Although not all of the projects analyzed in this brief are strictly open source, all are non-commercial. Non-commercial means that the organization funding the voting system development will not have a product to sell to customers. Rather, the purpose of development is to improve the election process through one or many components, most of which would be publicly licensed under an open source license. For non-commercial, non-open source projects, there are generally no public statistics on development, and none have been included in this analysis.

Non-Commercial Voting Systems Quantitative Comparison

Using the methods from above, each of the projects was analyzed using a combination of the number of healthy public project components, commits, pull requests, contributors, published strategy, published plans, and published milestones.

Open Source Activity	Name	Location	Date	License	Technology
High	Los Angeles County Registrar-Voting Solutions for All People Project	Los Angeles, CA	2019	TBD	Contracted hardware and Go, Android, Angular, CSS, HTML5 software, Cassandra, Kafka
Low	Galois Free & Fair ColoradoRLA	Portland, OR	2018	AGPLv3, GPLv3	Java, Haskell, C
Low	Democracy Earth Sovereign	San Francisco, CA	2018	MIT	Blockchain compatible online voting
Medium	Cornell Computer Science Department Condorcet Internet Voting System	New York, NY	2018	Free, retaining copyright	Perl, python, JavaScript based online voting system
Medium	Open Source Election Technology Trust the Vote Online Voter Registration, Tabulator, Election mgt systems, firmware for casting ballots on BMD	Palo Alto, CA	2018	OSET v 1.2	Ruby, Java, PHP, Sharp, Grommet(android)
Medium	VotingWorks Helios Server	Redwood City, CA	2018	Apache v2	Python, JavaScript
Medium	VotingWorks ARLO (RLA)	Redwood City, CA	2018	Open Source but charges to run audit	Python (ARLO is the replacement to CORLA)
Low	FollowMyVote	Virginia, US	2014	MIT, Unlicensed	N/A

Non-Viable Projects

Status	Name	Location	Date	Complete	License	Technology
Cancelled	Travis County STAR-vote	Austin, TX	2017	0%	GPL	N/A

As a point of comparison, the following open source data was gathered from GitHub. For the purposes of this analysis, open source survey applications are assumed to have similar utility as election-focused applications. Additionally, for scale, two of the most engaged open source applications are provided. The main conclusion that can be drawn from this exercise is that the level of recent GitHub activity around these projects varies significantly and that they have not attracted a large number of contributors or are experiencing a large amount of activity.

Type	Open Source Application	# of Contributors	# of Commits
Baseline for Comparison	Lime Survey	143	29,792
Baseline for Comparison	Tell Form	30	1,401
Baseline for Comparison	Odoo	1,022	132,107
Baseline for Comparison	Magento	1,294	100,508
Avg- Baseline		**622**	**65,952**
Voting Project	LA VSAP	N/A	N/A
Voting Project	Galois, Free & Fair	??	??
Voting Project	Democracy Earth	24	2516
Voting Project	Condorcet	7	864
Voting Project	OSET	8	3093
Voting Project	Voting Works	??	??
Voting Project	Travis STAR-Vote	N/A	N/A
Voting Project	FollowMyVote	0	0

Voting Solutions for All People (VSAP) – Los Angeles County Registrar-Recorder/County Clerk

Summary

The Voting Systems Assessment (VSAP) Project started September 16, 2009, and since renamed to the Voting Solutions for All People (VSAP). The vision of the project is to use a transparent process to develop and implement voting solutions that focus on the needs and expectations of current and future County voters. This human-centered approach is guided by the VSAP General Voting System Principles. The Los Angeles County RR/CC VSAP 8-year planning period allowed the team to fully vet multiple avenues of product design and community interest before embarking on the voting system design. The solution is developed using open source tools and the software specifications remain County intellectual property (IP). The County intends to make the VSAP solution available to other jurisdictions, however a licensing model has not yet been solidified. VSAP election operations may be publicly auditable and independently verifiable. While VSAP has no public code repository, it has published strategy and architecture, plans, and milestones. There also have been commercial and academic contributors to the strategy and architecture. Even without publicly licensed software, this project is the best from the perspective of transparency, contributions, and momentum relative to all available options.

Overview

The Voting Systems Assessment Project (VSAP) began on September 16, 2009, when Los Angeles County was unable to find a commercially available voting system that could meet the needs of its large, diverse electorate. VSAP's development began with a multi-year public engagement and research campaign, resulting in extensive information on the needs and preferences of both election staff and the voting public. This human-centered approach was guided by the VSAP General Voting System Principles, which were adopted in 2011 "to ensure the needs of County voters remained a top priority throughout the life of the program." The VSAP project was rebranded as the Voting Solutions for All People (VSAP) in Fall 2017. A couple VSAP components, such as the VAP Vote-By-Mail ballot and VSAP Tally (for VSAP VBM ballots) were implemented in Fall 2018. The full VSAP Solution, including new voting machines (VSAP Ballot Marking Devices), will be implemented for the 2020 Presidential Primaries.

Governance & Organization

The VSAP Executive Sponsor is the Los Angeles County Registrar-Recorder/County Clerk (RR/CC) Department head. The VSAP Program is governed by the VSAP Executive Steering Committee (ESC), which consists of the Los Angeles County Registrar-Recorder/County Clerk Department head, his Chief Deputy, and the Assistant Registrar-Recorder/County Clerks. The VSAP ESC manages strategy, budget, cross-functional dependencies, and partner relationships. It also represents the project before the Los Angeles County Board of Supervisors.

The VSAP Program receives guidance from its Advisory Committees. Furthermore, the County engages partners for additional project support including IDEO who provides design stewardship, as well as Digital Foundry and Smartmatic for software development and hardware manufacturing. In addition, there have been many community meetings since 2010 with attendees numbering in the thousands giving feedback on the VSAP design.

The Los Angeles County RR/CC retains the rights to VSAP's intellectual property (IP). The RR/CC has stated they eventually intend for other voting districts to benefit from the VSAP voting system, possibly through shared review and testing. Full licensing options are still being considered, as well as the possibility of an independent non-profit organization to manage the VSAP IP.

Funding & Budget

VSAP is primarily funded by Los Angeles County. The County has sought and been awarded matching funds at both the federal and state level. At the state level, the County has received 3:1 matching funds from the state's Voting Modernization Fund, which was expanded to include non-commercial voting options by Senate Bill 360 in 2014. LA County also received one-time allocations from the state's General Fund. In June 2018, LA County staff estimated that VSAP development and implementation would require $225.3 million in funding over the following three years.

Los Angeles County RR/CC contracted with Smartmatic USA Corporation (Smartmatic) for manufacturing hardware, software, and custom-designed ballot marking devices (BMDs) for the VSAP project, to be completed in time for the 2020 election cycle. The VSAP project contract runs from June 12, 2018 through March 31, 2027 with three two-year, optional extensions available through March 31, 2033 for a maximum cost of $282M including extensions. The VSAP contract can be increased by the RR/CC with simple two-week prior notice given to the Los Angeles County Board of Supervisors. Under this contract at least 31,100 BMDs will be developed, manufactured, implemented, certified, and warrantied, with maintenance and support provided.

