



**A Preliminary Investigation of
ES&S Electronic Poll Book Issues
in
Johnson County, Indiana
for the
2018 General Election**

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

December 31, 2018



Introduction

On Election Day November 6, 2018, the Voting System Technical Oversight Program (VSTOP) learned from the Indiana Secretary of State that there were issues with voter check-ins on Johnson County electronic poll books (ES&S EZRoster 3.2.2.1 Encore 2 Tablets). VSTOP participated in two conference calls with the Secretary's Office, ES&S, IED and Baker Tilly to troubleshoot the problem. During the course of the day, VSTOP monitored the situation through the Secretary's office and media reports. Later in the day, it appeared the issue was resolved. VSTOP had preliminary communication with ES&S in early November when ES&S identified an issue with the functionality of a Microsoft service which caused a significant increase in voter check-in times.

The anomaly report from ES&S, required by law, was limited in scope concerning the issues encountered. Issues may have also occurred in all ES&S counties on Election Day as well as during early voting (see Appendix A).

In a phone conference on December 7, 2018 with Secretary Lawson and others, the Secretary asked VSTOP to submit a brief proposal for an investigation of Johnson County's electronic poll book issues. VSTOP submitted this proposal (see Appendix B) to Secretary Lawson on the same date.

In a December 7, 2018 letter to ES&S and VSTOP (see Appendix C), Secretary Lawson directed VSTOP to investigate and report on ES&S performance issues in the November 2018 General Election and to provide a preliminary report with findings and recommendations no later than December 31, 2018.

Scope of the Preliminary Investigation

The scope of this preliminary investigation covered the following activities approved by the Indiana Secretary of State:

- Conduct interviews and gather information from all involved parties regarding the issues described above.
- Contract with a technical expert to assist with the investigation.
- Discuss with ES&S and Microsoft what may have been the root problem(s).
- Conduct reviews of technical documentation, logs and other relevant documents. Conduct technical testing if needed.
- With the information gathered, draw conclusions regarding the findings and engage in a risk management assessment to advise ES&S, the State and the County regarding potential ways to avoid such problems in the future. Provide periodic and timely updates to the Secretary and the Johnson County Election Board regarding preliminary findings.

A copy of the original approved investigation proposal may be found in Appendix C. The investigation, which is preliminary in nature, is covered in the following pages.



ES&S Electronic Poll Book System Used in Johnson County

Johnson County uses the Indiana certified ES&S electronic poll book (ePB) EZRoster 3.2.2.1 with a Toshiba Encore 2 tablet. The components of this certified system are as follows.

Software

Component Name	Model/Version
ExpressPoll-3.2.2.1 Cardwriter- 1.16 CE-5000.zip*	3.2.2.1

**This software component is the install package for the ExpressPoll EZRoster 3.2.2.1*

Hardware

Component Name	Model/Version	Description
Toshiba Encore 2 Tablet Intel® Atom CPUZ3735F 1.33GHz 2.00GB Windows 8.1 Pro 32-bit OS, x64 bit-based processor	Encore 2	COTS ePB Tablet
Pollbook Stand with Magnetic Stripe Reader**, Smart Card Reader & Ethernet	Pedestal	Integrated Tablet Pedestal Stand

***Mag-Stripe Reader is included because it is part of the standard list of system equipment; however, this component is not utilized in the State of Indiana*

Peripherals

Part Name	Model Number	Description
Seiko SII Thermal Printer	DPU-S445-01A-E	16 GB
Topaz Signature Pad	T-L460-HSB-R, T-LBK-750SE- BHSB-R*	Digital signature capture device
USB Smart Card Reader	SCR3310/V2	COTS smart card writer
Symbol Tech Scanner	D56708- SR2007ZZR	COTS Scanner
Custom MY3 Thermal Printer	911CR010100A33	COTS USB thermal printer
DYMO Printer Label/Writer 450 Turbo	1750283	COTS USB thermal printer
USB Hub	Tripp-Lite 422- 004 -R	COTS USB hub
ExpressVote Printer	Microcom 4200	ExpressVote Card printer
CradlePoint Router	MBR1200B	COTS WAN Router
Dell Laptop	Latitude E6440 Windows 7 Pro	COTS Server laptop
Verizon Jetpack	MIFI6620L	COTS MiFi Hotspot
Verizon USB Modem	Pantech ULM290	COTS USB air card
D-Link Router	DGS-1D8G	LAN Ethernet Router
SanDisk Imagemate 12-in-1	SDDR-89	COTS multi reader/writer

