Kazakhstan: The Sailau E-Voting System

Douglas W. Jones[34]

Background

Kazakhstan declared its independence from the Soviet Union in 1991, after what was, effectively, two centuries of Russian colonial rule. Initially, there were a large number of parties, most of them very small, but by 2002 the number of parties fell to seven. By 2005, five parties offered presidential candidates.[35] While subject to some changes, the post-Soviet Kazakh electoral system is relatively simple, with direct election of the president and local council (Maslikhat) members and party-list election of the lower house of parliament (the Majilis). There are typically only a small number of selections in each race, and only a small number of races combined in each election.

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35 Lidia Karmazina, Institutionalization of the party system in the Republic of Kazakhstan: Past and Present, *Central Asia and the Caucasus*, 5(53), 2008. http://www.ca-c.org/journal/2009-01-eng/13.shtml

It is fairly easy to justify some degree of automation in elections where voters may select between hundreds of candidates, as in parliamentary elections in the Netherlands, or where voters vote in large numbers of races on a single ballot, as is common in the United States. In these cases, the complexity of the election makes hand counting difficult and clerical errors likely. Since Kazakh elections are simple, voting machines cannot be easily justified on these grounds.

Even in the 19th and early 20th centuries, a second reason for election automation was understood. Mechanized voting machines take control away from local election officials.[36,37] This transfers responsibility from local election officials to the technicians who design and maintain the machines and the officials who oversee them. When there is widespread local corruption, this centralization can be a powerful reform tool, but if the central authorities are not trustworthy, it can be dangerous.

The original ideas for the Kazakh Sailau (Сайлау) voting system have their origins in an electronic government project undertaken at the United Institute of Informatics Problems of the National Academy of Sciences of Belarus. Prior to 2003, a group at this institute explored the combination of electronic voter lists with bar-code scanning technology. In 2003, in partnership with the Kazakh Central Election Commission, they began developing this into a practical voting system.[38,39]

36 Republicans Carry Lockport: The New Voting Machine Submitted to a Practical Test, *New York Times*, April 13, 1892. http://spiderbites.nytimes.com/free_1892/articles_1892_04_00001.html

37 Joseph P. Harris, *Election Administration in the United States*, Brookings Institution, 1934, Pages 259, 261. http://vote.nist.gov/election_admin.htm

38 S. Ablameyko and V. Lipen, Electronic Voting System: Experience of Creation and New Projects, Eastern Europe e-Gov Days, 2007: Best Practice and Innovation, April 11-13, Prague. http://uiip.bas-net.by/eng/lab214/img/Session5A_Lipen.pdf

39 Липень Виталий Юльянович (Vitaly Yulyanovich Lipen) and Увалиев Самат Альмахынович (Samat Almahynovich Uvaliev) , Система Электронного Голосования (Electronic Voting System), Eurasian Patent Organization patent 006712, granted February 24, 2006. http://www.eapo.org/rus/reestr/patent.php3?id=6712

The project was incubated by the Central Election Commission, under Kuandyk Turgankulov. President Nursultan Nazarbayev endorsed this development in 2004. In March 2004, the election law was amended to permit electronic voting.[40] The Sailau electronic voting system was first deployed in Kazakhstan in the September 2004 parliamentary elections,[41] and has remained in use, with significant modifications, in subsequent elections.[42,43]

In Kazakh documents, the Kazakh electronic voting system is generally referred to as the Automated Information System «Sailau» (АИС «Сайлау»»or AIS «Sailau»). As the word sailau means election in Kazakh, calling it the Sailau electronic voting system is redundant. Nonetheless, the latter usage has become established. The system we describe here is the touch-screen voting system deployed in 2005 and 2007; we will largely ignore the aspects of the 2004 prototype that were abandoned in later elections, notably the bar-code reader used for voter input. It should be noted that the replacement of this bar-code reader with a touch-screen voting terminal in the voting booth had little effect on the rest of the system.

The *Sailau* voting system

The Kazakh Sailau electronic voting system might best be described as an indirect-recording electronic voting system. In a direct recording voting system, a single mechanism is used both to capture the voter's intention and to record or tabulate the voter's ballot. In contrast, in the Sailau system and a small number of similar systems, separate mechanisms are used for these two functions. In such systems, the voting terminal used in the voting booth records votes on a token that the voter then carries to an electronic ballot box.

40 *Sailau Electoral Information System*, Kazakh Central Election Commission web site. http://e.gov.kz/wps/portal/Content?contentPath=/library2/3_vlast/elections/article/473&lang=en

41 *Republic of Kazakhstan Parliamentary Elections 19 September and 3 October 2004,* OSCE/ODIHR Election Observation Mission Report, Warsaw, December 15, 2004. http://www.osce.org/item/3997.html

42 *Republic of Kazakhstan Presidential Election 4 December 2005,* OSCE/ODIHR Election Observation Mission Final Report, Warsaw, February 21, 2006. http://www.osce.org/item/18133.html

43 *Republic of Kazakhstan Parliamentary Elections 18 August 2007,* OSCE/ODIHR Election Observation Mission Report, Warsaw, October 30, 2007. http://www.osce.org/item/27638.html

A second feature of the Sailau system is the integration of pollbook functions with voting functions. Kazakhstan has a system of universal national identification cards that include a bar code. The Sailau voting system integrates a national-scale distributed voter database, with provisions to scan ID cards, check them off in the voter database, and issue ballots to voters, without any need for paper records or signatures.

Both indirect-recording electronic voting systems and electronic pollbooks have a long history. Before continuing with discussion of the Sailau system, we will discuss some comparable systems.