Technology

VSAP is a complete voting system consisting of new vote tabulating software, new ballot marking devices (BMDs), new Vote By Mail (VBM) paper ballots, and new digital sample ballots (ISB or Interactive Sample Ballot) which is available through a web-based browser. The solution uses Knowink electronic pollbooks (epollbooks).

VSAP's centralized vote tabulating software, VSAP Tally 1.0, was certified in 2018 to tabulate the new VSAP VBM ballots and was implemented with the new VSAP VBM in 2018. Tally supports ballot-level auditing by capturing and storing ballot images, working both with ballots from polling places and with the newly-redesigned VBM ballots.

VSAP BMDs, currently in development and underway with its certification testing campaign, support a wide range of accessible voting features, including an audio jack for headphones, a tactile controller, an adjustable touch screen, and a QR code scanner to pre-populate the voter's selections if they used the Interactive Sample Ballot (ISB). The ISB is accessible from a web-based browser and allows voters to pre-mark their ballot selections. A QR code is generated that the voter prints or saves on their mobile device, which is scanned at the BMD at the Vote Center. Once the QR code is scanned at a BMD, the voter's pre-selections are displayed for the voter to review and modify, if applicable, before their selections are printed on the paper ballot. Once a voter completes their selections, their selections are printed on their paper ballot for review and validation before formally being cast. The paper ballots are securely transported to RR/CC for tallying.

Schedule

Phase I: Public Opinion Baseline Research (2009 – 2010)

- VSAP met with election stakeholders and subject matter experts including voters, poll workers, advocates, key community organizations, and election staff through town halls and community meetings.

Phase II: Process Assessment (2011)

Phase III: System Design and Engineering (2012 – 2017)

- VSAP partnered with the design firm IDEO to develop an intuitive, user-centered voting system.
- Consultation with community groups and stakeholders continued throughout this time.

Phase IV: Manufacturing and Certification (2018 – 2020)

- California Secretary of State Certification for the VSAP Solution - January 2020
- BMDs Ready for Full Rollout - March 2020 Presidential Primary Election

Phase V: Phased Implementation (2020)

- Full rollout of the VSAP Solution for the March 2020 Presidential Primary Election.

Accomplishments

Seven years of initial idea and plan development created a strong foundation for the VSAP project. VSAP engaged with 3,734 voters, election workers, and experts over 43 engagement activities between the project's start in 2009 and August 2016. Activities included phone surveys, focus groups, community discussions on language and accessibility needs, and symposium presentations, as well as a dozen user testing sessions during the design process. This attention to the community's needs and proactive solicitation of feedback has created a voting system that can meet the requirements of an enormous, diverse population, while also establishing a firm relationship of trust between the County and voters. VSAP's attention to accessibility needs, including conducting user testing and product demonstrations with the United Cerebral Palsy of Los Angeles and the California Council of the Blind, helped create a BMD design with an impressively broad range of accessibility features.

VSAP's deliberative planning process also led to the creation of a project timeline that has realistically reflected the time required to complete each phase of a project as large as VSAP. Schedule changes have been rare, and the project is on track to complete rollout and implementation in time for the March 2020 Presidential Primary Election.

Issues

Open source advocates have raised questions about the extent to which VSAP may be considered 'open source,' meaning the extent to which the project's code will be shared under an open source license. Los Angeles County has since clarified that VSAP's software and hardware will be available for review and testing by other municipalities, with the eventual possibility for shared use, while the County will retain intellectual property rights.

Takeaways

VSAP's eight-year planning process created both an effective, lasting foundation for subsequent design work and a deeply positive relationship with the Los Angeles County community. Through extensive community meetings and engagement with its advisory committees, they developed a thorough

understanding of voter needs and earned a reputation for transparency and accessibility, all of which resulted in a focused design process and widespread public support.

VSAP also benefited from a detail-focused approach to product development and a multi-phase production schedule with achievable timelines, as well as a well-organized project management team that continues to meet milestones and provide deliverables on schedule. Projects seeking to emulate VSAP can learn much from Los Angeles County's approach to planning, design, and execution.

Free & Fair – Galois

Summary

This is a professional team that has worked on open source elections implementations, sponsored by Galois, a computer science company. Strategy, funding, and contributors from a commercial software development organization is an important milestone for an open source project. They have 35 public GitHub repositories. They have a published strategy, published plans, and published milestones. They have multiple commercial contributors to their project. They have transparency, contributions, and momentum, but lack clear product they are working towards. In 2019, Galois announced partnerships with DARPA as well as Microsoft (ElectionGuard).

Overview

Galois is a Portland, Oregon, computer science research and development company that provides security technologies for defense, intelligence, and private industry. In 2016 they launched Free & Fair, a spinoff company dedicated to election technology and security, including the development of multiple open source voting tools. Free & Fair has implemented two of its tools, Qubie and OpenRLA, and is currently working on non-open source projects with Microsoft and DARPA.

Governance & Organization

Based on available information, Free & Fair is most likely supported entirely in both budget and staff by Galois.

All Free & Fair staff are shared with Galois. Ten people are identified as part of the Free & Fair project: two business developers, one marketer, one project manager, and six computer scientists, including Free & Fair's CEO.

Funding & Budget

There is no public information on the Free & Fair funding or budget. It can be assumed that Galois wholly subsidizes the Free & Fair product development and implementation.

Technology

Free & Fair has five open source products and thirty-five public repository projects on GitHub. Two of its open source products have been implemented: OpenRLA, a Risk Limiting Audit project that has been used in Colorado as ColoradoRLA, and Qubie, a poll monitoring tool.

OpenRLA

Free & Fair created their own risk-limiting audit (RLA) system that was first used 2017 in Colorado. Based on the same risk-limiting concepts spearheaded in the Travis County STAR-Vote project, this project aims to verify elections through a statistical comparison audit.

In this system, a random sample of paper ballots are compared to their digital versions to verify the audit and/or adjudication of the voter's intent is valid, with the number of ballots sampled being dependent on the calculated risk of an election having an outcome-changing error and on the number of ballots cast. Replacing random precinct or voting machine audits, RLA attempts to increase confidence in election results while lessening the need for more costly audit measures.

Free & Fair's original project, OpenRLA, was implemented in Colorado as ColoradoRLA for 2017 statewide elections. Per Free & Fair, this was the first regular, statewide RLA conducted in the country.

Qubie, the Poll Queue Monitor

Qubie is an anonymous, mobile-based poll monitoring system using low-cost COTS computer hardware and open source software. It provides simple reporting data that can be used by polling place officials to monitor the effectiveness of the election location, and automatically published reports can help voters find voting centers with the shortest wait times.

Qubie has completed research and development and has well-established features. It has so far been deployed in Shasta County, CA. No information is available regarding future features or implementations.