Supporting Materials

Thermal Paper Roll		
BackStrap Tab	H00254/1	Tablet Protector
Kingston ThumbDrive	DT100G3/16GB	16 GB
Smart Cards	---	Central Administrator/Voter Access/Key Cards



Figure 1: Client – Server Communication Architecture

Electronic Pollbook Data Flow and Network Communication



The following is a brief overview of how communication occurs with a cloud service, such as the Amazon Web Service (AWS) or the Microsoft Azure cloud service. Prior to October 2017, ES&S utilized AWS for its cloud services. In October 2017, ES&S migrated its ePB web services to Microsoft Azure cloud services.

The ES&S electronic poll book in Indiana uses two servers: CentralPoint (a Web Server) and SyncPoint (an Application Server). ES&S refers to the combination of CentralPoint and SyncPoint as “CentralPoint.”

CentralPoint is a web application that displays and tracks data sent to the server from the ePB tablets during an election and can be configured to display and update in near real-time. SyncPoint is a Windows Communication Foundation (WCF) application which communicates with host ePBs in the field which send and receive updates.

The Microsoft Azure Application Gateway is a web traffic load balancer that enables one to manage traffic to web applications. A Web Application Firewall (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.

Figure 1 (provided by ES&S) shows how communication occurs between a client (a host ePB or a CentralPoint web application user’s computer) and the respective application server (CentralPoint or SyncPoint server). When a host ePB or CentralPoint web application user sends



a request to the application server, it first goes through the Application Gateway. The Application Gateway contains the WAF and a set of routing rules which sends the client requests to the proper application server.

Timeline of Events

2018

May 8: Johnson County had a similar issue (a “yellow host wait indicator”) with their electronic poll books in some locations (no anomaly report was submitted by ES&S), and VSTOP was unaware of this issue.

Early Voting: Howard County experienced delays in the check-in process two days. (No anomaly report was submitted and VSTOP was unaware until December 2018).

November 6 (Election Day): On Election Day, Johnson County experienced delays during the voter check-in process, as did other ES&S ePB counties. ES&S held a conference call with SOS, VSTOP and others. After the call, ES&S sent an advisory email to customers (see Appendix D).

November 8: VSTOP received an anomaly report for this issue via email from TJ Burns at ES&S.

November 12: VSTOP sent additional questions to ES&S regarding the anomaly report submitted.

November 14: TJ Burns sent responses for additional questions to VSTOP via email.

November 20: Jeremy Burton sent a letter to the Johnson County Clerk apologizing for the situation that occurred on Election Day (see Appendix E).

December 3: The VSTOP Co-Directors were contacted by the Johnson County Election Board Attorney Stephen Huddleston about conducting an investigation into the ES&S ePB issue experienced on Election Day.

December 7: A conference call was held with individuals from Johnson County, SOS, IED, VSTOP and Baker Tilly. VSTOP sent a proposal for the scope of an investigation to SOS. SOS sent notice to ES&S that VSTOP was to begin the investigation.

December 12: VSTOP sent the initial investigation questions to ES&S.

December 13: ES&S provided VSTOP with Microsoft personnel contact information.

December 14: Requests for further information were sent to all ES&S ePB counties in Indiana. Porter County responded noting a different issue during early voting. This issue was not reported to the State or VSTOP by ES&S. Hancock County responded as well and noted they did have issues similar to Johnson County in some locations on Election Day.



December 18: ES&S responded to VSTOP's initial questions.

December 19: ES&S's initial responses were sent to the Microsoft contacts for independent verification. Johnson County responded to VSTOP's initial questions (see Appendix F).

December 20: Carroll County responded to VSTOP's inquiry and confirmed that they also had a similar issue occur with their ePBs on Election Day (see Appendix F).

December 21: A meeting via conference call was held with Microsoft, ES&S, VSTOP, SOS, Johnson County and Baker Tilly.

December 26: ES&S sent a written copy of their responses to the follow-up questions from VSTOP.

December 27: Brown County informed VSTOP that they had issues with ePB pedestal stands during the Primary of 2018 (unreported anomaly). On General Election Day, they also had host issues which they dealt with by not waiting for the host to respond. Howard County informed VSTOP they also experienced this issue on Election Day and two days during early voting. Porter County sent follow up information as well (see Appendix F). In the afternoon, Pro V&V had a conference call with VSTOP regarding this issue.

