



**An Investigation of Issues Regarding
Election Systems & Software, LLC Electronic Poll Books
Used During the 2018 Primary and General Elections**

**Conducted by
The Voting System Technical Oversight Program (VSTOP)**

April 10, 2019



Executive Summary

The Indiana Voting System Technical Oversight Program (VSTOP) conducted an investigation of issues related to a significant increase in voter check-in times in Johnson County, Indiana during the General Election on November 6, 2018. A preliminary report based on the investigation, was submitted to Secretary Lawson on December 31, 2018. During the investigation it was discovered that there were electronic poll book (ePB) malfunctions and problems in several Indiana counties using ES&S ePBs during both the Primary Election in May 2018 and the General Election in November 2018. Secretary Lawson asked VSTOP to carry out a comprehensive investigation of these issues.

This comprehensive report describes the follow-up investigation of ePB problems in ES&S counties in Indiana. This report incorporates by reference the preliminary report submitted to Secretary Lawson on December 31, 2018. See Appendix A for a copy of this preliminary report.

ES&S's ePB problems during the 2018 Primary and General Elections included delays with voter check-ins, which was caused by slow access and response times through the Microsoft Azure Web Application Firewall (WAF). A WAF is a feature of an Application Gateway that provides centralized protection to Web Applications. It has configuration rules to allow, block and monitor the requests based on customizable rules and definitions. WAF was not properly scaled out due to the configuration chosen by ES&S personnel. As a result, this limited the number of WAF instances available caused serious widespread problems. There were additional problems with ePB bases and related connectivity issues.

VSTOP conducted interviews with ES&S and with eight ES&S counties. VSTOP also conducted a technical analysis of server and client transaction logs provided by ES&S.

This report includes VSTOP's findings and recommendations based on the follow-up investigation. The findings of the preliminary report are also included as summaries.

VSTOP's findings include the extent of the November 2018 Election Day problems and their impact, analysis of the technical logs that explain the slow check-in times, problems with retention of logs, issues with filing of anomaly reports, inability to replicate errors, and lack of contingency planning.

VSTOP's recommendations include suggestions for a review of ES&S's internal quality control processes, failsafe methods to prevent recurrence of problems, a review of anomaly reporting processes, and communication protocols to ensure technical support to ES&S's customers.



Introduction

VSTOP conducted an investigation of issues related to a significant increase in voter check-in times in Johnson County during the General Election on November 6, 2018. A preliminary report based on the investigation was submitted to Secretary Lawson on December 31, 2018. During the investigation, it was discovered that there were ePB malfunctions and problems in several other Indiana counties using ES&S during both the Primary Election in May 2018 and the General Election in November 2018. Secretary Lawson asked VSTOP to carry out a comprehensive investigation of these issues.

ES&S's ePB problems during the 2018 Primary and General Elections included delays with voter check-ins, which was caused by slow access and response times through the Web Application Firewall (WAF). WAF was not properly scaled out due to the configuration chosen by ES&S personnel. As a result, this limited the number of WAF *instances*¹ available caused serious widespread problems. There were additional problems with ePB bases and related connectivity issues.

VSTOP conducted interviews with ES&S and with eight ES&S counties. VSTOP also conducted a technical analysis of server and client transaction logs provided by ES&S.

This report includes VSTOP's findings and recommendations based on the follow-up investigation.

Scope of the Comprehensive Investigation

The comprehensive investigation included the following activities:

- a. Conducting further interviews and gathering information from ES&S and the involved counties;
- b. Contracting with a technical expert to assist with the investigation;
- c. Conducting reviews of responses from ES&S and the involved counties;
- d. Reviewing and analyzing logs submitted by ES&S;
- e. Reviewing documentation;
- f. Drawing conclusions regarding the findings and engaging in a risk management assessment to advise ES&S and the Secretary of potential ways to avoid such problems in the future; and
- g. Providing recommendations related to these issues.

ES&S Electronic Poll Book Systems Used in Indiana

¹ An "instance" is a resource (virtual server) that validates the https or http request from the client. For more information, please visit <https://docs.microsoft.com/en-us/azure/application-gateway/waf-overview>



In 2018, ES&S's ePBs were used in the following eight Indiana counties: Brown, Carroll, Elkhart, Hancock, Howard, Johnson, Monroe, and Porter.

All ES&S ePB counties in Indiana used the EZRoster 3.2.2.1 in the 2018 elections. For a complete description of the components, please see the preliminary report (Appendix A).

Timeline of Events

2018:

For a timeline of events in 2018, please see the preliminary report (Appendix A).

Additionally, on December 27, 2018, VSTOP sent a second email to Elkhart County asking for a description of ePB issues. At the same time, VSTOP began preparing follow-up questions for ES&S.

2019:

January 3: Stephen Berger (VSTOP Technical Consultant) compiled a list of potential problems uncovered in the investigation, as described in the preliminary report.

January 22: ES&S filed anomaly reports for Brown, Elkhart, and Hancock Counties (see Appendix B)

February 7: VSTOP communicated with Ms. Kathy Rogers, ES&S Senior Vice President of Government Affairs, to discuss progress on ES&S's internal research and follow-up questions.

February 8: VSTOP sent the third set of questions to ES&S (see Appendix C).

February 14: VSTOP sent a third email to Elkhart County asking for a description of ePB problems. VSTOP spoke on the phone with Ms. Carol Smith in the Elkhart County Clerk's office. VSTOP received an email with responses from Elkhart County Circuit Court Clerk Christopher Anderson.

February 15: VSTOP received responses to the third set of questions from ES&S.

February 18: ES&S uploaded county client log files to a secure Ball State University box account.

February 21: VSTOP sent a set of fourth set questions to ES&S.

February 25: After an analysis of client logs from counties, VSTOP sent a fifth set of questions to ES&S and requested a phone call with ES&S; VSTOP received responses from Johnson and Monroe Counties.



February 26: VSTOP received responses to questions about the client logs from ES&S.

February 27: VSTOP called ES&S to seek further clarification on the client logs.

February 28: VSTOP submitted a draft report to Secretary Lawson.

March 6: VSTOP received written responses from ES&S following the February 27th phone call.