Schedule

At this time, there are no publicly listed plans for future development or implementation of Free & Fair's open source projects. The most recent public release was in 2017, with ColoradoRLA, and the most recent project releases on GitHub are dated 2018. It is not known if any of these releases were included in a product.

Accomplishments

In 2016, Qubie was implemented in at ten polling places in Shasta County, CA with over 30,000 Wi-Fi identifiers logged by the end of the election.

In 2017, the Colorado Department of State awarded a contract to Free & Fair to implement RLA to support audits in Colorado's 2017 statewide election. The election audit results have been publicly published for review, and the ColoradoRLA software continues to be used.

Issues

Only two of Free & Fair's open source components have progressed to implementation, in 2016 and 2017, and no documentation exists indicating plans to implement any other open source projects. Currently Free & Fair are collaborating with Microsoft and DARPA on non-public projects, which may indicate that they are pivoting away from open source.

Takeaways

Free & Fair launched two viable open source products in OpenRLA and Qubie—OpenRLA remains in use today in Colorado as ColoradoRLA. Although their current work is no longer open source, working in partnership with Microsoft and DARPA on further election security projects, OpenRLA and Qubie remain excellent examples of implemented open source tools, and Free & Fair may return to open source work in the future.

Sovereign – democracy.earth

Summary

The organization claims future compatibility with Ethereum blockchain for online voting. The project appears to be a viable organization, but the commercial support is not strong. The Foundation behind the organization is searching for funding. They have 21 GitHub repositories. This project has one healthy code repository Sovereign, with 2516 commits, 92 pull requests, 31 branches, and 24 contributors. They have a published strategy, published plans, and published milestones. There are multiple commercial contributors. They have transparency, contributions, and momentum, but lack a clear product roadmap and consistency of direction.

Overview

The Democracy Earth Foundation (democracy.earth) seeks to reduce government corruption through the use of blockchain for voting and contracts. Their major ongoing project is Sovereign, a governance platform utilizing the blockchain and open source "liquid democracy" that aims to decentralize both political power and accountability worldwide using smart contracts and a financially valuable "vote token."

Democracy.earth began in 2015 following the formation of the Partido de la Red's (Net Party) DemocracyOS project in Argentina. Start-up funding was provided by Y Combinator, and their guiding principles and strategy are available in their online white paper, "The Smart Social Contract."[10] Sovereign is currently used for online polling and debate, and was piloted on a large scale in October 2016, when democracy.earth conducted a digital plebiscite for Colombia's 6 million expatriate citizens on the country's referendum on peace with the FARC rebels.

Governance & Organization

Democracy.earth is a non-profit charitable organization, based in New York, with three officers as of 2016. Fifteen employees are listed on their website. Volunteers contribute code and serve as global "ambassadors," encouraging use of the platform in their communities.

Funding & Budget

Democracy.earth received start-up funding of $100,000 from Y Combinator in 2015. Further institutional contributions have come from the Fast Forward accelerator and the Templeton World Charity Foundation, and 33 individual contributors are listed on democracy.earth's website.

Democracy.earth raised $1.5 million in early 2018 in a pre-sale of its vote-tokens. The foundation plans to mint a maximum of 500 million tokens, provisionally priced at 12 cents each, for a company valuation of $60 million. Future foundation employees will be compensated with tokens.

Technology

Democracy.earth's major ongoing project is its vote platform Sovereign, currently in beta testing. Sovereign allows its user to spend vote-tokens to signal their preference on a variety of issues, intended for application in both governmental and non-governmental contexts. The platform is based on the Ethereum blockchain and makes use of Ethereum's "smart contract" capabilities, potentially allowing for the immediate disbursement of funds at the conclusion of a vote on financial issues. Democracy.earth plans to

[10] "The Smart Social Contract," Santiago Siri, 25 January 2018, http://paper.democracy.earth/

make the platform “blockchain-agnostic” in the future, allowing for participation from a variety of public and private blockchains.

Democracy.earth has 21 public GitHub repositories, of which one, Sovereign, is active and healthy.

The organization has also created DemocracyOS which supports public comments and online voting at the local. DemocracyOS has since been spun off with a different team, called Democracia en Red (Net Democracy).

Schedule

Following 2016’s pilot with expatriate voters in the Colombian peace referendum and the 2017 release of their white paper, democracy.earth proceeded with their vote-token presale in 2018, and released their beta software on test.democracy.earth. Their full product launch is scheduled for 2019.

Accomplishments

Sovereign’s 2016 pilot, wherein 7,000 expatriate Colombians cast symbolic votes on Colombia’s peace agreement with the FARC, drew significant attention from news media and governments. The Colombian government’s Centre for Digital Public Investigation (CDPI) began investigating the viability of blockchain voting following the pilot. Special interest has been given to the transparency and auditability potential of the blockchain.

Issues & Risks

Sovereign is currently dependent on existing ID databases, such as the Colombian national register, to verify voting eligibility in government elections. The organization plans to identity verification to the blockchain, with proof of identity coming from the use of vote-tokens to hold the hashed proof of identity. Cryptocurrency experts have raised concerns about the potential cost of supporting proof of identity in the blockchain, a medium primarily intended for financial transactions, and elections experts have questioned the ability of voters to navigate the complex cryptographic keys and software required to cast their vote.

Takeaways

Sovereign is an active open source project with good momentum that has already seen success in its 2016 Colombian pilot. As the platform is intended as a reimagining of the entire political process its applicability to the needs of US municipal elections is limited when considered as a whole product, but components of its platform, and its emphasis on transparency and accountability, could serve as models for public elections.

Condorcet Internet Voting System (CIVS) – Cornell Department of Computer Science

Summary

A 15-year-old voting system project that has hosted over 15,000 polls and 400,000 votes. This is the system that OpenStack and many other organizations use year over year to run ranked choice polls. CIVS is a simple, stable project and implemented product with a long successful track record. They have 864 commits, 7 pull requests, 1 branch, and 7 contributors. The Cornell Computer Science Department has a published project strategy, plans, and milestones. They have a few commercial contributors over the past 10 years. This project has transparency, few contributions, and steady momentum. CIVS is a simple online public voting system using sophisticated algorithms.

Overview

The Condorcet Internet Voting System (CIVS) is a free online voting service that uses Condorcet election methods to determine winners of user-submitted polls. Since CIVS began in 2003 it has hosted over 15,000 polls and tallied 400,000 votes, and it is used frequently to run ranked choice polls among open source communities like OpenStack.

Governance & Organization

CIVS is the ongoing project of Andrew Myers, a Professor at the Cornell University Department of Computer Science. Myers has been sole manager of the project since 2003, as well as the main code contributor. Supporters may contribute code, as well, and the software is provided with permission to use, copy, modify, and distribute for any purpose while retaining the copyright.

Funding & Budget

No funding information is publicly available. Donations made to Cornell may be directed to Myers' research group to support CIVS' ongoing maintenance. Myers solicits these donations on the CIVS site.