December 28: Pro V&V emailed written responses to VSTOP's questions.

December 31: VSTOP sent this draft report to SOS.

Description of the Issue

At the request of the Indiana Secretary of State, the VSTOP Team began its investigation by identifying the various contacts at Johnson County, ES&S and Microsoft relevant to the inquiry. The Team also gathered information it had received through e-mail communications, phone conferences and media reports (see Appendix G).

In consultation with SOS, IED and Baker Tilly, VSTOP prepared an initial list of questions for Johnson County (see Appendix F). We describe selected responses below.

The Events

Johnson County's verbatim description of the issues encountered on Election Day in November 2018 is as follows:

Johnson County Voter Registration staff first received a support phone call from the vote center at Grace United Methodist Church about 7:40 AM ET on election day. They indicated that there were pauses of between 5 to 30 seconds during the voter check-in



process. Specifically, they were receiving a yellow host wait indicator when the electronic pollbook was attempting to connect to ES&S servers to verify the voter was valid. Once the yellow indicator cleared, they could continue to process the voter successfully.

Johnson County IT/Network Specialist Scott Henry was dispatched to Grace United Methodist Church to observe first-hand what was occurring. At that time, he observed that the two electronic pollbooks at the center were both exhibiting the host wait issue, however not always at the same time. It was noted that the yellow wait indicator was appearing anywhere from 5 to 30 seconds before allowing the poll worker to continue. The electronic pollbooks were both rebooted at the time, but that did not solve the issue. Since it was apparent this issue was related to a network connectivity issue of some kind, Mr. Henry also temporarily connected the electronic pollbooks to a Verizon mobile hotspot to rule out any possible problem with the local network. That also did not resolve the problem.

Meanwhile, several other vote centers began to call in to the Voter Registration office to declare they were also having host wait issues. At this time, it became clear that this was not a problem with the pollbook hardware or the local internet connections at particular vote centers. At 7:56 AM, Reagan Higdon from the Voter Registration office attempted to call our ES&S account executive, Susan Casey, to report the problems we were experiencing. She did not receive an answer and then proceeded to send Ms. Casey an email asking for help with this issue. She did not receive a reply to the email either. A short time later Mr. Henry returned to the Voter Registration office, whereupon he was handed a phone call from Jeremy Burton, Indiana's ES&S Sales Representative (Though not a support representative himself, Mr. Burton has always attempted to lend support to Johnson County wherever possible and coordinate help as needed). Mr. Burton said that he would immediately contact Ms. Casey for assistance. This call occurred about 8:30 AM.

On-site ES&S support representative Su Clark was also made aware of the electronic pollbook connectivity issue as soon as it began. Ms. Clark also placed a call to Ms. Casey, but received no answer. Ms. Clark then followed up with a text to Ms. Casey, and Ms. Casey responded that Ms. Clark should have someone contact the ES&S Helpdesk to seek a resolution.

At 9:13 AM, Mr. Henry placed a call to ES&S Support and spoke with Larry Kennell. Mr. Kennell seemed to be surprised by the issue and then told Mr. Henry that ES&S had recently discovered that there were some latency issues with the CradlePoint MBR 1200 routers that the County uses that could be causing the host wait issue. Mr. Henry inquired when this was first discovered and why as the local election IT support he had not been informed about this prior to the election. Mr. Kennell said it was discovered during the early voting period and that Ms. Casey as the account executive had been informed about the issue and that it would have been up to her to communicate that to the County. Mr. Kennell also stated that as it regarded the present issue, it was probably too late to implement a fix.



Likewise, at VSTOP's request, ES&S independently provided a description of the issue which occurred on Election Day. A collection of initial questions were posed to ES&S on December 12, 2018. Responses to this initial set of questions appear in Appendix H.

The description is as follows:

On Election Day, ES&S started receiving reports of system slowness (slow voter check-in times) shortly after 8 a.m. CST, from more than one county in Indiana. ES&S initiated immediate troubleshooting itself by testing the response time of each server allocated to Election Day utilization. While each server's response times didn't indicate any performance degradation, the access and response times through the Web Application Firewall (WAF) were higher than desired. ES&S then opened a call ticket with Microsoft Azure engineers who proceeded to assist ES&S in diagnosing the reported performance issues.