Description of the Issues

Based on reports, the following issues occurred in the May 8, 2018 Primary Election, the November 6, 2018 General Election, or both:

- a. Delays in checking-in voters significantly impacted the 2018 General Election.
- b. Although ES&S had performed system load testing, the methods ES&S used failed to predict the problems experienced. Since the election, ES&S has been unable to reproduce the problems through simulations or additional testing.
- c. Similar issues were experienced during the 2018 Primary Election, but they were not effectively documented and the potential for these problems to become much worse in the General Election went unrecognized.
- d. Johnson County experienced significantly longer access and response times through the Microsoft Azure WAF. These delays continued for several hours.
- e. Some county election administrators reported that they were unable to receive information and responses from ES&S, even as delays became more significant.
- f. ES&S had no immediate contingency plan for the problems that manifested. This resulted in counties using different work-arounds, some of which were ineffective and not compliant with Indiana law.
- g. There was a failure of communication and coordination among those involved. This resulted in county election administrators wasting time and effort duplicating unsuccessful workarounds.
- h. The WAF was not and could not be scaled sufficiently to meet demands due to the limited capacity contracted for by ES&S on Election Day. Their contract did not allow for rapid response to meet voter demands on Election Day and as a result impeded access to voters at the polls.
- i. Many voters in Indiana counties using this ES&S equipment on Election Day were affected by the malfunctions. The ES&S ePB in Indiana uses two components: CentralPoint (a web application) and SyncPoint (a web service). ES&S refers to the combination of CentralPoint and SyncPoint as "CentralPoint."
- j. There were problems with ePB bases and related connectivity issues.

ES&S's Responses to Questions



During February of 2019, ES&S and VSTOP had numerous discussions regarding the matters addressed in this preliminary report. The following is a summary of the responses from ES&S to questions from VSTOP, regarding these topics:

Retention of Logs: ES&S stated that their WAF and firewall logs were not retained due to a configuration problem. In other words, the configuration did not appear to have been properly set. This is a point of serious concern. Logs are “election materials”, for which retention requirements are governed by Indiana and federal law. It is the position of ES&S that they did not have the understanding that logs were election materials, and therefore did not provide for retention of those records. In the ‘recommendations’ section in the latter part of this report, VSTOP recommends appropriate corrective actions for ES&S to come into compliance for proper retention with Indiana law.

Reporting of Issues and Anomalies: Johnson County reported an issue during the May 2018 Primary Election, which was similar to the check-in delays that occurred later during the November 2018 General Election. Johnson County confirmed the occurrence of this issue in correspondence to VSTOP on February 26th. Johnson County also stated that it reported the issue to ES&S’s local staff. In their response to Question 3-5, ES&S stated “...it is possible that site support personnel may have been notified of an issue, we cannot provide a copy of any communication for this reason.” This raises a concern about ES&S’s reporting practices and procedures and a potential noncompliance with Indiana’s anomaly reporting requirements.

Additionally, Porter County and Brown County reported problems with ePB stands that arose during the Primary Election. In response to Question 3-8, Item #3, “ES&S was made aware of the stand [the stand is the base on which the ePB is mounted] issues that occurred during the Primary Election. As stated above, after the Primary Election, Brown County’s stands were sent back to our Omaha facility for testing and repair.” VSTOP has no record that ES&S filed anomaly reports regarding this problem, as required by Indiana law.

ES&S’s Internal Research Procedure on Replication/Reproducing Errors: During the call on Friday, December 21, 2018, ES&S staff mentioned that they were conducting internal research on the status code 500 internal server issues. This was also mentioned in ES&S’s response to Questions 2-13. In the preliminary report, it was stated “VSTOP expects that ES&S will share the results of its research with the State as soon as those are available.” In response to Questions 3-6, ES&S stated “ES&S has not been able to reproduce the 500 internal server issue encountered and research to date has not indicated why the 500 internal server issue was indicated in the log file. ES&S continues to monitor for any application exceptions as a result of it, but currently there is no clear indicator of the cause of the message.” During the call on February 27th, ES&S stated that the HTTP Status Code 500 issues might be caused by validating the client certificate from Azure Certificate Revocation List (CRL). In the response received on March 6th, ES&S stated “The reason [for the 500 internal server issue] was due to the server making a call to another TLS [Transport Layer Security] secured service and not being able to completely negotiate the secure channel.” This does not strengthen VSTOP’s confidence that such complications can be avoided in the future.



ES&S's Replication/Reproducing of Performance Issues: In response to Questions 3-7, ES&S stated "ES&S has not been able to reproduce or replicate the performance issue related to the web application firewall issue that occurred in the General Election. ES&S has made several changes to allow for further diagnostics and logs to be collected if issues arise in the future. In addition, ES&S has also made configuration changes allowing for greater scalability without interruption, such as using the ability to scale up to more instances of the web application firewall instead of the previous limitation of 7." Without ES&S being able to replicate or reproduce the performance malfunctions, and without testing, VSTOP is concerned by ES&S's confidence that the stated configuration changes will resolve the problems. In a follow-up response, ES&S stated that the scaling up of WAF instances is an interim step and it will not be utilized long-term in ES&S's hosting environment. Without any testing data and other evidence, VSTOP remains skeptical that scaling up of WAF instances will completely avoid a recurrence of the glitches and malfunctions.

Change in ES&S's infrastructure and hosting environment: In response to Questions 3-9, ES&S stated, "After additional research of the issues and to further reduce its dependency on third parties, ES&S will be transitioning its e-poll book server infrastructure to ES&S' hosting environment. ES&S expects the transition will be completed in advance of the November 2019 Elections. Further notification will be provided to the State in subsequent communications by ES&S." VSTOP requested further information regarding ES&S's plans for testing, including load and performance testing of the server infrastructure before its expected use in November 2019. In response, ES&S stated, "Our load and performance test plan is similar to what was previously shared with VSTOP in prior communications. We are prepared to share the results of those tests when completed."

In the written response received on March 6th ES&S stated, "due to commitments to support its customers throughout the months of March, April, and May with scheduled elections, [we] will not be able to migrate off of the Azure environment until after the May 2019 Municipal Elections. Consequently, ES&S will continue to service Indiana ePB customers within the current Azure environment until after the May Municipal Elections." ES&S has also stated, "The issue experienced on Election Day was an unexplained slowdown in the performance of the Azure WAF component, and a configuration that did not allow scale-out of this component. This component is being removed from the ePB architecture and being replaced with equivalent technology that has been proven successful through numerous elections and daily use by ES&S customers." However, VSTOP's concerns regarding the replication of the problem with WAF instances remains the same.