Technology

CIVS hosts public and private online polls that determine winners using the Condorcet voting method. Condorcet voting uses user's rankings of each choice to compare each candidate or alternative to every other in head-to-head contests. In case a clear Condorcet winner cannot be determined (one candidate cannot beat every other candidate in head-to-head contests), CIVS allows users a choice between five "completion rules" to resolve preference cycles and determine final rankings. Vote tallies are then available by html or email to poll participants, if the poll is private, or posted on the CIVS site, if the poll is public.

The CIVS GitHub project is active and healthy, with 864 commits and multiple releases. The latest release being 2.18.2 published 02 December 2017. The software is developed using Perl, Python, and JavaScript.

Schedule

CIVS was launched in 2003 and released version 2.18 in December 2017. Release 2.19, which includes documentation updates and command line improvements, has not been scheduled yet.

Accomplishments

CIVS has hosted more than 15,000 polls over the past 15 years, with more than 400,000 votes cast. It is currently used by many major organizations such as Google, Yale University, OpenStack Foundation, Linux Foundation, and Canonical. At any one time, there are more than 30 online polls currently underway using the CIVS Software-as-a-Service implementation.

Issues & Risks

Without any commercial support, Andrew Myers has been supporting the development and operations almost entirely alone over the past 15 years. Institutional support has come through Cornell University professors and students, and some code has been contributed directly to the CIVS GitHub repository by project supporters.

Takeaways

CIVS is a simple, online Internet election tool that has reliably provided Condorcet-determined polls for fifteen years. Although it is not a tool that could ever scale to serve a public election, it is an example of a successful open-source voting tool with wide usage.

TrustTheVote – Open Source Election Technology (OSET) Foundation

Summary

OSET started its project with a voting system architecture that, with collaboration, could be the basis of an open source voting system. OSET has built a few prototypes from the architecture. It is likely OSET has held back publishing some of the architecture designs while searching for funding. They have 39 GitHub repositories. This project has one healthy repository, Online voter registration that has 3093 commits, 97 pull requests, 49 branches, and 8 contributors. There is some transparency, some contributions, and some momentum to the work completed. This organization needs a commercial partner to implement its strategy.

Overview

Trust the Vote is a project of the Open Source Election Technology Institute (OSET), founded in 2006 to develop a complete set of open-source software for the election process, ranging from voter registration to election result analytics. This suite, called ElectOS, is planned for implementation in the 2020 general election. Some of their third-party voter registration tools are already in use, including Rocky, an online voter registration platform used by Rock the Vote since 2009.

Governance & Organization

OSET is a 501(c)(3) non-profit public benefit corporation headquartered in Palo Alto, California. It has seven corporate directors (two of them full time), eight board members, and a 22-member Strategic Advisory Board. TrustTheVote employs 22 people, with the project running on a team of 60 overall, including volunteers. OSET's software is available through the OSET Public License, an OSI-accredited open source license based on the Mozilla Public License.

Funding & Budget

TrustTheVote leadership predicted in 2014 that they would need $24 million over four years to complete work on ElectOS in time for the 2018 midterm elections (the implementation date has since been rescheduled.) The project's funding comes from grants and philanthropic contributions. They collaborate with corporate partners such as Accenture and Amazon Web Services on components of ElectOS.

Among other grants, TrustTheVote received $50,000 from the Knight Foundation in 2013 to develop a prototype of its VoteStream open source results reporting service, and $500,000 over two years from the Democracy Fund in 2015. OSET exceeded $250,000 in gifts and grants in 2018. They spent $115,000 on software development in 2015, and $254,000 in 2016.

VoteReady, a voter record protection tool that provides mobile alerts whenever a user's voter registration is changed, suspended, or purged, is currently crowdfunding for its development. The project is seeking $250,000.

Technology

ElectOS is a suite of 16 separate components, which may be used independently, with other ElectOS components, or integrated into existing voting systems. ElectOS is software-only—TrustTheVote does not design or produce hardware components, such as ballot marking devices.

ElectOS' components cover the whole of election process, including Reporting, Managing (including tools for the Election Office, the Registrar of Voters' Office, and the Central Counting Place), Registering Voters, and Voting. Open Data Standards are also being developed. A full list of ElectOS' tools in development are:

- Reporting: VoteStream
- Managing (Election Office): Election Data Manager, Ballot Design Studio, Device Manager
- Managing (Registrar of Voters' Office): Registrar, Digital Poll Book Manager, Vanadium (blockchain-based voter rolls)
- Managing (Central Counting Place): Central Ballot Counter, Tabulator
- Registering Voters: Voter Services Portal, BusyBooth (polling place wait tracker), Balloteer
- Voting: Digital Poll Book, Voter Kiosk, Accessible Ballot Marker, Precinct Ballot Counter

Overall, ElectOS maintains 39 GitHub repositories with their architecture, with the Online Voter Registration repository being the most active. A prototype for VoteStream, a 12-state collaboration that provides precinct-level results reporting for entire counties, is available online.

Schedule

OSET has stated that ElectOS is slated for release in time for the 2020 general election. VoteStream, the results reporting service, has been published online as a prototype, and VoteReady, the records protection tool, is currently seeking funding for development.

Accomplishments

OSET has strengthened its relationships with public and private stakeholders in recent years, forging deeper partnerships with corporations interested in collaborating on ElectOS like Amazon and Accenture, and establishing themselves as subject matter experts on election security through appearances before the US Congress and on cable news. In the United States, they've joined with the states of Pennsylvania and Virginia to roll out online and app-based voter registration services connected to the states' voter registration databases. In Canada, OEST recently established a set of design guidelines and principles for next generation voter services with the government of Ontario.

Issues & Risks

None at this time based on the information available.

Takeaways

OSET has worked diligently to improve public understanding of voting system and open source technologies as they have progressed towards the completion of ElectOS. Their partnerships are wide-ranging across the public, private, and non-profit sectors, and they've collaborated frequently with local and state election departments in their work. Although there is limited information about the exact state of ElectOS' development, their architecture and roadmap are easily accessible, and they are committed to implementation by November 2020.

VotingWorks Project

Summary

VotingWorks holds 17 repositories on Github. Their main and most public work is ARLO. ARLO is a rewrite of CORLA in Python. VotingWorks has commercialized ARLO by charging a fee to perform an RLA audit.

Overview

VotingWorks is a continuation of the work that was started with Ben Adida's other projects Helios Voting and Helios Server. Helios Server started from Ben's Helios paper published in 2008. Helios Server is not intended for public elections, rather online elections. The project specified that the software is not recommended for public elections. There has been some work done on this product over the last few years. But most of the work has stalled. The documentation references 2010 release date for the next version.

Governance

VotingWorks is using the Center for Democracy & Technology (CDT) as their host organization while they work on their non-profit.

Ben Adida previously started Helios Voting, which is not being maintained. There were 6 advisors for this previous venture. No information on if these advisors are involved with VotingWorks.