Through troubleshooting with the Microsoft engineers, it was determined that the Web Application Firewall was not able to be scaled out due to the configuration chosen by ES&S personnel that limited the number of WAF instances utilized. In order to bypass the Web Application Firewall configuration limitations, the specific Web Application Firewall was disabled, still leaving the standard firewall configuration intact, which removed the bottleneck. This action was executed shortly after noon CST on Election Day, with the configuration being applied fully prior to 12:30 p.m. CST, and latency dropping accordingly and all performance returned to optimal levels.

Similar issues were not encountered during the primary election period in 2018.

Based on the initial responses, VSTOP posed a set of follow-up questions to ES&S. These were sent to them on December 20, 2018. With the aforementioned information, along with conversations with Johnson County officials and the Office of the Indiana Secretary of State, VSTOP had email as well as telephone conversations with ES&S. One of these conversations (on December 21, 2018) also included representatives from Microsoft.

In the interest of time, the follow up questions were partially addressed in the telephone conference call on December 21, 2018 which included representatives from the Office of the Secretary of State, Baker Tilly, Johnson County, Stephen Berger (VSTOP Technical consultant) and VSTOP. Even though some of the areas from the follow-up questions were addressed in the telephone conference call, a formal written response to the follow-up questions was requested and received.

Findings

The findings for this report are organized around thematic areas. Each of the headings below represents a key area investigated by VSTOP.



The extent of the problem in the field and its impact

The problem on Election Day, November 6, 2018, involved technical issues with electronic poll book performance resulting in longer than expected wait times at Johnson County, Indiana vote centers. Johnson County, Indiana election officials first began to see slow electronic poll book performance at around 8:00 am ET on November 6, 2018. The problem with slow electronic poll book performance seriously disrupted the voting process in Johnson County, Indiana on Election Day. However, the extent of the problem extended beyond Johnson County. In Johnson County, the problem caused stress, confusion, and a crisis in confidence in ES&S by county election officials. The negative election publicity may have also impacted voter confidence and was embarrassing for the County.

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.*”

ES&S initially maintained that the problem with slow electronic poll book performance on Election Day was caused by the Microsoft Azure Web Application Firewall (WAF). It was discovered in responses to VSTOP questions by ES&S, and in subsequent conversations with ES&S, that the problem was caused by the limited number of *instances* in the WAF that ES&S secured through Microsoft Azure for electronic poll book data traffic. WAF instances refer to an object that validates the https or http request from the client.¹ ES&S also stated in the conference call on December 21, 2018 that they did not prefer to use autoscaling² which could have opened more WAF instances. Rather, they preferred a “human” factor to make scaling determinations. ES&S offered Johnson County an Election Day work-around to restore electronic poll book use within, but not between, vote centers. However, this work-around was not adequate as required by IC 3-11-8-10.3(b)(7) since the electronic poll books could not transmit “...information immediately to every other polling place...” or make the “...information immediately available to every other polling place...” within the County.

ES&S and Microsoft both maintained that the original configuration for Election Day was

¹ <https://docs.microsoft.com/en-us/azure/application-gateway/waf-overview>

² Autoscaling is the process of dynamically allocating resources to match performance requirements. As the volume of work grows, an application may need additional resources to maintain the desired performance levels and satisfy service-level agreements (SLAs).
<https://docs.microsoft.com/en-us/azure/architecture/best-practices/auto-scaling>



sufficient to handle the electronic poll book data traffic. The evidence offered for this was the pre-election load testing which took place. Therefore, it is ES&S's contention that the problem could not have been avoided since they thought they were prepared for the election.

VSTOP's technical analysis of logs provided by ES&S

Several logs were provided to VSTOP by ES&S. These logs are Internet Information Server (IIS) logs covering CentralPoint and SyncPoint activities for the Primary Election in May 2018 and the General Election in November 2018, as well as the load test results conducted in summer/fall 2018. The Investigation Team analyzed eight logs: Three CentralPoint logs CP1, CP2, and CP3, and five SyncPoint logs SP1, SP2, SP3, SP4, and SP5. The logs listed numerous server errors that show performance issues experienced during the Primary Election in May 2018 and the November 6, 2018 General Election Day in Johnson County. This analysis yielded a number of findings.

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 that, *"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."*

In a follow-up question regarding ES&S's policy regarding enabling and retaining such logs, ES&S stated, *"ES&S generally retains access logs for web servers and firewalls according to PCI DSS guidelines (365 days)."*

In the telephone conference on December 21, it was stated by Microsoft/ES&S that logs generated by Microsoft were not saved. VSTOP expresses concern about whether this complies with State and Federal guidelines concerning the twenty-two-month retention period for such election related materials.