Please see the 'findings' section below for VSTOP's findings based on its analysis of ES&S's responses.



Responses from Counties

VSTOP contacted all eight ES&S counties in Indiana and sought descriptions of any issues with ePBs in the Primary or General Elections in 2018. Below are the responses by the counties.

Brown (Responses received December 27, 2018):

During the 2018 Primary, we had issues with the power supply on 3 pollbook bases. The bases were changed out and voting continued. I sent all the stands back to ES&S and they tested and corrected all the stands.

During the 2018 General, we did have issues with the poll books connecting to the internet. However, the Election Board informed the polling locations not to wait on the host, therefore, voting continued.

Carroll (Responses received December 20, 2018):

Question 1: On Election Day, November 6, 2018, did you encounter any delays with the check-in of voters at your voting locations that were related to electronic poll book performance? If yes, please explain in detail.

Response 1: *Yes, at times it took up to 5 mins to pull up a voter in the electronic poll book to check them in.*

Question 2: During Early Voting for the 2018 General Election, did you encounter delays with the check-in process related to electronic poll book performance? If yes, please explain in detail.

Response 2: *No*

Question 3: If the answer to either of the questions above is yes, please list all ES&S personnel by name who assisted with resolving this issue and how the problem or problems were resolved. Do you believe the ES&S personnel were appropriately trained to handle the issues? Were the problems resolved to your satisfaction?

Response 3: *The ES&S help desk, I did not log names, the first time I called I was told there were no issues, then I called Jeremy Burton and he contacted someone, eventually I was told that they were having this problem nationwide. The Secretary of State called and said that ES&S had a temporary solution and that I would be hearing from ES&S soon. I was called by ES&S and given steps to bypass Central Point, I had to call each vote center and walk them through the steps. About an hour or so later, they called back and said they had the problem fixed and that we need to reverse the steps on each poll book. I would not say that everyone I spoke with was trained to handle this situation, but my problem was solved, but my first issue happened around 8:00am and the problem was not fixed until early afternoon. This resulted in long lines for a good portion of the day.*



Question 4: Did you experience any similar issues in relation to your electronic poll books during the 2018 Primary period? If so, please explain in detail.

Response 4: *No*

Elkhart (Responses received February 14, 2019):

Question 1: On Election Day November 6, 2018, did you encounter any delays with the check in of voters at your voting locations that were related to electronic poll book performance? If yes, please explain in detail.

Response 1: *Elkhart County did experience a “slow down” in our E-poll book check-in process on Election Day, November 2018. We were never “shut down” in regard to processing voters! It did back up the check-in process, maybe adding, at max 30 minutes to process voters. It is very hard to say for sure due to the fact that it was a busier than usual election.*

Question 2: During Early Voting for the 2018 General Election, did you encounter delays with the check in process related to electronic poll book performance? If yes, please explain in detail.

Response 2: *We did not experience any type of problems or issues during early voting in the E-poll book process.*

Question 3: If the answer to either of the questions above is yes, please list all ES&S personnel by name who assisted with resolving this issue and how the problem or problems were resolved. Do you believe the ES&S personnel were appropriately trained to handle the issues? Were the problems resolved to your satisfaction?

Response 3: *Elkhart County were supplied with two very good technicians from ES & S. Between Kyle and Deepti from ES & S, and our own voter registration manager Chad Clingerman, they were more than qualified to deal with the “slow down” issues we experienced once we were made aware of them from our vote center staff.*

We feel that things were handled in a professional manner and we were quite satisfied.

Question 4: Did you experience any similar issues in relation to your electronic poll books during the 2018 Primary Period? If so, please explain in detail.

Response 4: *We did not experience any type of problems or issues during the 2018 Primary election season.*



Hancock (Responses received December 14, 2018):

Question 1: On Election Day November 6, 2018, did you encounter any delays with the check in of voters at your voting locations that were related to electronic poll book performance? If yes, please explain in detail.

Response 1: *Hancock County received a “host error” message on our poll books. We instructed poll workers to enter the Supervisor Password and to issue regular ballots – no real delay except to call the Inspectors and direct them to use the Supervisor Password so they could move on to issue the ballots*

Question 2: During Early Voting for the 2018 General Election, did you encounter delays with the check in process related to electronic poll book performance? If yes, please explain in detail.

Response 2: *No*

Question 3: If the answer to either of the questions above is yes, please list all ES&S personnel by name who assisted with resolving this issue and how the problem or problems were resolved. Do you believe the ES&S personnel were appropriately trained to handle the issues? Were the problems resolved to your satisfaction?

Response 3: *Susan Casey, Project Manage; Sara Mahon, Site Support. Yes, we called in a ticket to ES&S help Desk to alert them of the issue. Yes, system was back up and from what I could see running properly by around 1:30 or 2:00 (incident regarding Host Error occurred around 10:00 a.m. if I recall) The Host Error problem was only intermittent from 10 – until it came back up – some of our polling locations never experienced a problem at all. CentralPoint had a delay in showing a status report earlier in the day around 6:00 a.m. but looked alright by 7:00 a.m. a ticket for this issue was also submitted.*

Question 4: Did you experience any similar issues in relation to your electronic poll books during the 2018 Primary period? If so, please explain in detail.

Response 4: *I do not recall any Host Error problems with the Primary*

Howard (Responses received December 27, 2018):

Question 1: On Election Day November 6, 2018, did you encounter any delays with the check in of voters at your voting locations that were related to electronic poll book performance? If yes, please explain in detail.

Response 1: *Yes. It was an insignificant amount of time. It was a “wait” error. We could still issue ballots. No one was turned away. We just had to click on “host error, issue ballot” and retype the name of the voter.*



Question 2: During Early Voting for the 2018 General Election, did you encounter delays with the check in process related to electronic poll book performance? If yes, please explain in detail.