Indirect recording electronic voting systems

Indirect recording electronic voting systems are similar to paper ballot systems, except that voters do not directly mark their ballots. Instead, voters use a ballot marking machine of some kind before carrying the marked ballot to a ballot tabulating machine. Urban G. Iles patented a punched-card voting system that conformed to this model in 1893.[44] The Votomatic punched card system[45] formerly in widespread use in the United States is similar, particularly if used with a precinct-count tabulating machine. The similarity is most pronounced when ballot marking is done using an electronic device such as the Automark[46] to mark paper ballots that are then fed into a precinct-count ballot tabulator such as the ES&S Model 100.[47]

All of these systems offer voters the opportunity to directly inspect and check the records of their votes. In contrast, as with direct-recording electronic voting systems, a pure indirect-recording electronic voting system does not permit voters to directly inspect the records of their votes. In 1993, Texas Instruments patented an indirect-recording electronic voting system.[48] To vote on this system, voters were to be issued bar-coded paper tickets. The voter would then insert this ticket in a touch-screen voting terminal to begin voting. At the end of the voting session, the terminal would print the votes on the ticket as an additional bar code. To cast the vote, the voter would then drop the voted ticket through a tabulating bar-code reader into a ballot box.

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44 Urban G. Iles, *Ballot-Registering Device*, U.S. Patent 500,001, June 20, 1893. http://patft.uspto.gov/netahtml/PTO/srchnum.htm

45 Joseph P. Harris, *Data Registering Device,* U.S. Patent 3,201,038, Aug. 17, 1965.

46 Eugene M. Cummings, *Ballot Marking System and Apparatus,* U.S. Patent 7,080,799, July 25, 2006.

47 Steve Bolton, Tim Cordes and Herb Deutsch, *Method of Analyzing Marks Made on a Response Sheet,* U.S. Patent 6,854,644, Feb. 15, 2005.

48 Julien Anno, Russell Lewis and Dale Cone, *Method and System for Automated Voting*, U.S. Patent 5,189,288, Feb. 23, 1993.

The first indirect-recording electronic voting systems to be deployed were the Belgian *Jites* and *Digivote* systems.[49] These systems closely parallel the Texas Instruments patent, except that data is recorded on the tickets using a magnetic stripe instead of the bar codes proposed in the Texas Instruments patent.

Bruck, Jefferson and Rivest coined the term "frog" as a technology independent term to describe the medium used to carry the voted ballot from the vote recording component of a voting system to the electronic ballot box or vote tabulation system.[50] To use their terminology, the magnetic card used in the Belgian voting systems, the bar-coded paper ticket in the Texas Instruments patent, and punched-card paper ballots can all be described as frogs.

A central feature of frog-based voting systems is that they can offer transparency and re-countability comparable to that of conventional paper ballots if voters and election auditors can independently verify the contents of frogs without use of tools provided by the electoral authority. When votes recorded on the frog are not directly readable, Bruck, Jefferson and Rivest proposed that voters or independent election monitoring groups could provide frog reading machines to allow voters to verify that their ballots are correctly recorded. This requires that, once a frog is recorded, it becomes a read-only device, and it requires that the election authority disclose all details of the data formats used on frogs.

Electronic Pollbooks

In general, an electronic pollbook serves to replace or supplement the use of paper voter lists and pollbooks at the registration table in a polling place. In a conventional polling place, election workers spend a considerable amount of their effort looking up voters in paper voter lists or pollbooks. An electronic pollbook maintains the voter list as a database. Poll workers either enter voter names on a keyboard or electronically read voter ID cards. In some cases, electronic pollbooks capture voter signatures on a graphics input device, in some cases, multiple pollbooks can be connected by a computer network; and in some cases, electronic pollbooks integrate closely with the voting machines used at the polling place.

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49 *Expert Visit on New Voting Technologies: 8 October 2006 Local Elections, Kingdom of Belgium,* OSCE Office for Democratic Institutions and Human Rights, no date. http://www.osce.org/item/22177.html

50 Shuki Bruck, David Jefferson and Ronald Rivest, *A Modular Voting Architecture ("Frogs"),* VTP Working Paper #3, Caltech/MIT Voting Technology Project, August, 2001. http://www.vote.caltech.edu/drupal/files/working_paper/vtp_wp3.pdf

In 1996, US-based I-mark Systems developed an electronic pollbook for use in conjunction with their Electronic Ballot Station, the direct ancestor of the Premier AccuVote TS. Voters were expected to identify themselves to pollworkers, who would check off names on the electronic pollbook, using it to issue each voter a smart-card that served as a token permitting one ballot to be cast on one of the associated voting machines. These early electronic pollbooks were autonomous; each held only the voter list for one polling place and there was no provision for networking. A voter using I-mark electronic pollbook and their Electronic Ballot Station would have a voting experience very similar to a voter using the Sailau system, but the internal architecture of these two systems are quite different.

In this century, several other vendors have brought out electronic pollbooks. Some of these do not interface with the voting system, such as the systems from Datacard.[51] Others such as the systems from TruVote[52] and Premier Election Solutions[53] integrate closely with the voting system. Yet others, such as that from ES&S,[54] offer optional linkage to the voting system.

The Sailau Architecture

Voting systems are seen from several perspectives, and their architecture is best described from the perspective of each class of users. In the case of the Sailau system, three classes of users are paramount: voters, poll workers, and system administrators.