Load tests: The logs provided by ES&S included results of load tests conducted in the fall/summer 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 load tests were not retained.

Comparison of Primary Election Day and General Election Day logs: Table 1 shows the different types of status errors on the SP1 server during the 2018 Primary and General Elections (see Appendix I). It is evident from these records that there were a large number of errors. While the number of Error Code 400 errors are proportionately



comparable, there were a very large number of Error Code 500 errors in the General Election compared to almost none in the Primary Election. ES&S has stated that, “*This error was noted by our technicians and is still being researched. It is generic in nature and should be debugged while not in production.*” It is important to find the cause(s) for these large number of occurrences during the General Election and the absence of such errors during the Primary Election.

VSTOP expects that ES&S will share the results of its research with the State as soon as those are available.

Table 1: SyncPoint 1 server errors in the 2018 primary and general election

Primary Election										General Election									
ET		Total	Error Codes							ET		Total	Error Codes						
Date	Hour	Records	206	302	304	400	401	404	500	Date	Hour	Records	206	302	304	400	401	404	500
5/7/18	20	1,384	0	0	0	5	0	1	0	11/5/18	20	2,571	0	0	0	3	0	1	0
5/7/18	21	1,365	0	0	0	6	0	1	0	11/5/18	21	2,210	0	0	0	2	0	0	0
5/7/18	22	1,359	0	0	0	3	0	2	0	11/5/18	22	2,115	0	0	0	2	0	2	0
5/7/18	23	1,367	0	0	0	5	0	2	0	11/5/18	23	2,112	0	0	0	0	0	1	0
5/7/18	24	1,362	0	0	0	4	0	2	0	11/5/18	24	1,961	0	0	0	1	0	0	0
5/8/18	1	1,329	0	0	0	5	0	1	0	11/6/18	1	1,894	0	0	0	2	0	0	0
5/8/18	2	1,312	0	0	0	5	0	2	0	11/6/18	2	1,929	0	0	0	0	0	1	0
5/8/18	3	1,310	0	0	0	5	0	4	0	11/6/18	3	1,878	0	0	0	1	0	1	0
5/8/18	4	1,407	0	0	0	9	0	3	0	11/6/18	4	1,873	0	0	0	3	0	1	0
5/8/18	5	12,378	0	0	0	5	0	0	0	11/6/18	5	2,741	0	0	0	2	0	1	0
5/8/18	6	32,474	0	0	0	7	0	2	0	11/6/18	6	12,915	0	0	0	2	0	0	0
5/8/18	7	38,158	0	0	0	5	0	1	0	11/6/18	7	90,965	0	0	0	2	0	2	0
5/8/18	8	46,067	0	0	0	5	0	2	1	11/6/18	8	232,501	0	0	0	3	0	0	28
5/8/18	9	59,608	0	0	0	9	0	4	0	11/6/18	9	249,009	0	0	0	8	0	1	34
5/8/18	10	60,923	0	0	0	3	0	1	0	11/6/18	10	211,017	0	0	0	7	0	0	47
5/8/18	11	58,276	0	0	0	9	0	3	0	11/6/18	11	124,308	0	0	0	8	0	1	264
5/8/18	12	51,828	0	0	0	6	0	2	0	11/6/18	12	216,138	0	0	0	10	0	3	273
5/8/18	13	54,736	0	0	0	7	0	3	0	11/6/18	13	140,456	0	0	0	7	0	3	120
5/8/18	14	58,246	0	0	0	7	0	5	0	11/6/18	14	309,715	0	0	2	3	0	15	74
5/8/18	15	57,274	0	0	0	5	0	2	0	11/6/18	15	287,098	0	0	0	3	0	0	14
5/8/18	16	64,044	0	0	0	6	0	1	0	11/6/18	16	293,000	0	0	0	3	0	1	23
5/8/18	17	64,471	0	0	0	4	0	3	0	11/6/18	17	333,074	0	0	0	1	0	1	25
5/8/18	18	19,076	0	0	0	5	0	1	0	11/6/18	18	385,722	0	0	0	3	0	0	27
5/8/18	19	3,326	0	0	0	5	0	3	0	11/6/18	19	374,903	0	0	0	1	0	0	30

Comparison of load test results and General Election Day logs: Table 1 shows the different types of SP and CP server errors in the simulated tests and in the November 2018 General Election (Appendix I). Again, this comparison shows large variations in the numbers of errors in the load tests and actual errors on Election Day. This raises a number of questions, including: (1) Why were there almost no errors in the simulation (even with a large number of simulated pollbooks)? (2) What caused the large number of errors on Election Day? and (3) What is missing in the simulation methods which may have helped in identifying problems before an election? Table 2 lists similar comparisons between simulation results and Election Day results for SyncPoint and CentralPoint. This raises similar questions.