Organization

Two published employees Ben Adida and Matt Pasternack as co-founders. Assumed that CDT provides some administrative functions while VotingWorks builds the organization.

VotingWorks is working with the Center for Democracy & Technology (CDT) on operations.

Funding / Budget

VotingWorks can now accept tax-deductible donations by way of the Center for Democracy & Technology (CDT).

Technology

Ben Adida's GitHub organization has 44 GitHub repositories. Helios Server is the one healthy repository. VotingWorks is a new organization without a viable system directly related to the open source work. This is holding back contributions and limits momentum.

VotingWorks states it will develop voting equipment that:

- embodies the state-of-the-art in usability, security, design, and development
- are affordable to maximize any benefit to all sizes of election jurisdictions
- allow speedy, efficient voting processes
- that is extensible to the needs of all types of localities
- and all of this will be developed in the open for the public good

Their partnership CDT could allow them to establish a product and roadmap for customers to get engaged.

Schedule

Voting Works as a company is a new venture. There is no published product roadmap.

Helios Server releases

10 August 2010 version 3.0.0

04 March 2011 version 3.1.0

The most recent release is from 10 March 2011 version 3.1.4

Issues and pull requests have continued to be created, collaborated on, and closed 2011 through 2018. Not known why releases stopped in 2011.

In addition to Helios, VotingWorks has released ARLO, a Risk-limiting audited derived from Free and fair CORLA. Although ARLO is open-sourced, VotingWorks charges for the use of ARLO per election based on size of registered voters.

Accomplishments

The open source core Helios Server project behind VotingWorks has been forked (copies of the source code made) 170 times and has had 84 pull requests (change recommendations by people outside the VotingWorks organization). This shows the project to be interesting and possibility showing that a product based on the project could be successful.

Issues

The work behind VotingWorks has gone through many interactions, without any explanation. This generally makes potential customer uneasy.

Risks

VotingWorks hasn't published since 2010 and the team has been focused on Helios Voting specifically. Helios is limited to online voting and has publicly stated that they no interest in paper ballots/public elections.

Takeaways

The VotingWorks team has created a small community following around public election technology. A partnership on open source project would require a clear roadmap, funding and milestones.

FollowMyVote Project

Summary

FollowMyVote. FollowMyVote completed a Blockchain proof of concept, which was demonstrated at several events. In 2014, the project joined the California Association of Voting Officials (CAVO). They have no healthy repositories. No strategy, plan, or milestones. No commercial contributors. This project appears to be a stalled effort.

Overview

Follow My Vote's mission is to promote truth and freedom by empowering individuals to communicate effectively and implement non-coercive solutions to societal problems. The organization wants to improve the integrity standards of voting systems used in elections worldwide. Their focus is on developing an online open source voting platform that provides transparency into election results. Their version of ultimate transparency is to provide voters the ability to independently audit the ballot box.

Governance

Follow My Vote is a nonpartisan US public benefit corporation founded in 2012.

Organization

5 people are published as employees, include the 3 co-founders. The organization lists 3 advisors, who appear to be focused on helping with business strategy.

Their current office is listed as Longmont. CO with their previous Blacksburg, VA publicly listed as closed.

Funding

No information is publicly available. However, it appears that the organization is targeting broadcast events and student organizations as potential customers.

Technology

Follow My Vote claims development of open source end-to-end verifiable blockchain voting software for auditable online voting. The organization has the vision of supporting government-sponsored elections worldwide. They believe by using Blockchain, they can implement election security and transparency, while protecting each voter's right to privacy.

Follow My Vote completed a Blockchain proof of concept, which was demonstrated at several events. In 2014, joined the California Association of Voting Officials (CAVO).

Schedule

There is not a published, public product development or implementation schedule.

Accomplishments

There does not appear to be any public implementations or funding rounds for Follow My Vote.

Issues

Due to lack of project or product momentum, it will be difficult for Follow My Vote to gain traction with potential customers.

Risks

Without product proven features, the Follow My Vote project will not evolve into a product with features that customers are willing to subscribe to.

Takeaways

As with most great ideas, it is difficult to move beyond the idea phase. The founders needed to find customers that are willing to pay for features that could be developed over a short period of time.

Microsoft ElectionGuard

In May 2019, Microsoft unveiled ElectionGuard, an open source SDK built in partnership with Galois. The software supports Risk-Limiting Audits, and end-to-end verification process that allows both voters and third-party vendors election officials to audit election results without disclosing the substance of individual recorded votes. The SDK is available on GitHub under an MIT license.

The ElectionGuard resources available on GitHub today extend across four GitHub repositories, or storage spaces, and are first generation functionality which should not be confused with a complete end to end voting system. These are each described below.

- ElectionGuard specification. The ElectionGuard specification includes both "informal" and "formal" road maps for how ElectionGuard works. The informal spec is authored by Dr. Josh Benaloh of Microsoft Research and provides the conceptual and mathematical basis for end-to-end verifiable elections with ElectionGuard. The formal spec contains detailed guidance manufacturers will need to incorporate ElectionGuard into their systems, including a full description of the API – which is the way voting systems communicate with the ElectionGuard software – and the stages of an end-to-end verifiable election.

- Software code. This repository contains the actual source code vendors will use to build their ElectionGuard implementations. It is written in C, a standard language commonly used by open-source software developers and includes a buildable version of the API. This documentation is also viewable here. This code was built together with our development partner Galois.

- Reference verifier and specification. Announced in May, ElectionGuard enables government entities, news organizations, human rights organizations, or anyone to build additional verifiers that independently can certify election results have been accurately counted and have not been altered. The resources available on GitHub today include a working verifier as well as the specifications necessary to build an independent verifier.

- Ballot marking device reference implementation. Voting system manufacturers will be free to build ElectionGuard into the systems in a variety of ways. At the Aspen Security Forum in July, ElectionGuard demonstrated a sample voting system, built with the help of industrial designer Tucker Viemeister, which showcased a great way the features enabled by ElectionGuard can be used in voting systems. The ballot marking device demonstrated included accessibility features built under the guidance of the Center for Civic Design, authors of the original "Anywhere Ballot," and incorporated the Xbox Adaptive Controller as an optional device to mark ballots. The ballot marking device open source repository released today includes a variety of tools and visuals necessary to build or augment election.

STAR-Vote – Travis County Clerk

Summary

Travis County attempted to find vendors to build an open source voting system STAR-Vote. In the end, they did not find a vendor that was interested in the open source development and had to change their approach. The project has no public code repository. STAR-Vote published a governance strategy and broad architecture but there was no project strategy, plan, or milestones. There were commercial and academic contributors to the STAR-Vote published design documents. There was transparency, but no code contributions, and no momentum to this effort. It is not clear why the STAR-Vote project did not pool their contributors and develop the project as they had planned. The project was cancelled in 2017.