Response 2: *Same as issue as above. Only happened 2 different days.*

Question 3: If the answer to either of the questions above is yes, please list all ES&S personnel by name who assisted with resolving this issue and how the problem or problems were resolved. Do you believe the ES&S personnel were appropriately trained to handle the issues? Were the problems resolved to your satisfaction?

Response 3: *Mike Manna, Sarah Mahon. They thought they knew but made a phone call to main office to verify. They were correct*

Question 4: Did you experience any similar issues in relation to your electronic poll books during the 2018 Primary period? If so, please explain in detail.

Response 4: *During the Primary it happened at one poll location. It didn't last very long. The ESS team called the main office to verify and then educated us on how to handle.*

Johnson: See detailed responses in the preliminary report. Additional responses were received on February 26th.

In its initial set of questions to Johnson County, VSTOP asked the following:

Question 5: Were there similar issues encountered during the Primary Election period in 2018?

Johnson County's Response: *Yes. We had a similar (but not as severe) problem during the 2018 Primary Election. If memory serves, the delays were not quite as long, nor was it quite as widespread. So we are not sure if the issues in the Primary were also related to a problem with Microsoft Azure or something completely different. This was reported to ES&S at the time, but we never received an explanation for the underlying cause.*

VSTOP asked for more details on February 20, 2019 and received the following responses.

Question 6: Do you have more information about the nature of the problem and the delays that occurred during the Primary 2018 election?

Response: *The issue that occurred in the 2018 Primary Election was similar to the issue experienced in the 2018 General Election in that the electronic poll books at several locations were giving the yellow "Host Wait" messages. My recollection is that the delays to bring up the voters were between 5 and 10 seconds or so. The problem was not as widespread as it was in the 2018 General Election. I want to say that only a handful of sites (perhaps 5 or so) reported the slowdown.*



Do you have the name or names of the ES&S personnel to whom this problem was reported? On what date?

Response: I made a call to ES&S on election day when the problem was actually occurring. Unfortunately I do not recall the name of the person I spoke to at that time. Our on-site project manager, Su Clark, recommended the person that I spoke with. Initially, this person said they did not think there was an issue on their end. Then, during a second phone call, they said they looked into it more deeply and found something that perhaps needed to change, and they supposedly made that change. I do not recall what they said they changed, but I know I had never heard of it before. At the time I was just pleased that they seemed to have found something. The problem eventually seemed to clear up after a couple hours. I do not know if it was the result of the change they made or something else entirely. I know we did not make any changes on our end to get it working better.

On June 20, 2018, our clerk at the time, Susie Misiniec, received an email from our ES&S Sales Manager, Jeremy Burton, in which he admitted that ES&S still did not know the cause of the connectivity problems on election day but that they were still researching it. It was admitted that it was known that the problem was not on Johnson County's end.

Monroe (Responses received February 25, 2019):

Question 1: On Election Day November 6, 2018, did you encounter any delays with the check in of voters at your voting locations that were related to electronic poll book performance? If yes, please explain in detail.

Response 1: We did have delays on Election Day. The poll worker would have to wait for the host errors from Central Point to go away. But it was possible to force it through. It slowed down our voting process. It continued all day and it was never fixed. To our knowledge, it still hasn't been fixed.

Question 2: During Early Voting for the 2018 General Election, did you encounter delays with the check in process related to electronic poll book performance? If yes, please explain in detail.

Response 2: Early Voting did not have delays.

Question 3: If the answer to either of the questions above is yes, please list all ES&S personnel by name who assisted with resolving this issue and how the problem or problems were resolved. Do you believe the ES&S personnel were appropriately trained to handle the issues? Were the problems resolved to your satisfaction?

Response 3: Susan Casey from ES&S was contacted. She knew the right person to contact within ES&S. Also our IT personnel contacted Central Point directly but does not know the name of that person.



Question 4: Did you experience any similar issues in relation to your electronic poll books during the 2018 Primary period? If so, please explain in detail.

Response 4: *Yes, it was the same problem.*

Porter: See detailed responses in the preliminary report. In its responses Porter County had identified issues with the ePB bases and connectivity issues. In a February 22, 2019 response to a follow-up question from VSTOP, former Clerk Karen Martin explained that the connectivity issues were related to the issues with bases:

“It is my understanding that most of the connectivity issues were due to the bases at the Portage and Chesterton locations. After the bases were exchanged the system seemed to function properly.

Although a majority of the issues were at the Portage location which also has internet issues.

Sorry I can't be more specific.”

Please see the ‘findings’ section below for VSTOP’s findings from the county responses.



Technical analysis of Client Logs provided by ES&S

The VSTOP team and Mr. Stephen Berger conducted a detailed investigation of the logs provided by ES&S. In the preliminary report, VSTOP provided a technical analysis of the Internet Information Services Server (IIS) logs. IIS is a web application server used for storing, processing, and serving web pages to a requesting client.

On February 18th, ES&S provided client logs (EZRoster Tablet Logs) to VSTOP, which contain logs of transactions occurring in the EZRoster Tablets. These logs provided November 2018 Election Day transactions of ePBs in seven counties (Brown, Carroll, Elkhart, Hancock, Howard, Johnson, and Monroe). Porter County used ePBs only for early voting.

Client transactions include time-stamps for each of the following: login and logout information, communication with the server, and power status. The communication transactions include ballot transactions and error transactions. A “ballot transaction” records an issuance of a ballot, that is, a successful check-in. An “error transaction” records errors, such as printer and network issues.

Using the time-stamp values provided with the transactions, VSTOP computed several parameters. Table 1 shows the total number of ballots issued and errors that occurred by hour in Indiana on Election Day. We observed that counties began having more errors at 8:00 AM.

Table 1: Client Logs (EZRoster Tablet Logs)

Date/Start Time (1 Hour) (ET)	Client Logs (7 Indiana Counties)	
	Ballots Issued	Errors
11/6/2018 6:00	11960	280
11/6/2018 7:00	11446	352
11/6/2018 8:00	10854	1098
11/6/2018 9:00	9858	2087
11/6/2018 10:00	9511	2876
11/6/2018 11:00	10074	3095
11/6/2018 12:00	9460	1401
11/6/2018 1:00	10360	1113
11/6/2018 2:00	10189	1273
11/6/2018 3:00	10580	7689
11/6/2018 4:00	11971	1024
11/6/2018 5:00	10506	873

Note: Only non-printer errors were included in VSTOP’s error calculations.