VSTOP expects that ES&S’s research will include a discussion of these questions.



Table 2: SyncPoint and CentralPoint errors in simulation results and in the 2018 General Election

	Simulation Results	Election Day Results from IIS Logs (6:00 AM to 6:00 PM)
# of pollbooks	12,000	Unknown to VSTOP
# of requests per sec	1,000	322
Http Status Issues		
500	2	4,723
400	0	259
404	0	124
304	0	13
405	0	6
CentralPoint		
	Simulation Results	Election Day Results from IIS Logs (6:00 AM to 6:00 PM)
# of users	150	Unknown to VSTOP
# of requests per sec	43	11.7
Http Status Issues		
304	2	12,696
404	0	4,601
302	0	2,735
400	0	866
401	0	305
500	0	53
206	0	16
405	0	1

ES&S’s move from Amazon Web Services (AWS) to Microsoft Azure cloud services

In September 2017, VSTOP conducted a survey of ePB vendors operating within Indiana to learn about security precautions and best practices. A report of the results of this of survey was submitted to Secretary Lawson in April 2018 (see Appendix J for a copy of ES&S’s responses to this survey).

Question 1 of the survey was: Describe the server set up for all election activity for your ePB solution in Indiana. Include details such as how the server is hosted (by the county or jurisdiction, internally by the vendor, by a third party such as Amazon Web Services (AWS) or other). On September 25, 2017 ES&S provided the following response to Question 1: *“The ePB solutions for Indiana products are hosted on a combination of private data center and private cloud environment platforms. The private data center is provided by ES&S Empower® solutions. The Empower® solution offers disaster protection, security, uptime, 24/7 physical security and*



onsite support. ES&S maintains the systems. This environment is located in Nebraska and a failover site Kansas. This platform provides the following services: Central Point website and database functions. The private cloud components are hosted in AWS. This environment is responsible for pollbook data communications.”

In October 2017, ES&S migrated their ePB web services from AWS to Microsoft Azure cloud services. ES&S provided the following explanations for this switch:

“The reasons for migration from AWS to Microsoft Azure were a combination of issues, namely cost, usability/performance, and available expertise.”

“ES&S found Microsoft Azure more usable immediately due to fewer differences in regular computing resource "vernacular", as well as having a more straightforward pricing structure.”

VSTOP has no record of ES&S informing VSTOP or the State of Indiana of the switch from AWS to Microsoft Azure cloud services. According to Section 6.0 of the ePB Protocol (see Appendix K), any changes should be submitted to VSTOP “...in a timely manner for approval before they are implemented in the field.” (p. 18). A change in cloud services constitutes an “infrastructure modification.” See Appendix L for the opinion from Pro V&V, a Federally Certified VSTL.

ES&S’s configuration setup on Microsoft Azure cloud services

As described above, ES&S initially maintained that the problem with slow electronic poll book performance on Election Day was caused by the Microsoft Azure Web Application Firewall (WAF) and the limited number of instances in the WAF that ES&S secured through Microsoft Azure for electronic poll book data traffic.

According to ES&S, “The configuration was chosen based on expected traffic and load testing that simulated multiples of the expected traffic. ES&S employed ‘Large’ WAF instances, with the ability to scale up to seven instances, and tested this configuration with the test case provided to VSTOP. All of those tests passed. Cost was considered, but was not the primary factor.

“On Election Day, ES&S started receiving reports of system slowness (slow voter check-in times) shortly after 8 a.m. CST, from more than one county in Indiana. ES&S initiated immediate troubleshooting itself by testing the response time of each server allocated to Election Day utilization.”

“While each server’s response times didn’t indicate any performance degradation, the access and response times through the Web Application Firewall (WAF) were higher than desired. ES&S then opened a call ticket with Microsoft Azure engineers who proceeded to assist ES&S in diagnosing the reported performance issues.”



“Through troubleshooting with the Microsoft engineers, it was determined that the Web Application Firewall was not able to be scaled out due to the configuration chosen by ES&S personnel that limited the number of WAF instances utilized.”