Voter's perspective

A voter entering a polling place using the Sailau electronic voting system follows a path that is quite similar to the path at a polling place using conventional paper ballots.[55] The voter checks in at a registration table, where a ballot is issued to the voter. The voter then carries this ballot to a voting booth,

51 *Datacard Electronic Poll Book Solution,* Datacard Group, 2005, http://www.datacard.com/downloads/ViewDownLoad.dyn?elementId=repositories/downloads/xml/EPB_Datasheet_050809.xml&repositoryName=downloads&index=2

52 *TruVote Software, Operating and Data Base System and System Security,* TruVote International, no date. http://www.truvote.com/TruVoteDocs/TruVoteStuctureAndSecurityVersion2.pdf

53 *ExpressPoll 5000 Automated Voter Verification Solution,* Premier Election Solutions, no date. http://www.premierelections.com/documents/product_sheets/expresspoll_5000.pdf

54 *The intElect Electronic PollBook From ES&S,* Election Systems and Software, no date. http://www.essvote.com/HTML/docs/ess_electronic_pollbook.pdf

55 Паспорт Автоматизированной Информационной Системы "Сайлау" *(Passport Automated Information System "Sailau"),* Central Election Commission, Republic of Kazakhstan, Astana, 2007, Section 5.1.1. http://election.kz/docs/ais_saylau.rar

votes on the ballot, and returns the ballot to the ballot box before leaving the polling place. While the overall flow is familiar, each step outlined above involves interaction with the Sailau system.

Every voter in Kazakhstan has been issued a national ID card that includes both photo identification and a machine-readable bar code. Each polling place equipped with the Sailau electronic voting system has a bar-code reader at the registration table. Where a conventional polling place requires the voter to sign a pollbook, voters using the electronic voting system merely wave their ID card under the bar code reader. The computer at the registration table then looks up the ID card in the voter database, issues an electronic ballot, and marks that the ballot has been issued to that voter. The ballot is issued by recording it onto a smart card.

The smart card used to hold the ballot is a card the size of a credit card that incorporates a small microprocessor and a flash memory. The voter carries this card from the registration table to the voting terminal in the voting booth. When the card is inserted in a slot in the voting terminal, the terminal displays the ballot on a small touch screen display. If there is more than one race on the ballot or more than three candidates per race, the ballot display involves multiple screens.

At the end of the voting session, the voter is offered the opportunity to verify that the ballot was properly recorded. Voters accepting this offer are issued a random 4-digit control number before the votes are recorded on the smart card.[56] A voter wishing to complete the voter verification process must return to the polling place after the polls close and check that this number is correctly reported.

Having voted, the voter carries the smart card from the voting terminal back to the registration table and inserts it into the slot in the smart card reader. This records the ballot in the electronic ballot box and allows the card to be reused for another voter's ballot. This use of smart cards comes very close to the frog model discussed above, except that the election authority has not disclosed full details of the data format used on the smart card.

56 *Electronic Voting Chart,* Central Election Commission, Republic of Kazakhstan, Astana, 2007. http://election.kz/portal/page?_pageid=153,75206&_dad=portal&_schema=PORTAL or http://election.kz/img/shema-rus.jpg

At the end of the day, after the polls are closed, the computer at the registration table prints out several reports. One of these reports lists the 4-digit control numbers that were issued to those voters who opted to verify their ballots. The control numbers on this report are sorted by race and selection, so voters can easily check that their number is listed by the correct candidate or party. Complete end-to-end verification of an election requires that a sufficient number of voters check on the correctness of their control codes at the close of the polls, and that, for each polling place, members of the public note the polling place totals and compare these with the official totals for that polling place that were added to the national totals.

Poll worker's perspective

Each polling place is equipped with one computer system for use at the registration desk, as well as one voting terminal for each of several voting booths plus a stack of smart cards to be used as ballot carriers. From the perspective of polling place setup, assembly of the computer system at the registration desk is a major job, involving attaching the keyboard, display, printer, modem, bar-code reader, and smart-card base. This must be completed three days before the election.[57] Once this is set up and tested, a USB device (resembling a common USB memory stick) is attached to the computer to start the voting application. The USB device is a Belarussian product, the Enigma (Знигма) CryptoKey, also known as the ∏-card.[58]

The polling place computer used with the Sailau system is sufficiently complex that each e-voting polling place has a technician assigned to it in addition to the statutory precinct election committee.[59] The technician is responsible for setting up the computer system, while the precinct election committee has statutory responsibility for all election-related activity at the polling place.[60]

57 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-1, Paragraph 5, amended June 2007. http://election.kz/docs/zakon.doc

58 *Enigma CryptoKey 2001,* Знигма (Enigma). http://www.enigma.by/apparat-enigma.html

59 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-3, Paragraph 2.

60 *Constitutional Law of the Republic of Kazakhstan,* Chapter 2, Article 18.

With many electronic voting systems, there are serious questions about chain of custody for the voting equipment. The Sailau system addresses these issues in two ways. First and foremost, the Sailau voting terminal is a very simple fixed-program device. It does contain a small microprocessor, but the program has read-only memory and need not be modified from one election to the next. The only election specific information available to the voting terminal is provided by the smart card carrying the electronic ballot. Thus, the voting terminal is not exposed to the invasions and consequent security vulnerabilities most direct recording electronic voting systems face before each election.

It is instructive to contrast the Sailau voting system with cosmetically similar smart-card based voting systems such as the Diebold/Premier AccuVote TS system.[61] In both of these systems, the voter, on checking in at the registration desk, is issued a smart card that is used to begin a voting session. With the AccuVote TS system, the smart card carries only authorization, while with the Sailau system, the card carries the ballot itself. After voting with both of these systems, the voter returns the smart card to the registration desk. The AccuVote TS voting machine itself records the votes and the only reason to return the card is to allow its reuse. The card carries no useful information. In contrast, with the Sailau voting terminal, the card carries the voted ballot and the terminal forgets everything between voting sessions. Thus, under normal circumstances, the Sailau voting terminals are comparatively trivial to test and require minimal effort to set up before each election.

The second feature that, to some extent, simplifies the software authentication question is the CryptoKey issued to each polling place. This device is prepared by the Central Election Commission (CEC), and when it is inserted in the polling place computer system, the system makes a connection, by modem, to a server controlled by the CEC. Public key cryptography is used, so we have reasonable assurance of the integrity of the communication path.