Table 2 shows “Ballots per Unit by Hour” and “Errors per Unit by Hour.” These are averages of overall units with over 2-hour or 4-hour periods in each county. The table shows that most counties experienced the most errors during the 10:00 AM to 12:00 PM time period. In comparison, Johnson County consistently had less errors than any other county until 2:00 PM. Despite fewer errors, Johnson County’s ballot rate was lower compared to other counties during



the 10:00 AM to 12:00 PM timeframe. Johnson County stated in the preliminary report that the workaround was approved by the County Election Board after 12:00 PM.

The number of errors per unit by hour was larger in Brown, Elkhart, and Howard Counties than in Johnson County. However, Brown, Elkhart, and Howard continued to have consistent volumes of ballot transactions. During the same time period, Johnson County’s ballot rate decreased to about 12 ballots compared to rates of 35 and 34 ballots in the periods before and after. This confirms the slowdown in reported check-ins.

The error rate was high for Elkhart County during the 2:00 PM to 6:00 PM timeframe, but these issues were limited to eight of 133 units in operation on Election Day.

Table 2: County Client Logs Hourly Information

County	6:00 AM to 10:00 AM (ET)		10:00AM to 12:00 PM (ET)		12:00 PM to 2:00 PM (ET)		2:00 PM to 6:00 PM (ET)	
	Ballots per Unit by Hour	Errors per Unit by Hour	Ballots per Unit by Hour	Errors per Unit by Hour	Ballots per Unit by Hour	Errors per Unit by Hour	Ballots per Unit by Hour	Errors per Unit by Hour
Brown	27.20	1.08	28.47	14.43	20.13	2.67	21.10	0.05
Carroll	31.40	0.71	24.58	6.75	26.13	1.25	30.52	0.00
Elkhart	24.95	3.58	22.89	7.00	25.29	6.65	26.91	19.47
Hancock	29.20	1.07	26.93	5.70	20.58	1.20	25.37	0.15
Howard	42.32	8.64	44.27	38.07	46.09	3.77	46.32	0.03
Johnson	34.58	0.56	11.94	5.21	33.72	1.19	39.28	0.13
Monroe	28.23	0.99	27.40	6.44	20.39	0.92	22.15	0.41

Note: Only non-printer errors were included in VSTOP’s error calculations.

Table 3 shows the average wait time (mm:ss) between ballot transactions per unit (overall units) for each hour on Election Day. To obtain the average wait time, the difference between timestamps from successive ballot transactions for each unit were calculated, then averaged for each hour. The average wait time by county drastically increased during the 10:00 AM to 12:00 PM timeframe for Johnson County (shown in bold).

In comparison with the Table 2 and 3, Howard County maintained average ballot issue rate even with the increased error rate (see Question 1 of Howard County’s responses received December 27, 2018). Whereas, Johnson County retained the average ballot issue rate during 12:00 PM to 2:00 PM by following the workaround approved by the Johnson County Election Board.



Table 3: Average wait time by County

	Average wait time between ballots by unit per County (mm:ss)						
	Brown	Carroll	Elkhart	Johnson	Hancock	Howard	Monroe
6 AM	01:44	01:39	02:08	01:11	01:46	01:19	01:18
7 AM	01:58	01:55	02:06	01:15	02:04	01:19	01:22
8 AM	01:44	01:58	02:24	01:29	02:12	01:21	01:23
9 AM	02:01	02:10	02:49	01:52	02:21	01:26	01:26
10 AM	01:45	02:32	03:13	03:48	02:03	01:15	01:08
11 AM	01:43	02:24	02:03	04:12	02:33	01:32	01:16
12 PM	02:25	02:51	02:18	01:39	03:06	01:13	02:02
1 PM	02:39	01:54	02:18	01:15	02:55	01:09	01:50
2 PM	02:52	02:12	02:14	01:16	02:48	01:20	01:52
3 PM	02:30	01:58	02:05	01:15	02:30	01:22	01:49
4 PM	01:57	01:31	01:58	01:12	02:04	01:06	01:32
5 PM	02:17	02:07	01:59	01:11	02:09	01:09	02:12

Table 4 shows the number of requests made to the Microsoft IIS Server and the number of successfully processed requests. We observe that the server was a shared resource for all ES&S client jurisdictions in the U.S. Other ES&S client jurisdictions include Arizona, Arkansas, Illinois, Mississippi, and Texas where the polls opened later than in Indiana. The polls opened in these jurisdictions at the following times:

	Eastern Time	Central Time	Mountain Time	Eastern Time
Indiana	6:00 AM	6:00 AM		6:00 AM, 7:00 AM
Illinois		6:00 AM		7:00 AM
Mississippi		7:00 AM		8:00 AM
Texas		7:00 AM		8:00 AM
Arizona			6:00 AM	8:00 AM
Arkansas		7:30 AM		8:30 AM

Except for Porter County, the Indiana counties that reported problems are located in the Eastern Time zone. The opening of additional polls for voting in these states is reflected in the increase in the number of requests from Indiana between 6:00 AM to 9:00 AM, which was particularly noticeable beginning at 8:00 AM eastern time.

However, during the 9:00 AM to 1:00 PM eastern timeframe, the server was not receiving all the client requests. This may be related to the reported delay in check-in times. This highlights the significance of WAF logs which are not available. Later in the day, the number of requests appeared to stabilize.



Table 4: Server Logs (IIS Logs)

Date/Start Time (1 Hour) (ET)	Server Logs	
	Total Number of Requests Per Hour	Successfully Processed Requests (HTTP Status Code 200)
11/6/2018 6:00	454757	454739
11/6/2018 7:00	1162376	1162219
11/6/2018 8:00	1245095	1244889
11/6/2018 9:00	1055019	1054740
11/6/2018 10:00	620515	619206
11/6/2018 11:00	627907	626395
11/6/2018 12:00	702375	701713
11/6/2018 1:00	1548724	1548272
11/6/2018 2:00	1435399	1435301
11/6/2018 3:00	1464816	1464684
11/6/2018 4:00	1665515	1665362
11/6/2018 5:00	1928387	1928240

Please see the ‘findings’ section below for VSTOP’s findings from the analysis of logs.