The above shows that ES&S’s load testing failed to predict the actual volume of traffic on Election Day, leading ES&S to misjudge server needs and the impact of WAF instances.

ES&S’s work-around on Election Day in November 2018

In order to resolve the issue caused by delays due to the WAF, ES&S employed a work-around. According to ES&S, *“The work-around performed was a standard procedure based on EZRoster 3.2.2.1, allowing a pollworker to disable the “Host Status Required” function so that voters could be checked in locally to the e-pollbook.”*

While this work-around may have checked voters locally, it disabled the syncing requirement as specified in IC 3-11-8-10.3 (b)(6) and (7):

(6) After the voter has been provided with a ballot, the electronic poll book must permit a poll clerk to enter information indicating that the voter has received a ballot.

(7) The electronic poll book must transmit the information in subdivision (6) to the county server so that:

(A) the server may transmit the information immediately to every other polling place or satellite absentee office in the county; or

(B) the server makes the information immediately available to every other polling place or satellite office in the county.

ES&S’s corrective action for the near future

In response to questions about ES&S plans for improvements in their systems and to help Johnson county in the near term, ES&S responded:

“In addition to providing a more scalable configuration of the WAF functionality, ES&S is researching providing an equivalent function through an alternate technology that would not have a hard dependency on a single vendor, and could be scaled up or down more rapidly. While there would still be some reliance on third parties for the CentralPoint solution, this would provide a layered approach so that any sub-optimal performance of any single component could be more efficiently diagnosed.”

“There is no established timeline of an alternate solution at this time. If/when pursued, it would benefit all customers, not just Johnson County, but will likely not be in place for the 2019 municipal primary. ES&S is in ongoing engagement with Microsoft to establish a more scalable configuration that will alleviate any issues with WAF in the future, and this configuration is our primary focus at this time.”



Additionally, ES&S reported in a telephone conference on December 21, 2018 that they have already contractually added 93 WAF instances with Microsoft Azure (up to 100 from 7 originally). VSTOP has not seen any evidence at this time that this will resolve the problems completely. In the following sections, VSTOP will recommend immediate and continued evaluation and improved load testing.

Findings regarding this issue from other ES&S counties in Indiana

ES&S reported that this issue affected all Indiana Counties served by ES&S electronic poll books to some degree. These counties are Brown, Carroll, Elkhart, Hancock, Howard, Monroe and Porter, as well as Johnson County. VSTOP contacted the other seven counties in Indiana that use ES&S electronic poll books to corroborate this and to find out how this impacted them. Five of seven counties responded (see Appendix F). Porter County is the only jurisdiction that did not believe they were affected by this problem, and they do not use electronic poll books on Election Day. Howard County is the only locality that reported this issue occurred two days during Early Voting for the 2018 General Election as well as one day during the 2018 Primary. Satisfaction with the response of ES&S, as well as each county's understanding of the work-around, was mixed. VSTOP has yet to receive a response from Elkhart and Monroe Counties.

Related findings regarding ES&S's electronic poll books in Indiana

In December 2018, VSTOP was informed by two counties, Brown and Porter, that the Integrated Tablet Pedestal Stand for the Toshiba poll books had to be replaced due to issues.

According to a December 14, 2018 email from the Porter County Clerk, *"We had major issues with the bases that had to be replaced more than once in Portage and Chesterton had to be replaced also."*

According to a December 27, 2018 follow-up email from the Porter County Clerk, *"There were connectivity issues. The problem occurred [sic] more than once. We used 1 unit at each of our 5 early voting locations. We had to replace 2 locations once and 1 location twice."*

According to a December 27, 2018 email from the Brown County Clerk, *"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."*

According to IC 3-11-18.1-14 (b), *"A person that receives a certification for an electronic poll book shall file not later than forty-eight (48) hours after the discovery of an anomaly or problem with the poll book a written report describing the anomaly or problem with the secretary of state."*

VSTOP has no record that these issues of electronic pollbook pedestal stand failures in these two counties were reported by ES&S.



VSTOP's Conclusions

To work toward the conclusion of this preliminary report, we offer two areas within this section. The first section consists of facts generated from this investigation. The second section is an overall assessment of the problem and solutions which is offered prior to moving into VSTOP's recommendations.