Once this communication path is established, all election specific information, including both a template for the ballots and the voter list are downloaded to the precinct. This download is done using commercial, off-the-shelf distributed database technology so that simple database queries extract the precinct voter list and the relevant candidate list or lists.

61 Tadayoshi Kohno, Adam Stubblefield, Aviel D. Rubin, Dan S. Wallach, Analysis of an Electronic Voting System, *IEEE Symposium on Security and Privacy, Oakland, CA, May, 2004.* *http://avirubin.com/vote/analysis/*

At the close of the polls, before any ballots are examined (either electronic or paper), the Precinct Election Committee is required to announce the number of voters who have voted at the precinct.[62] To simplify this, the polling-place computer for the Sailau system incorporates a large display giving the number of electronic ballots that have been issued and the number of ballots that have not yet been returned.

At the close of the polls, the polling-place computer system prints out several reports. One of these, printed in duplicate, is the official "results protocol," a document listing each race on the ballot and the number of votes for each candidate. A copy of this is posted at the polling place and copies are given to each election observer who requests one.[63] At the close of the polls, as well as several times during the day, the polling-place computer system makes modem connections to the server. The final connection is made after the Precinct Election Committee approves the precinct election results and they are recorded, with electronic signatures, on the CryptoKey. At this point, the distributed database mechanisms automatically incorporate the election results and updated voter lists into the central database.

Kazakh laws give the electronic record stored on the CryptoKey priority over all other records.[64] The results are recorded on the same USB device that is used to distribute the security keys.[65] This device is considered as evidence in any appeal of the results,[66] and it must be retained from for one year after the election.[67]

62 *Constitutional Law of the Republic of Kazakhstan,* Chapter 8, Article 43, Paragraph 3-1.
63 *Constitutional Law of the Republic of Kazakhstan*, Chapter 9-1, Article 50-6, Paragraphs 2-3.
64 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-7, Paragraph 1.
65 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-6, Paragraph 1.
66 *Constitutional Law of the Republic of Kazakhstan*, Chapter 9-1, Article 50-8.
67 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-9.

System Administrator's Perspective

The system administrator for the voting system sees it as a distributed database system.[68] The central server is in a secure area of CEC Headquarters in Astana. This is linked by dedicated communications lines to regional servers.[69,70] The regional servers are located in each oblast or equivalent administrative unit, typically on the premises of the corresponding regional election committee. The server hardware and database system are provided by Todes (Тодес), a Belarussian partner of HP.[71]

The database includes the national voter list, the list of races in the election, the list of candidates for each race, and geographic coding sufficient to identify which voters are assigned to which polling places and which races apply to each polling place. It should be noted, however, that Kazakh absentee voting rules allow voters to vote at the polling place nearest their current residence using an "off the register certificate" issued at the polling place.[72] As a result, the electronic voting system must allow voters to vote at polling places where they are not registered, and there is a possibility that a dishonest voter will vote several times. This can be detected at the close of the election when the lists of voters from each polling place are consolidated.

Long before the election, the system administrators must create the public-key infrastructure for the voting system.[73] This involves using the server at the CEC to initialize one CryptoKey device for each polling place. After initialization, these must be distributed to the polling places. These keys, while small, contain an embedded microprocessor as well as flash memory; in principle, this could make it impractical for a machine to open the contents of the CryptoKey without first connecting to the Central Election Commission, and it should make it impractical to impersonate a precinct's computer system without using the authorized CryptoKey.

Because of the centralized network connecting all precincts during opening and closing the polls, it is easy to centrally monitor the extent to which polling places have technical difficulties with opening or closing the polls. On the other hand, it exposes polling places to potential difficulties if electrical

68 Паспорт *(Passport)*, Section 8.
69 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-2, Paragraph 3.
70 *Constitutional Law of the Republic of Kazakhstan,* Chapter 9-1, Article 50-7, Paragraph 1.
71 Тодес Продукты (Todes Products). http://www.todes.by/ru/products.html
72 *Constitutional Law of the Republic of Kazakhstan*, Chapter 7, Article 41, Paragraph 6-1.
73 Паспорт (Passport), Section 7.

systems or communication lines fail. Kazakh law requires that these be reliable,[74] but legal requirements cannot be relied on in the face of natural events such as storms.

A voting system could be constructed where the central machine was directly connected to the Internet, so that election results are immediately visible on a web site as the results come in. This would pose dangerous security problems because it would expose the central system to attacks from the web. To avoid this, the central server of the Sailau system is isolated from the Internet by an air gap. That is, there is no direct connection. Any import or export of data between the Internet and the central server must be done by hand.[75]

The Acquisition Process

As mentioned above, the available public record makes it clear that the original conception for what became the Sailau system came from workers at the United Institute of Informatics Problems in Minsk, Belarus.[76] The institute and the Kazakh Central Election Commision cooperated in continued development through the end of 2003, and on 4 March 2004 there was a public demonstration of the new system. By this time, the estimated cost of using the system nationwide was 4.2 billion Kazakh tenge (about USD $30 million).[77] Legislation authorizing the use of electronic voting was only passed in April 2004.[78] This law was adopted after an extended debate, with preliminary drafts distributed for public comment to organizations such as the OSCE in September 2003.[79,80] Unfortunately, the early drafts only included the briefest mention of electronic voting. It was only in March 2004 that substantial legislation dealing with electronic voting was inserted into the law by amendment.[81]

74 *Constitutional Law of the Republic of Kazakhstan*, Chapter 9-1, Article 50-1, Paragraph 6.

75 *RFC 4949 - Internet Security Glossary,* Internet Engineering Task Force Network Working Group, August 2007. http://tools.ietf.org/html/rfc4949

76 S. Ablameyko and V. Lipen, Electronic Voting System.

77 *News Bulletin No 10, March 8, 2004,* Embassy of Kazakhstan to Great Britain. http://www.kazembassy.org.uk/embassy_news_115.html

78 *Constitutional Law of the Republic of Kazakhstan*, Chapter 9.1, amendments signed into law April 14, 2004.