Overview

In 2005 Travis County Clerk Dana DeBeauvoir directed her office to being studying alternatives to Travis County's direct-recording electronic (DRE) voting system, in use since 2001. This study grew into the STAR-Vote Project (Secure Transparent Auditable and Reliable), a coalition of Travis County Clerk's Office staff, academics, and election security experts who worked between 2012 and 2016 to design an open source voting system that fit all of Travis County's needs. The design was heralded as secure, transparent, cheap, and potentially deployable nation-wide thanks to its emphasis on open source software and commercially available hardware. However, none of the vendors that responded to Travis County's 2016 RFP were willing to build the entire STAR-Vote system, and the County was forced to put the project, as originally conceived, on hold. Travis County has since procured a commercial voting system that fits the majority of their needs as defined in the STAR-Vote project, and STAR-Vote continues to be used as a model of open source voting designs by other municipalities.

Governance & Organization

STAR-Vote was developed and managed by the Travis County Clerk's office with the help of a 24-member Election Study Group and a group of technical consultants, including academics and industry experts from companies such as Microsoft. On STAR-Vote's research paper, published August 2013 in USENIX's Journal of Election Technology and Systems and laying out the STAR-Vote design as it existed at that time, six Travis County Clerk Employees, five university professors, and three independent advisors are credited as co-authors.

Travis County ultimately planned to hand administration of the STAR-Vote Project's open source code base over to a dedicated non-profit entity. Founding members of the non-profit would have included counties, states, and other public and private entities with a long-term interest in open source voting software, with all founding members granted voting rights in the STAR-Vote entity proportional to their financial contributions to the project. Bylaws, management structure, operating procedures, budgets, and open source licensing were all expected to be determined once there were significant financial commitments to the non-profit.

Funding & Budget

Travis County invested $330,000 in the STAR-Vote project before it was put on hold. Funding was allocated through the Travis County Clerk's Office's general budget.

The County planned to invest $4 million in the initial development of STAR-Vote's hardware and software. They sought an additional $11 million from the founding members of the STAR-Vote non-profit, for a total

of $15 million in minimum projected costs over the first five years. Their fundraising goal was $25 million total, to cover possible schedule changes and to maintain healthy cash reserves. Had they been unable to solicit $11 million from their non-profit partners, Travis County planned to pursue alternate funding plans, not detailed at the time of the project's hiatus.

Technology

The STAR-Vote design emphasizes security, accountability, accessibility, and transparency. County Clerk staff sought to create a system that not only increased voter faith in the electoral process, and allowed all voters to participate without undue hardship, but was also resistant to interference and could be easily audited.

To that end, STAR-Vote was designed as an electronic voting system with paper receipts for each vote, designed to be built on commercial off-the-shelf hardware using open source software. Electronic voting machines would minimize the risk of voter errors such as overvoting or making stray ballot marks while also allowing voters to use accessibility devices such as screen readers or jelly switches. Paper receipts create an audit trail that can be used in a risk-limiting audit, reducing the risk of a full hand count by election staff. STAR-Vote planned to use the SOBA risk-limited protocol, which includes the option of publishing anonymized ballot images for full transparency. Each ballot includes an encrypted ballot/contest identifier to link electronic ballots to paper ballots, and vote centers electronically transmit election data through private county satellite Receiving Substations to the Central Counting Station, ensuring election network security.

To keep costs low, improve security, and allow other states and municipalities to adopt the STAR-Vote framework as quickly as possible, the project runs on open source software and commercial off-the-shelf hardware, such as consumer tablets. Voting machines must be able to support lengthy ballots and be able to run for extended periods without charge, should there be a power failure at the polling center.

Schedule

The Travis County Clerk's Office began initial research into secure election systems alternatives in 2005, with a study group founded in 2009. Active research and design on the STAR-Vote project began in 2012, and a paper detailing the majority of STAR-Vote's final design was published in the USENIX Journal of Election Technology and Systems in August 2013.

The STAR-Vote RFP was issued in October 2016, and the Travis County Commissioners Court voted to reject all proposals received in September 26, 2017, as no vendor was willing to build the entirety of the STAR-Vote system, especially its open source software. On September 28, 2017, the County Clerk's Office formally announced that the project would be put on indefinite hold.

Accomplishments

Travis County designed a comprehensive open source voting system that would have been secure, transparent, cost-effective, and usable by cities, counties, and states across the country. Although the full system as designed is not currently in development, the work of the STAR-Vote team has served as reference and guide for many other open source voting projects—Galois' Free & Fair project, described above, based their OpenRLA project in part on STAR-Vote's work, as an example.

Issues & Risks

Ultimately the project was unable to go forward due to a lack of vendors willing to build the open source software integral to the STAR-Vote model. Many of the project's other components will be included in the commercial voting system now being developed by Travis County, and the County Clerk has encouraged academics and other municipalities to continue referencing the work of the STAR-Vote project.

Takeaways

Although STAR-Vote did not progress beyond the planning stage, the STAR-Vote project was an opportunity for election staff, academics, and tech experts to come together to design, as defined by Travis County, the ideal open source voting system. The system is secure, transparent, accessible, and accountable, and thought it may not be manufactured as the Travis County Clerk originally intended, the work of the STAR-Vote team has gone on to guide other projects in the open source voting world

Appendix

Appendix I: California Approved Commercial Voting Systems

Voting Systems approved for use in California as of September 27, 2018, per the California Secretary of State website.[11]

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
Hart Intercivic 15500 Wells Port Drive Austin, Texas, 78728	Approved November 16, 2018	Verity Voting 3.0.1 Verity Data version 3.0.1 Verity Build version 3.0.1 Verity Count version 3.0.1 Verity Election Management version 3.0.1 Verity Desktop version 3.0.1 Verity User Manager version 3.0.1 Verity Print version 3.0.1	Verity Scan version 3.0.1 Verity Central version 3.0.1	Verity Touch Writer version 3.0.1 Verity Reader version 3.0.1
Robis Elections Inc. 1751 S. Naperville Road, Suite 104, Wheaton, IL 60189	Approved November 15, 2018	AskED ePollbook with On-Demand Ballot Printing Version 3.4		
KNOWiNK, LLC 2111 Olive Street Saint Louis, MO 63103	Approved May 22, 2018	Pollpad Plus V. 1.0		
Tenex Software Solutions 5402 W. Laurel Street Suite 207 Tampa, FL 33607	Approved May 22, 2018	Precinct Central e-Pollbook System V. 4.0		
Los Angeles County 12400 Imperial Hwy Norwalk, CA 90650	Approved August 21, 2018	VSAP Tally v1.1.2.2	IBML ImageTrac v. 6400	

[11] Full table available online at the following link: https://votingsystems.cdn.sos.ca.gov//cert-and-approval/vote-sys-appr-in-ca-2.pdf