VSTOP’s Findings

Our findings include those of Mr. Stephen Berger’s. Please see Appendix D for a complete copy of his report. Some of his finding are included below.

Findings in the Report: VSTOP’s follow-up investigation is a continuation of the investigation for Johnson County and other counties. The findings of this report include all the findings from the preliminary report (see Appendix A). Below are summaries of the findings from the preliminary report.

The extent of the problem in the field and its impact:

The problem on Election Day, November 6, 2018, involved technical issues with ePB performance resulting in longer than expected wait times at Johnson County vote centers. The Johnson County election officials first began to see slow ePB performance at around 8:00 AM on November 6th. The slow ePB performance seriously disrupted the voting process in Johnson County. Additionally, this problem extended beyond Johnson County to several other counties across Indiana. Please see the preliminary report for more details.

The technical configuration that caused the problem:

The *ExpressPoll EZRoster 3.2.2.1* deployed in Johnson County was used in conjunction with the CentralPoint and SyncPoint servers. The *ExpressPoll EZRoster 3.2.2.1* used Microsoft Azure as its web application gateway. According to information provided by ES&S, “*CentralPoint is the web application that overlays the data transmitted by the pollbooks, and is used primarily by election administrators to monitor turnout. Syncpoint is the web service utilized by the pollbooks*



to communicate limited data about voter check-ins from the polling places.” Please see the preliminary report for more details.

VSTOP’s technical analysis of IIS Server logs provided by ES&S:

Retention of logs: In response to a VSTOP request for any activity logs, diagnostic logs, firewall request logs, access and performance logs, ES&S stated, *“Any logs that would reflect activity, diagnostics, requests, access or performance were not saved and, thus, not available for the WAF functionality used on Election Day.”*

Load tests: The logs provided by ES&S included results of load tests conducted in the summer and fall of 2018. In response to a VSTOP question about the timing and frequency of load tests, ES&S responded that *“ES&S is certain load tests were performed prior to the May Primary, however those results are not retained. Load tests are performed at specific times when elections are not occurring. Load testing will continue to be part of ES&S’ toolset in order to ensure environments are ready for election days in the future, and will undoubtedly evolve further as a result of this.”*

VSTOP is concerned that the results for the May Primary Election load tests were not retained.

Please see the preliminary report for more details on other findings.

Additional Findings: VSTOP’s follow-up investigation led to several additional findings. Each of the headings below represents a key area investigated by VSTOP.

Retention of logs: As part of this investigation, VSTOP analyzed two sets of logs provided by ES&S. Another set of logs were not available and these were the WAF logs. ES&S indicated that “the logs weren’t retained due to a configuration issue. This configuration issue was corrected in December and firewall logs have been configured to be retained for 365 days.” VSTOP communicated to ES&S that Indiana law (IC 3-10-1-31.1) and the United States Code (52 USC 20701) require a 22-month retention of election materials. In response, ES&S stated, “it is ES&S’s understanding that the retention of election records is the duty of the election entity charged with conduct of the election. Please note that once logs are received via SFT [Secure File Transfer] for data conversion post-election processes they are retained in our storage location for at least 22 months unless state law dictates they are to be deleted sooner. To ensure that the State of Indiana and ES&S are in full compliance with retention requirements, ES&S is happy to review and discuss current and required retention requirements during our in-person meeting.” VSTOP is concerned that the WAF logs were not saved. See VSTOP’s recommendations in the next section in this regard.

Findings from ES&S counties in Indiana: In response to the first set of questions and the lack of anomaly reports, ES&S stated that performance issues similar to those that occurred in Johnson County in the November 2018 election “...were not encountered during the primary election period in 2018.” However, since that time, three counties (Howard, Johnson, and Monroe) reported similar problems in the 2018 Primary Election.



Howard County stated, “During the Primary it happened at one poll location. It didn’t last very long. The ES&S team called the main office to verify and then educated us on how to handle.” Monroe County stated, “Yes, it was the same problem.”

Johnson County provided a detailed response to VSTOP on February 20th. See Johnson County’s response in the ‘responses from counties’ section above. VSTOP found that Johnson County experienced similar issues in the Primary Election, but the delay times were not as severe as those in the General Election. Johnson County reported the problem to ES&S. According to the county, ES&S may have made some changes and the problem seemed to have been resolved after some time. In a June 20, 2018 email communication between Clerk Susie Misiniec and ES&S’s Sales Manager, Jeremy Burton, he “admitted that ES&S still did not know the cause of the connectivity problems on Election Day but that they were still researching it. It was admitted that it was known that the problem was not on Johnson County’s end.” VSTOP has no record of these problems being filed as anomalies per IC 3-11-18.1-14(b). It is also a concern that a cause had not been discovered by ES&S until June 20, 2018.

ES&S Workarounds regarding Host Issues: In the phone call on February 27th, ES&S stated that there are two workarounds. The first involves disabling the host on the client and the second bypasses the host to continue voter check-in. In the response received on March 6th, ES&S provided the following details.

“There was only one workaround that was sent out to counties in an email approved by the IN SOS office. This involved the following steps which were outlined in the PDF attachment to the email to the counties:

- a. From the main screen, go to the Manage System Tab
- b. Select the System Setup Tab on this screen
- c. At the bottom of the screen click on Manage Devices
- d. You may need to enter the supervisor password to proceed
- e. Select the Network Tab
- f. Uncheck the box in front of the Enable Remote Host Network
- g. Click OK Save Changes
- h. Return to the Issue Ballots Tab

While other counties or polling locations may have taken an alternate approach, we do not have have [sic] any evidence that another approach was taken.”

However, on December 19, 2018, Johnson County stated the following:

“Shortly after 11 AM ET, ES&S Support representative Tim King suggested to Ms. Clark that the host wait issue could be bypassed by having poll workers enter a 4-digit supervisor code. This was tested at one of the vote centers, and it was successful. The County Election Board then met about 12 PM ET to discuss whether to instruct each vote center to utilize the supervisor code



to speed up the check-in process. Of concern was the fact that implementing such a bypass would theoretically allow a voter to be issued a ballot at more than one location. The election board and Johnson County Clerk Susie Misiniec decided that this risk was not great enough to override the need to move the voters through the lines and voted unanimously to implement the workaround. Voter Registration employees were immediately directed to contact inspectors at the vote centers to implement the workaround. The workaround was very effective, and the vote centers once again began to process voters at a good rate.