79 *Amended Law on Elections of April 2004 -- Key Reforms,* briefing paper, Republic of Kazakhstan, no date. http://www.kazelection2004.org/downloads/Briefing%20of%20the%20Amended%20Election%20Law%20of%202004.DOC

80 *Preliminary Assessment of the Draft Amended Election Law of the Republic of Kazakhstan,* OSCE ODIHR, Warsaw, September 19, 2003. http://www.osce.org/item/2580.html

81 *Republic of Kazakhstan Parliamentary Elections 19 September and 3 October* 2004, OSCE ODIHR, page 7.

The election law established a State Commission for Acceptance of the Electronic Electoral System, but the commission was only formally authorized on 14 September 2004.[82] This commission approved the use of the system on 15 September 2004.[83] This was just days before the 19 September parliamentary elections, where 961 polling places were equipped to use the system. The final scope of the first trial use was only decided on September 17, just two days before the election.

This timeline makes it quite clear that the development of the system was conducted in parallel with the development of the law governing the system, and that the decision to use the system was made in advance of the establishment of a legal basis for such use. This informal development process led to fiscal problems. The CEC incurred a 210% cost overrun in 2005 and was specifically cited for improper accounting for the acquisition costs for the Sailau system.[84] In addition, one contractor, Alsi (ТОО "Алси"), was fined for delayed delivery of some of the components of the Sailau system.

Because of the development environment in a region where there are ongoing changes in the relationships between government and private enterprise, it is not surprising that corporate involvement in the Sailau system is complex. Kazakhtelecom both provided dedicated communications lines to connect the system and conducted the initial acceptance testing.[85] A 2007 news release gave credit to the Agency for Information and Communication, Kazakh Telecom, Microsoft, and Oracle.[86] As already mentioned, key technology originated in Belarus, most notably, the Enigma CryptoKey. Another critical Belarussian contributor was Todes Ltd, which developed the Oracle database framework for Sailau. Todes is

82 О создании Государственной комиссии по приемке электронной избирательной системы *(Creation of a State Commission for the acceptance of electronic election system)*, Resolution of the Government of the Republic of Kazakhstan dated 14 September 2004, N 962. http://ru.government.kz/docs/p040962_20040914.htm

83 *Sailau Electoral Information System*, Kazakh Central Election Commission.

84 Отчет об исполнении бюджета Республики Казахстан за 2005 год (A report on the financial performance of the Republic of Kazakhstan for 2005), Счетным комитетом по контролю за исполнением республиканского бюджета (Accounts Committee for Control over Execution of the Republican Budget), Section 3.2, http://www.nomad.su/esep/b2005.html

85 *Sailau Electoral Information System*, Kazakh Central Election Commission.

86 Еженедельный информационный бюллетень сферы связи и информатизации (Weekly newsletter of Communications and Information), Центр науно-техночеких и маркетинговых исследований (Center for Science, Technology and Marketing Research), Tashkent, July 23-29, 2007, page 16. http://www.aci.uz/files/bulletins/WIB19%2023.07-29.07.2007.pdf

also listed as the copyright holder on most of the web pages of the Central Election Commission. Following the 2004 election, Delta Plus of Almaty developed the touch-screen voting terminal.[87]

Another complexity lies in the relationship between the Central Election Commission, the developers of the system, and the system administrators. When the same people both develop a system and then approve its use, there are many potential conflicts of interest. To avoid this, the CEC spun off its data processing center as a state owned enterprise, the Engineering Center of the CEC of the Republic of Kazakhstan (РГП "Инженерно-технический центр ЦИК Республики Казахстан"). The organization of this quasi-independent agency did not go smoothly.[88]

On paper, the certification and approval process used resembles that for electronic voting systems in the United States since the 1990s. Otan Security, an independent testing laboratory in Almaty, certified to the Central Election Commission that the system was in conformance with applicable standards, after which the system was approved for use. A more detailed analysis shows that the certification was done prior to a variety of changes in the system and that there is no requirement for recertification after such changes. Furthermore, the standards to which the voting system was tested prior to the election included requirements that remain a state secret.[89,90]

Practical Use of the Sailau System

The Sailau system was first used in a high-profile national election, without benefit of a pilot project. This may explain some of the suspicion expressed about the system by opposition parties. In its first use in 2004, the prototype version was used in 961 out of 9,480 polling places.[91] In the 2005 election, the new touch-screen version was used in 1,451 polling places. While this is only a small fraction of the polling places, the equipped polling places were largely in urban

87 *Republic of Kazakhstan Parliamentary Elections 18 August 2007,* OSCE/ODIHR, page 12.

88 Отчет об исполнении бюджета Республики Казахстан за 2005 год (A report on the financial performance of the Republic of Kazakhstan for 2005), Section 3.2.

89 *Republic of Kazakhstan Presidential Election 4 December 2005*, OSCE/ODIHR, page 29.

90 *Republic of Kazakhstan Parliamentary Elections 18 August 2007*, OSCE/ODIHR, pages 12-13.

91 *Republic of Kazakhstan Parliamentary Elections 19 September and 3 October 2004*, OSCE/ODIHR, page 8.

centers, so they served approximately 32 percent of the electorate.[92] In 2007, the number of polling places was expanded to 1,512, covering approximately 33 percent of the electorate.[93] Limiting the use of the system to urban polling places significantly reduced the likelihood of problems caused by unreliable power and communication lines.