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
Dominion Voting Systems 1201 18th street Suite 210 Denver, Colorado 80202	Approved May 8, 2018	ImageCast Remote 5.2		
Election Systems and Software 11208 John Galt Blvd Omaha, NE 68137	Approved November 27, 2017	EVS 5.2.1.0 CA ElectionWare v 4.7.1.0 Election Reporting Manager v 8.12.1.0 Event Log Service v1.5.5.0 Removable Media Service v 1.4.5.0 VAT Previewer v 1.8.6.0 ExpressVote Previewer v 1.4.1.0 ExpressLink 1.3.0.0 PaperBallot v 4.6.1.0	Model DS850 Central Ballot Counter v1.0, Model DS200 Precinct Counter v1.3,	ExpressVote AutoMARK v1.0, 1.1, 1.3, & 1.3.1
Dominion Voting Systems 1201 18th street Suite 210 Denver, Colorado 80202	Approved October 16, 2017	Democracy Suite 5.2 Election Management System V. 5.2.17.1 Mobile Ballot Printing V. 5.2.18.2 Adjudication V. 5.2.1.16703	ImageCast Evolution ImageCast Central	ImageCast Evolution ImageCast ICX
Five Cedars Group 1500 NW Bethany Blvd Suite 200 Beaverton, OR 97006	Approved October 11, 2017	Alternate Format Ballot V. 3.4 Alternate Format Ballot Generator V. 1.5		
Democracy Live 2900 NE Blakeley Street Suite B Seattle, WA 98105	Approved October 11, 2017	Secure Select 1.0		

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
Election Systems and Software 11208 John Galt Blvd Omaha, NE 68137	Approved April 14, 2017	Unity 3.4.1.0 system	Model DS850 Central Ballot Counter v1.0, Model DS200 Precinct Counter v1.3, Model M100 Precinct Counter v1.3, Model M650 Central Counter v1.2	AutoMARK Voter Assist Terminal, v. 1.0 (A100) and v. 1.1 and v1.3 (A200)
Dominion Voting Systems 1201 18th street Suite 210 Denver, Colorado 80202	Approved: April 29, 2015	Democracy Suite 4.14-A.1 Election Management System V. 4.14.2301 Adjudication v. 2.4.1.3201	ImageCast Evolution ImageCast Central	ImageCast Evolution
DFM10 Chrysler Irvine, CA 92618		BC Win, v. 2.0 - 3.0	Mark A Vote	

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
Election Systems and Software 11208 John Galt Blvd Omaha, NE 68137	Approved June 30, 2008	UNITY Election Management System, v. 3.0.1.1 Election Data Manager, v. 7.4.4.0 ES&S Image Manager, v. 7.4.2.0 Hardware Program Manager, v. 5.2.4.0 Election Reporting Manager, v. 7.1.2.1 Audit Manager, v. 7.3.0.0 Model 100 Optical Scan Precinct Counter, v. 5.2.1.0 Model 650 Central Ballot Counter, v. 2.1.0.0 AutoMARK Information Management System, v. 1.2.1.8 AutoMARK Voter Assist Terminal, v. 1.1.2258	Model 100 Optical Scan Precinct Counter, v. 1.3 Model 650 Central Ballot Counter, v.	AutoMARK Voter Assist Terminal, v. 1.0 (A100) and v. 1.1 (A200)
	Original Approval April 21, 2006 Reapproval January 2, 2008	Unisyn Election Management System, v. 1.1, which includes: Ballot Generation, v.1.1 Election Converter, v. 1.1 Election Loader, v. 1.1	InkaVote Plus Precinct Ballot Counter with ADA unit, v. 1.10	InkaVote Plus Precinct Ballot Counter with ADA unit, v. 1.10
	Original Approval August 3, 2005 Reapproval December 6, 2007	UNITY Election Management System, v. 2.4.3 AutoMARK Information Management System, v. 1.0	Model 100, v. 5.0.0.0 Model 550, v. 2.1.1.0 Model 650, v. 1.2.0.0	AutoMARK Voter Assist Terminal, v. 1.0, with firmware v. 1.0

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
Los Angeles County 12400 Imperial Hwy Norwalk, CA 90650	Original Approval February 11, 2004 Reapproval January 15, 2008	MTS, v. 1.3.1	LRC 1000	
HART InterCivic 15500 Wells Port Dr Austin, TX 78728	Original Approval September 22, 2006 Reapproval December 6, 2007	Ballot Now, v. 3.3.11 BOSS, v. 4.3.13 Rally, v. 2.3.7 Tally, v. 4.3.10 eCM Manager, v.1.1.7 SERVO, v. 4.2.10	eScan, v. 1.3.14	JBC, v. 4..3.1 eSlate/DAU, v. 4.2.13 VBO, v.1.8.3
Premier Election Solutions Approved under the name Diebold Election Systems 1253 Allen Station Parkway Allen, TX 75002	Original Approval February 17, 2006 Reapproval October 25, 2007	GEMS, v. 1.18.24 Key Card Tool, v. 4.6.1 VC Programmer, v. 4.6.1	AccuVote-OS (Model D), v. 1.96.6 AccuVote-OS Central Count, v. 2.0.12 AccuFeed	AccuVote-TSX, with Ballot Station, v. 4.6.4 AccuView Printer Module Vote Card Encoder, v. 1.3.2
Sequoia Voting Systems 7677 Oakport Street, Ste 800 Oakland, CA 94621	Approved October 14, 2008	WinEDS, v. 4.0.116 WinEDS Extended Services Software, v. 1.0.47 WinEDS Election Reporting Software, v. 4.0.44 Memory Pack Reader (MPR), v. 3.01	Optech 400-C/WinETP, v. 1.16.6 Optech Insight Plus, APX K2.16, HPX K1.44	

Company	Approval Date	Software and Other Components	Scanner Hardware Components	Accessibility Hardware Components
	Original Approval March 20, 2006 Reapproval October 25, 2007	WinEDS, v. 3.1.012 Card Activator, v. 5.0.21 HAAT Model 50, v. 1.0.69L Memory Pack Reader (MPR), v. 2.15	Optech 400-C/WinETP, v. 1.12.4 Optech Insight, APX K2.10, HPX Optech Insight Plus, APX K2.10, HPX K1.42	AVC Edge Model I, v. 5.0.24 AVC Edge Model II, v. 5.0.24 VeriVote Printer

Legacy Voting Systems Certified Before January 1, 2005

Company	System Name and Software
DFM Associates 10 Chrysler Irvine, CA 92618	Mark A Vote BCWin V. 2.0-3.0
Los Angeles County 12400 Imperial Hwy. Norwalk, CA 90650	InkaVote (*certified 11/1/02*) MTS V. 1.2 (*certified 1/16/98*) MTS V. 1.3.1 (*certified 2/11/04*)
Martin & Chapman 1951 Wright Circle Anaheim, CA 92806	Opto-Mark V. OV-OV-1
Sequoia Voting Systems 7677 Oakport St., Ste. 800 Oakland, CA 94621	Datavote Data Information and Management Systems Advanced Ballot Count 4.0.3.1 *(certified 10/5/04)* DFM BCWin Sequoia Teamwork 6.0e and 8.1 *(certified 10/5/04)*

Appendix II: References

Federal Government

1. U.S. Election Assistance Commission (EAC) https://www.eac.gov/ was established by the Help America Vote Act of 2002 (HAVA) https://www.eac.gov/about_the_eac/help_america_vote_act.aspx
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Appendix III: Systems Mentioned by OSV Advocates

At the May 14th, 2019 meeting, OSVTAC asked about the exclusion of the Prime III, One4All, and Humboldt County Election Transparency Project from this document's analysis, which was presented to OSTVAC in draft form. These projects were excluded either because they are no longer active or because they are not open source.