At 12:30 PM ET, ES&S Support Representative Larry Kennell called Mr. Henry to say that ES&S had come up with a change that could be made to the ePB to disable the ability to check for network connectivity. The result would be that it would not get delayed waiting for a network connection and would allow ballots to be issued without the need for a supervisor code. However, it would also not continue to attempt to connect to the network, thus it would not be known when or if the ES&S servers had begun working again. Because of this and the fact that an effective workaround was in place already, this suggestion was not implemented.”

VSTOP’s analysis of the logs shows that three counties (Carroll, Hancock and Monroe) followed the process sent out to the counties by ES&S (HostEnabled option set to FALSE (0)). For Carroll and Hancock this occurred around 2:00 PM, while for Monroe this occurred around 5:00 PM. For all other counties (including Johnson), the HostEnabled option remained TRUE (1) showing that ePB were connected to the host throughout.

VSTOP is alarmed that there is an apparent discrepancy in the above statements provided by ES&S and Johnson County.

Failure to File Anomaly Reports: ES&S submitted several anomaly reports of ePB problems in 2018 (see Appendix B). However, in addition to the Primary Election performance problems in Howard, Johnson, and Monroe that were not reported, VSTOP has no record of the malfunctions with ePB bases that occurred in Brown County (Primary and General election 2018) and Porter County (early voting General Election 2018).

Late Filing of Anomaly Reports: During the first week of January 2019, in a review of November 2018 vote history records, GCR discovered a large number of Hancock County voters flagged as “Absentee.” These should have been Election Day voters. An anomaly report was submitted by ES&S on January 22nd for Brown, Elkhart, and Hancock Counties. In a report ES&S submitted on January 22nd, it was determined that “The root cause was an error in our conversion process that determines when to set this True or False based on a value stored for the date of the Election. This date was incorrect.” In the same report, ES&S also reported anomalies for Brown and Elkhart Counties concerning incorrect date encoded for provisional ballots. VSTOP is concerned that: 1. ES&S internal testing processes did not catch the incorrect encoding of dates and 2. The problem was not discovered by ES&S during its post-elections review.



Findings from the Analysis of Logs

The data in the tables above led to several findings.

- a. Johnson County's greatly decreased Ballot rate confirms the reported slow check-in times. For other counties the Ballot rate stayed largely consistent.
- b. Johnson County's average wait times went up during the 10:00 AM to 12:00 PM time period. For other counties the average wait time stayed largely consistent.
- c. In the absence of WAF logs, a correlation between server and client values cannot be established. However, the client requests are consistent throughout the day whereas, the server requests showed a drop from 10:00 AM to 1:00 PM. This is in agreement with the reported delays in check-in times during that period.

ES&S's internal Research into the 2018 General Election Issues

In ES&S's responses for the preliminary report, ES&S had stated that it was conducting internal tests. In response to VSTOP's third set of questions, ES&S stated, "ES&S has not been able to re-produce the 500 internal server issue encountered and research to date has not indicated why the 500 internal server issue was indicated in the log file. ES&S continues to monitor for any application exceptions as a result of it, but currently there is no clear indicator of the cause of the message."

Further, ES&S stated, "ES&S has not been able to reproduce or replicate the performance issue related to the web application firewall issue that occurred in the general election."

During the call on February 27th, ES&S stated that the HTTP Status Code 500 issues might be caused by validating the client certificate from Azure Certificate Revocation List (CRL).

In the response received on March 6th, ES&S stated, "The reason [for the 500 internal server issue] was due to the server making a call to another TLS [Transport Layer Security] secured service and not being able to completely negotiate the secure channel."

VSTOP is concerned that lack of such testing results (a) does not help improve quality control and improvement and (b) limits the degree of confidence that future performance issues can be avoided.

ES&S's Corrective Action for the Short-Term and Long-Term

Short-term: In response to VSTOP's third set of questions, follow-up questions, and a phone call on February 27th, ES&S described corrective actions to the Azure configuration and a long-term plan for transitioning to ES&S's hosting environment.

According to ES&S, "ES&S has made several changes to allow for further diagnostics and logs to be collected if issues arise in the future. In addition, ES&S has also made configuration



changes allowing for greater scalability without interruption, such as using the ability to scale up to more instances of the web application firewall instead of the previous limitation of 7.”

ES&S stated further that “ES&S is confident this will prevent this happening in the future as the source of the issue is being completely removed. The issue that occurred in November was a slow-down of the performance of the WAF component of the CentralPoint architecture as it exists with the Azure environment. In the interim, ES&S has reconfigured this component within the Azure infrastructure in order to allow it to scale further than it did in November. This specific component will no longer be utilized long-term with the transition to ES&S’ hosting environment.”

On March 6th, ES&S stated, “The issue experienced on Election Day was an unexplained slowdown in the performance of the Azure WAF component and a configuration that did not allow scale-out of this component.”

Given ES&S stated on two occasions that there was unexplained slow-down in the performance of the Microsoft Azure WAF component and configuration, VSTOP is alarmed that in the absence of ES&S internal research not being able to reproduce or replicate the performance issues, and unavailability of WAF logs, there is a lack of conclusive evidence that this scaling up will resolve and prevent further occurrence of performance issues.

Long-Term: According to ES&S, “After additional research of the issues and to further reduce its dependency on third parties, ES&S will be transitioning its e-poll book server infrastructure to ES&S’ hosting environment. ES&S expects the transition will be completed in advance of the May [2019] municipal elections. Further notification will be provided to the State in subsequent communications by ES&S.”

ES&S stated further that “Our load/performance test plan is similar to what was previously shared with VSTOP in prior communications. We are prepared to share the results of the tests when completed.”

In the phone call on February 27th, ES&S explained that the ES&S hosting environment has been in existence since 2013. However, in the last two years, it has not been used to host ePB server infrastructure. In response to a question, ES&S did not provide names of any jurisdictions where the ES&S hosting environment was used in the past to host ePB server infrastructure.