The Sailau system was not imposed on voters. Rather, voters have always been given the option of using paper ballots or electronic ballots. Paper pollbooks have always been maintained, with voters signing the paper as well as using their ID cards to sign the electronic pollbook if they opted to use the Sailau system. This parallel system was not initially intended; rather, just three days before the 2004 election, the Central Election Commission offered this alternative as a response to concerns about the new system. Giving voters a choice at the polls and maintaining redundant paper records is strong insurance against any system failure, but it poses problems. It means that the polling place workers must manage two parallel election systems, and it raises the price of the election above what it would have been with either system alone.[94]

Before each election, the government undertook extensive public education efforts to explain the electronic voting system. The instructional materials provided to voters have all been placed on the web.[95] Noteworthy, among the materials, is a well-designed instructional poster that was placed at every polling place using the Sailau system.[96] Training for technicians and poll workers was also well designed, with operator training beginning in the month before poll worker training, and poll worker training well in advance of the election.[97] Well designed manuals were provided for poll workers,[98] district electoral

92 *Republic of Kazakhstan Presidential Election 4 December 2005,* OSCE/ODIHR, page 9.

93 *Republic of Kazakhstan Parliamentary Elections 18 August 2007*, OSCE/ODIHR, page 11.

94 *Sailau Electoral Information System*, Kazakh Central Election Commission.

95 *Sailau Electronic Voting System*, Kazakh Central Election Commission. http://election.kz/portal/page?_pageid=153,80988&_dad=portal&_schema=PORTAL

96 *Electronic voting chart*, Kazakh Central Election Commission, 2007. http://election.kz/portal/page?_pageid=153,75206&_dad=portal&_schema=PORTAL

97 *Press release*, Central Election Commission of the Republic of Kazakhstan, April 25, 2007. http://election.kz/portal/page?_pageid=153,529391&_dad=portal&_schema=PORTAL

98 *NOTICE To a member of the local election commission on elections of deputies of the Mazhilis of the Parliament and Maslikhats of the Republic of Kazakhstan*, Central Election Commission, 2007. http://election.kz/docs/chlenu-echastkov-kom-eng.doc

committees,[99] territorial electoral committees,[100] candidates,[101] and observers.[102,103]

Pre-election testing (sometimes called logic and accuracy testing) has long been recommended before the use of electronic voting systems.[104,105] Public pre-election testing for the 4 December 2005 presidential election began on 14 November, two weeks before the election.[106] These tests involved not only scripted sequences of test votes but also opening polling places for public demonstrations. Thus, the test period combined elements of a public relations campaign for the voting system with testing.

The communications architecture of the voting system allowed workers and observers at the Central Election Commission to monitor the opening and closing of the polls at polling places with electronic voting. In 2007, a single central observer was able to note that only three percent of the polling places equipped with electronic voting were not open by the start of Election Day at 7:00 am, and that almost all of

99 *Commemorative booklet for the member of district electoral committee on maslikhat deputies elections*, Central Election Commission, 2007. http://election.kz/docs/okruj-izbir-kom-eng.doc

100 *Instruction booklet for a member of territorial election committee for election of deputies of the Mazhilis of the Parliament and the Maslikhats of the Republic of Kazakhstan*, Central Election Commission, 2007. http://election.kz/docs/terizbircom_eng.doc

101 *What do Candidates for Deputies of Maslikhat, their Authorized Persons Need to Know about Elections,* Central Election Commission, 2007. http://election.kz/docs/Maslihat-kandidatu_Eng.doc

102 *Guideline on observation of the Senate deputies election of the Parliament of the Republic of Kazakhstan,* Central Election Commission, 2007. http://election.kz/docs/pamatka_nabludenia_senat_2008_eng.rar

103 *The reminder for observers of political parties, other public associations, non-commercial organizations, mass media representatives of the Republic of Kazakhstan at the elections of Majilis of the Parliament and masliakhats of the Republic of Kazakhstan*, Central Election Commission, 2007. http://election.kz/docs/nablyudatel-eng.doc

104 *Performance and Test Standards for Punchcard, Marksense, and Direct Recording Electronic Voting Systems*, United States Federal Election Commission, January 1990. See page xxi.

105 Roy G. Saltman, Accuracy, integrity and security in computerized vote tallying, *Communications of the ACM, 31*, 10 (October, 1988) see page 1189.

106 Introducing the Sailau e-voting system, *News release from the Permanent Mission of the Republic of Kazakhstan to the United Nations,* Geneva, November 11, 2005. http://74.125.95.132/search?q=cache:TRAquamvR84J:missions.itu.int/~kazaks/eng/news14.htm+sailau+legislation&cd=1&hl=en]

the problems were resolved by 7:30 am.[107] While the Central Election Commission did release approximately half of the Sailau system's Oracle database directly to OSCE observers, the public release remained limited. A preliminary breakdown giving vote totals for each of the 16 regions (oblasts and urban areas) was released based on the data available at 10:00 pm on election night.[108] Updated preliminary figures were released on the following day,[109] and final figures were released four days later, both in similar formats.[110]

Finally, nine days after the election, the Central Election Commission certified the winners.[111,112]

Controversy

From the start, there was significant opposition to the introduction of electronic voting in Kazakhstan. Opposition parties actively urged voters to vote on paper.[113,114] These opposition campaigns were symptomatic of a general lack of trust in the system. In the 2004 election, a second round of voting was required in some districts, and use of the electronic system fell from the first to second round.[115] In 2005, less than 14% of those who had the option to vote electronically did so.[116] A month

107 *Republic of Kazakhstan Parliamentary Elections 18 August 2007*, OSCE/ODIHR, page 25.