Prime III is a project of Dr. Juan Gilbert of the Human-Centered Computer Lab at the University of Florida to create a commercial elections system, funded in part by the Help America Vote Act (HAVA). Public work on the project does not appear to have taken place since 2009, and though the codebase was uploaded to GitHub in 2015, it has not been edited or contributed to since. It was excluded for a lack of activity.

One4All, a version of Prime III developed by the State of New Hampshire and currently in use in state elections, is based on open source code but not licensed or published publicly. Information on the project is thus limited, and it can't be classified as an open source project.

The Humboldt County Election Transparency Project has been running since 2002 as a citizen-led election auditing system using open source software. However, information about the project is extremely limited, and all websites previously connected to the project are currently out of service. A version of the project's code is online but has not been updated since 2013 at the latest. Due to this lack of current information, HCETP was not reviewed.

Questions at the May 14th, 2019 Open Source Voting Technical Advisory Committee (OSTVAC) Meeting, and Responses

City CIO and Director of the CCSF Department of Technology Linda Gerull asked the members of the OSTVAC four questions prior to their May 14th, 2019 meeting. Answers from two of the committee members, Brandon Phillips and Carl Hage, are included below. Full documents from the meeting are available online at this link: https://osvtac.github.io/meetings/2019/2019-05-14/agenda

Define Open Source voting: What is it and what is its value?

From Committee Member Brandon Phillips: Open Source Voting is a complete voting system for use by San Francisco that uses software development best practices from the open source community, runs easily on consumer off the shelf hardware, and is licensed for collaboration, audibility, and free use. The value to the city of such a system includes: 1. Long term voting system maintenance with costs controlled via vendor competition 2. Acquire/replace voting hardware without single vendor dependence or markup 3. Engage citizens with the ability to inspect the software and re-run elections for themselves 4. Opportunity to share the cost of software, hardware orders, training, and regulatory costs with other municipalities

From Committee Member Carl Hage: Elections where the software in electronic equipment is made visible to the public as source-code. The term "Open" usually also means a license to be able to copy and use that software. "Open Hardware" could also apply, where the electronic/hardware designs are

published and licensed for use by others, or is a system configuration that uses standard COTS parts. "Open Data" might also apply to OSV-- besides software, the data files used in an election that are made public enable the public to reproduce and audit used for voting and ballot counting, as well as provide information services to the public. Open data might include election definition files, scanned ballot images, cast vote records, detailed count subtotals, and intermediate files used in processing these. [Value is in the benefits.]

Set a vision for OSV: What does success look like?

From Committee Member Brandon Phillips: A successful OSV project has: 1. An ecosystem of motivated vendors with a profit motive; kept in check with competition around a shared platform 2. Incentivized core maintainers who are recruited by vendors for influence in the project and velocity to attract customers 3. Citizen engaged through easily operated deployments for system testing and auditing 4. Production deployments in-use across multiple municipalities Items 1-3 are properties of most successful open source ecosystem projects. This includes things like the Linux Kernel, the Android mobile operating system, PostgresQL and Kubernetes. If the incentives aren't considered and the project engagement metrics aren't careful tracked there is a risk of over investment in a failed project and/or a project that is only viable for a limited period of time.

From Committee Member Carl Hage: Open source software/hardware is certified and in use for elections. The software is used by multiple jurisdictions. To be useful for multiple jurisdictions, the system must be supported by commercial vendors, ideally multiple competitive vendors. OSV software is scrutinized by the public including security experts, and considered state of the art in secure elections. OSV software is well documented including code comments, and other people and organizations can easily contribute to additions/improvements. OSV code is highly modular enabling components to be replaced and additional components integrated to the whole system. Open data and code allows independent replication/validation of the software and auditing of results with independent processing. Phased development process ("agile") to minimize risk and build confidence.

Key Considerations: Who or what must be considered as we work to achieve our vision?

From Committee Member Brandon Phillips: 1. Who will be the core maintainers and how will they be incentivized? Will they work for the vendor? How is the vendor motivated to maintain the software long term? 2. Creating a new successful open source project is an expensive and long term effort. How much of the startup cost will San Francisco bear in the short run and long run? What opportunities exist to pool resources with other municipalities to create a market for multiple vendors? 3. What technology choices can we make early to entice motivated engineers to participate and reduce the cost to maintain the system? e.g. language choice, database choice, test automation choice. Further, how do we reduce complexity to a minimum? e.g. use familiar SQL products, choose at most two languages for the entire system

From Committee Member Carl Hage: There must be a plan to organize a means to publish plans, architectural definitions, data exchange formats, etc. and collect comments from the public. Likewise, there should be a plan to publish ongoing software development for voting system components. (Be open about the development as well, not just after-the-fact.) There should be a plan to create a collection of test data, both typical of real elections, and a smaller set of data that can test all special conditions.

What are the potential benefits of open source voting?

From Committee Member Brandon Phillips: Vendor independence: if a vendor is not providing the City with timely software development, quality training, or meeting SLOs we can select another vendor to provide the service without changing familiar systems - Auditability: citizens, regulators, and vendors can audit the code for bugs or vulnerabilities - Shared Platform: multiple municipalities can share file formats, code, training materials, and best practices - Easier Operations: as OSV becomes widely used automation for deploying and maintaining systems will become better understood, documented, and tested. This should reduce costs, improve uptime, and encourage wider adoption.

From Committee Member Carl Hage: Transparency and Trust: Translucent plastic ballot boxes seen in pictures of third-world voting allow the public to see the collection process and see that there are no mysterious things inside the box. Open Source voting software provides an analogous transparency to the computer processing used in elections. Transparency is also the greatest protection against fraud, tampering, or just mistakes. Enhanced Security/Integrity from public scrutiny: Published open software can be inspected by everyone, including computer security specialists. Any flaws/limitations can then be corrected. Ideally, members of the public can independently reproduce digitally signed executable files from its open source code. With open data, members of the public can audit and reproduce the processi0ng of election data. Open source software allows independent processing of open data. Shared cost and collaborative development: Most significant software systems are now open source. Companies often develop software to meet some internal need, then publish it as open source software, and the large user community adds to the original project. A larger user base finds and fixes errors faster than typical proprietary software. Support for generic COTS hardware and escape from vendor lock-in