In the written responses received on March 6th, ES&S stated, “Due to commitments to support its customers throughout the months of March, April, and May with scheduled elections, we don’t expect the migration off of the Azure environment to be completed until May [2019]. Consequently, ES&S is likely to continue to service Indiana e-pollbook customers within the current Azure environment until after the May municipal elections.”

VSTOP’s concerns regarding the replication of the issue with WAF instances remains the same for May 2019 Municipal Primary Elections.



Regarding ES&S migration to their internal hosting environment, ES&S provided the following details in the responses received on March 6th:

“ES&S’ hosting environments are housed in two disparate co-location facilities connected by multi-gigabit connections. Each environment contains telecommunications redundancy, network firewalls, application firewalls, host-based intrusion detection and prevention, anti-malware and power/electrical redundancy, and are located 125+miles apart.”

“Equivalent security is provided by default within ES&S’ hosting environment. This includes but is not limited to telecommunications provider redundancy, built-in DDoS protection, network firewalls, application firewalls, host-based intrusion detection and prevention, anti-malware. ES&S’ hosting environment also leverages two-factor authentication and geo-ip filtering on all internet-facing assets, as well as IP and domain-based reputation services to assist in filtering all unneeded traffic.”

“The issue experienced on Election Day was an unexplained slowdown in the performance of the Azure WAF component and a configuration that did not allow scale-out of this component. ES&S’ hosting environment does not depend on this component and employs equivalent technology that can be scaled and adjusted more easily if the need arises. As a comparison, to make any adjustment to the Azure WAF component can take up to 30 minutes to take effect. Conversely, in ES&S’ hosting environment, an equivalent change could be performed in under 5 minutes conservatively. The move to ES&S’ hosting environment will allow quicker reaction time to unforeseen events in the future. This is just one of the many strengths of the environment to which ES&S is migrating.”

However, ES&S also stated, “There are no past testing reports available for ES&S’ hosting environment with e-pollbooks.” The absence of such test reports remains a concern.

In this regard, see VSTOP’s recommendations in the next section.

Summary of conclusions from Stephen Berger’s Report

- a. Although the hypotheses proposed about the cause of the delays experience during the 2018 Midterm Election may be correct, they must be held as tentative until they can be reproduced in load testing.
- b. The failure of the current methods of system and load testing to replicate those failures raise grave doubts about the ability of the current methods to give early warning of the same or new problems.
- c. Because system changes are still being planned by ES&S, evaluating the sufficiency of those changes is not yet possible. It is important that the change approval process be clarified and agreed to by all parties. ES&S will do its own testing of the modifications it makes to its system. It is recommended that independent tests of the modified system be performed under the supervision of election officials as part of their independent due-diligence before using the new version of the system.



- d. Given the uncertainty in these areas, the lack of contingency planning is particularly troubling. Should the same or a different problem arise in the future, there is no reviewed and practiced contingency plan to deal with it or commitment by ES&S to communicate any plan to its county customers in advance of any similar problem occurring.

Please see Appendix D for the full report by Mr. Berger.

Recommendations

The findings in the last section are a cause for concern. VSTOP recommends the following corrective actions and best practices. Some of the recommendations below also appeared in the preliminary report and those are included herein with revisions based on the findings of this follow-up investigation.

- a) ES&S should carefully review its internal quality control and testing processes to implement failsafe methods to prevent recurrence of the problems that occurred in Indiana counties in the 2018 Primary and General Elections. Testing and simulation procedures should be reviewed to ensure that the load test results are closely aligned with the actual Election Day results. When issues are encountered, plans for replication/reproduction of such errors should be in place.
- b) ES&S shall revise and improve anomaly reporting processes so that anomalies and problems are reported to SOS and VSTOP within the legally required 48-hour period after discovery. Review internal communication processes so that anomalies or problems that are reported to local or on-site personnel are properly recorded and reported in the ES&S's reporting repositories.
- c) ES&S must comply with state and federal laws concerning the 22-month retention period for election related materials as identified by the Indiana Election Division and the Office of the Indiana Secretary of State including logs and test results. Implement as a standard practice saving all logs and making copies available to client jurisdictions and the state after each election. This will help jurisdictions comply with the twenty-two-month retention requirement of all materials.
- d) ES&S must inform the State and jurisdictions in a timely manner when modifications in the front-end or the back-end infrastructure changes planned and executed.
- e) ES&S must thoroughly assess its pre-election and ongoing risk management and mitigation strategies to appropriately serve electronic poll book clients within the Indiana.
- f) ES&S should carefully evaluate its deployment of alternative solutions with ample time for testing and simulation.
- g) ES&S must provide prompt, clear, and consistent service that meets their contractual obligations to their county customers when counties encounter issues.



- h) ES&S must review and improve internal ES&S communication protocols to ensure that employees are responding to both customers and to ES&S supervisors regarding issues. ES&S support personnel should work in close collaboration with the ES&S technical and troubleshooting personnel for resolutions and mitigation of issues and reports results to client jurisdictions in a timely manner.
- i) ES&S should respond with project and test results by a date specified by the Secretary.
- j) Anomalies in Brown, Hancock, and Elkhart Counties were caused by incorrect settings of dates. This should be entirely avoidable with proper quality control best practices which can be set in place and to monitor for compliance.

The Investigation Team

The following individuals formed the investigation team for the present inquiry.

- a. Dr. Jay Bagga and Dr. Bryan Byers, VSTOP Co-Directors
- b. Ms. Jessica Martin, VSTOP Project Manager
- c. Mr. Mani Kilaru, VSTOP IT Specialist
- d. Mr. Isaac Walling, VSTOP Computer Science Graduate Assistant
- e. Mr. Stephen Berger, Technical Consultant, TEM

For media questions regarding this report, please contact:

Valerie Warycha
Deputy Chief of Staff and Communications Director
Indiana Secretary of State Connie Lawson
201 Statehouse
Indianapolis, IN 46204
Email: VWarycha@sos.IN.gov
Phone Number: 317-233-8655

Or

Ian Hauer
Deputy Communications Director
Indiana Secretary of State Connie Lawson
200 W. Washington St.
Indianapolis, IN 46204
Email: IaHauer@sos.IN.gov
Phone Number: 317-234-9682