108 *On the preliminary results, News Release*, Central Election Commission web site, Aug. 18, 2007. http://election.kz/portal/page?_pageid=153,604861&_dad=portal&_schema=PORTAL

109 *The CEC announced preliminary results of election, News Release,* Central Election Commission, Aug. 19, 2007. http://election.kz/portal/page?_pageid=153,605104&_dad=portal&_schema=PORTAL

110 On the establishment and publication of the results of election, *Act of the Central Election Commission*, Aug. 22, 2007. http://election.kz/portal/page?_pageid=153,605758&_dad=portal&_schema=PORTAL

111 On the registration of the deputies, *Act of the Central Election Commission,* Aug 27, 2007. http://election.kz/portal/page?_pageid=153,609680&_dad=portal&_schema=PORTAL

112 *Elections of the Majilis 2007, News Release*, Central Election Commission, Aug 27, 2007. http://election.kz/portal/page?_pageid=153,511661&_dad=portal&_schema=PORTAL]

113 Kazakh parties call for rejection of electronic voting, *Kazakhstan Daily Digest,* Euasianet.org, May 21, 2004. http://www.eurasianet.org/resource/kazakhstan/hypermail/200405/0024.shtml

114 *Kazakhstan's Electronic-Voting System Challenged*, Radio Free Europe, August 16, 2007. http://www.rferl.org/content/article/1078191.html

115 *Republic of Kazakhstan Parliamentary Elections 19 September and 3 October 2004*, OSCE/ODIHR, page 9.

116 *Republic of Kazakhstan Presidential Election 4 December 2005,* OSCE/ODIHR, page 10.

before the 2007 election, polling data showed only 22 percent of the population preferred electronic voting.[117] In the election a month later, only about six percent of those who had the option to vote electronically did so.[118,119]

It should be noted that, in 1934, Joseph Harris observed that voting machines "have never been able to succeed if the voter is given his preference between voting on the machine and voting on a paper ballot."[120] While the circumstances in Kazakstan differ markedly from the situation in the United States in the early 20th century, this observation reminds us that it is easy to overestimate the importance of an anti-technology campaign. People have a natural distrust for technological alternatives they do not understand.

Some government actions have contributed to public distrust. On Election Day 2007 there were reports that the passwords for poll worker access to the Sailau system had been released.[121,122] The Central Election Commission's prompt reply to this complaint was that these were pre-election testing passwords and were not the same passwords used in the general election.[123] It would have been better if the passwords in question had never been revealed.

Partisan observers noted significant discrepancies between official results and results they observed at polling places.[124] Several observers noted, while the Central Election Commission's handling of complaints opened up

117 *Month before elections, 37: support Nur Otan, 20% NSDP* ,Interfax, July 17, 2007. http://www.interfax.kz/?lang=eng&int_id=10&function=view&news_id=1181

118 *Republic of Kazakhstan Parliamentary Elections 18 August 2007*, OSCE/ODIHR, page 25.

119 *Comments and remarks of Kazakhstan party to Statement of preliminary findings and conclusions The International Mission (ODIHR/OSCE, OSCE PA, PACE) on Election Observation Parliamentary Election, the Republic of Kazakhstan, 18 August 2007*, Central Election Commission, http://election.kz/portal/page?_pageid=153,621419&_dad=portal&_schema=PORTAL, section 6]

120 Joseph P. Harris, Election Administration in the United States, Brookings Institution, 1934, page 255. http://vote.nist.gov/election_admin.htm

121 *Appeal to CEC Chairman*, Democratic Party of Kazakhstan "Азат", August 18, 2007. http://eng.azat-party.info/activity/statements/2007/08/18/statements_2293.html

122 Oraz Zhandosov, *Letter to Kuandyk Turgankulov*, Aug. 18, 2007. http://election.kz/portal/page?_pageid=153,604805&_dad=portal&_schema=PORTAL

123 *The CEC RK answer to Oraz Zhandosov*, Central Election Commission, Aug. 18, 2007. http://election.kz/portal/page?_pageid=153,604812&_dad=portal&_schema=PORTAL

124 *Press release*, Democratic Party of Kazakhstan "Азат", August 24, 2007. http://eng.azat-party.info/activity/pressrelease/2007/08/24/pressrelease_2369.html

significantly between 2004 and 2007, the regional election commissions remained largely opaque.[125] Greater transparency, at all levels, would significantly improve public confidence.

Assessment

One contribution of the Sailau system is noteworthy; the use of an electronic voting terminal that needs no special preparation for election. This is possible because all election-specific information is carried to the Sailau voting terminal on the ballot card carried into the voting booth by the voter. This significantly reduces the complexity of pre-election set-up and testing for the voting terminals, and it means that the voting terminal firmware is considerably simpler than the firmware of cosmetically similar touch-screen electronic voting systems used elsewhere in the world.

The principal advantage of the Kazakh Sailau system is that it centralizes control. Election observer reports from all three elections where this system was used noted numerous problems at the polling-place level. Joseph Harris noted in 1934 that use of voting machines removes the opportunity for many of the traditional types of election fraud.[126] This clearly applies to ballot box stuffing and miscounting of votes. In the case of the Sailau system, because of the use of an electronic pollbook, the system also allows rapid detection of multiple voting as soon as the election results uploaded. In 2007, for example, OSCE observers were able to identify 585 voter ID numbers that had been used to obtain 1,324 ballots shortly after the polls closed.[127]

One feature of the Sailau system leaves open the possibility of retail vote fraud, that is, fraud involving buying individual votes or coercion of individual voters: the 4 -digit control numbers that the system issues to voters to permit voter verification. These numbers can be used to prove, to those who buy votes, that the voters have voted as instructed. To do this, the voters must give the buyer their number before the polls close. At the close of the polls, the buyer can then inspect the printout of verification numbers to verify that the voters voted as instructed. This constitutes a potential violation of voters' rights to a secretballot.[128]

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125 Jeremy Franklin, *Kazakhstan Parliamentary Elections August 2007,* Norwegian Centre for Human Rights, NORDEM Report 6/2007, pages 21-22. http://www.humanrights.uio.no/forskning/publikasjoner/nordem-rapport/2007/0607.pdf

126 Joseph P. Harris, *Election Administration in the United States.* Page 60

127 *Republic of Kazakhstan Parliamentary Elections 18 August 2007,* OSCE/ODIHR, page 25.

128 *Republic of Kazakhstan Presidential Election 4 December 2005,* OSCE/ODIHR, page 4

Centralized control is an advantage when there is evidence of widespread fraud at polling places, but it poses risks when central authorities may not be trustworthy. The following features of the Sailau system are cause for concern in this regard.

The Sailau system only releases a 4-digit control number to the voter on request, and it records the fact that the voter requested a control number on the electronic ballot. If the central authorities were dishonest, they could program the system to cheat only when voters do not request a control number, while remaining honest for those voters who opt to verify their ballots.

The 4-digit control numbers are supposed to be random, but without the ability to verify the actual software used to issue control numbers, there is no way to confirm this. If the randomization is not done correctly, it would be possible for voters, knowing their own control number, to infer the control numbers of other voters. While we do not know anything about how the Sailau system generates its random 4-digit codes, this problem has been observed in the Hart InterCivic voting system, which uses similar random 4-digit codes for different purpose.[129]

The use of the same computer system to perform both electronic pollbook functions and electronic ballot initialization allows the possibility that voter identity could be covertly encoded on the voter's electronic ballot.[130] This would allow a dishonest government to harass those citizens who did not vote correctly. In the case of the Sailau system, this problem is somewhat mitigated by the fact that, when multiple voters arrive in quick succession, it may be difficult to track which voter gets what ballot card. When there is no line of waiting voters, however, tracking is straightforward. It is noteworthy that this particular approach to election fraud is also a possibility in many other voting systems where the electronic pollbook function is integrated with the voting system.

The lack of full disclosure of the data formats used on the CryptoKey makes it impossible to know whether the electronic ballot box function of the Sailau system records the order in which votes were cast. Given that it is easy to observe the order of voters as they deposit their electronic ballots in the electronic ballot box, any sequential record of the votes is a potential violation of the voter's right to a secret ballot.

The legislation giving the electronic record priority over all paper records adds a layer of difficulty. If the record stored on the CryptoKey is actually the record

129 Srinivas Inguva, Eric Rescorla, Hovav Shacham, Dan S. Wallach, *Source Code Review of the Hart InterCivic Voting System*, July 20, 2007, page 46. http://www.sos.ca.gov/elections/voting_systems/ttbr/Hart-source-public.pdf

130 *Republic of Kazakhstan Parliamentary Elections 18 August 2007,* OSCE/ODIHR, page 12

approved by the election committee, and if the CryptoKey is actually secure, then giving priority to the electronic record is reasonable. Unfortunately, no amount of testing or demonstration can prove that there is not a way to corrupt the election results. Furthermore, there is evidence that changes were made to the CryptoKey or its drivers between manufacture and delivery to the Central Election Commission.[131] If there is any way that the data on the CryptoKey can be altered or falsified, the automatic legal priority given to this data allows all other evidence of what might have happened to be disregarded.

The secret legal requirement to which the Sailau system was certified may be benign, but since it has never been revealed, we cannot be sure of this. An untrustworthy government could secretly require that all cryptographic systems include provisions for the government to defeat the cryptography. The United States government attempted to openly legislate such a requirement in 1994.[132] Putting such a requirement in place, whether in the U.S. or in Kazakhstan, would allow state security services to make arbitrary changes in the voting system without anyone knowing.

The e-government web site of the Kazakh Central Election Commission is very well designed, but it does not provide access to either official or unofficial election results at the polling place level. Kazakh law requires paper copies of the polling place results be posted at the polling place. If voters could compare these results with the official results from the Central Election Commission, they could check that the national results correctly incorporated the results from their polling places. Unfortunately, as configured in the past three Kazakh elections, the aggregation of polling-place election results has not been conducted transparently.

In summary, the lack of transparency makes it impossible to determine if the Sailau electronic voting system is better or worse than the established paper system in Kazakhstan. The system transfers power away from the local election officials with known problems, but this transfer is not total. The weaknesses surrounding the 4-digit control numbers still permit classical forms of retail election fraud. Furthermore, the transfer of power to the central authorities poses risks because the Sailau system contains numerous elements that could allow a dishonest central government to falsify election results in a manner that would be very difficult to observe. Even if the current government is trustworthy, that is no guarantee that future governments will remain so.

131 *Republic of Kazakhstan Parliamentary Elections 18 August 2007,* OSCE/ODIHR, page 13

132 *White House Press Release,* Washington DC, February 4, 1994. http://epic.org/crypto/clipper/white_house_statement_2_94.html

Several defects of the Sailau system have been ignored in the above discussion. The touch-screen display used on the voting terminal was only large enough to display three options. With five candidates in the 2005 presidential election and seven parties in the 2007 parliamentary election, voters were forced to scroll up and down through the ballot to make their selections. While replacing the voting terminals might be expensive, there are no technical barriers to doing so.

The Sailau system, as used in 2005 and 2007, offers no way to conduct a recount, should there be any question about the integrity of the data from some polling place. In theory, if the smart cards used as electronic ballot carriers were single-use cards, a recount of the data from the electronic ballots would be possible. The Belgian system, using magnetic stripe cards, allows such a recount. Unfortunately, neither the Belgian nor Sailau cards are read-only; reading the ballot selections from a smart card or a magnetic stripe card requires specialized software. If there is already doubt about the correctness of the data from some polling place, it is hard to see how a recount conducted using specialized software on read-write media could alleviate this doubt. Only by moving all the way to the frog architecture could such doubts be addressed. This would require complete public disclosure of all details of the smart card, the data representations used on it, and the mechanism by which the card becomes read-only after the vote is cast.