Statements of Fact

From this inquiry, there are several statements of fact which can be proffered. These include:

1. The ES&S *ExpressPoll EZRoster 3.2.2.1* did not meet performance expectations at vote centers in Johnson County, Indiana on Election Day, November 6, 2018.
2. The *ExpressPoll EZ Roster 3.2.2.1* performance issues resulted in longer than expected wait times for voters.
3. ES&S made a business decision to move from Amazon Web Service (AWS) to Microsoft Azure but did not notify the State of Indiana or VSTOP.
4. ES&S offered Johnson County a work-around to allow voters to be checked in at the vote centers. However, this work-around resulted in electronic poll books not being able to communicate between vote centers in Johnson County. This solution was not in compliance with the Indiana Election Code.
5. ES&S has stated that the Microsoft Azure Web Application Firewall (WAF), which is part of the Application Gateway, is the key reason for the performance issues on Election Day.
6. It was learned that ES&S only contracted with Microsoft Azure for 7 WAF instances on Election Day which resulted in performance issues. ES&S claimed that this decision was based on load testing, perceived computing needs and "cost."
7. ES&S misjudged server needs and the impact of WAF instances for Election Day. Pre-election load tests conducted by ES&S did not adequately predict Election Day server needs. The logs for the load tests prior to the primary were not retained. Moreover, diagnostic logs were not retained by Microsoft or by ES&S for the General Election.
8. ES&S admitted, in retrospect, that 7 WAF instances was not sufficient for Election Day.



9. ES&S did not utilize autoscaling for WAF instances on Election Day. However, ES&S did utilize zone redundancy.³
10. ES&S maintains that it has already scaled up with Microsoft Azure to 100 WAF instances from 7. There is no evidence at this time to suggest that scaling up WAF instances will resolve future problems. ES&S maintains that there is no established timeline for an alternative solution at this time. ES&S stated that they will follow the configuration setup recommended by Microsoft in the future.
11. Johnson County, Indiana was not the only jurisdiction during Election Day on November 6, 2018 to experience slow ES&S electronic poll book performance since it affected all ES&S clients to some degree.
12. VSTOP became aware of certain issues during the Primary and General elections in Johnson, Brown and Porter Counties for which VSTOP has no record that ES&S submitted anomaly reports.

Overall Assessment

From the information and evidence provided, VSTOP offers a few remarks regarding the problems experienced by Johnson County, Indiana on Election Day, November 6, 2018.

The problems which occurred in Johnson County was a source of negative publicity for the County. In addition to embarrassment, the more important impact was on voters who did not understand what was occurring and this likely created voter anxiety, impacted confidence in the electoral process, and probably discouraged voters from continuing to wait to cast a ballot. The work around offered on Election Day was not in compliance with the Indiana Election Code.

The situation which occurred in Johnson is unacceptable for any Indiana electronic poll book vendor. The responsibility for what occurred rests on the shoulders of ES&S, because they opted for a limited WAF instance configuration with Microsoft Azure after switching from Amazon Web Services. The premise that their pre-election load testing adequately predicted election day needs is difficult to accept. Even though the test scenarios run by ES&S indicated that the pre-election configuration was adequate, vendors should know that actual Election Day needs cannot always be adequately predicted. This point is punctuated by the fact that several other jurisdictions in the country were using the same server space. The fact that ES&S has already scaled up to 100 WAF instances from 7 demonstrates this realization. Additionally, we wonder if ES&S had triggers in place to warn when capacity constraints of the available instances were

³ A resource can span multiple Availability Zones, removing the need to provision and spin separate Application Gateway instances in each zone with a Traffic Manager.

<https://docs.microsoft.com/en-us/azure/application-gateway/application-gateway-autoscaling-zone-redundant>



approached.

The question remains if ES&S is willing to attempt to make the needed changes in its processes to avoid similar problems. To adequately protect the County, a robust risk management system is needed. The following assessment is offered by Mr. Stephen Berger of TEM Consulting and more detail can be found in his full report in Appendix M. Changes in at least the following areas are needed if an experience like the 2018 Midterm Election is to be avoided:

- System Planning
- Verification Testing
- Support System
- Diagnostic Tools and Records
- Risk Mitigation

In all of these areas, the following higher-level management questions must be asked:

- Are the personnel assigned adequately skilled and experienced?
- Have they been given the training and resources they need?
- Are they appropriately authorized and supervised to meet expectations?

It is VSTOP's assessment that ES&S misjudged the need for appropriate resources to serve Johnson County on Election Day 2018. While likely not the only reason, service costs with Microsoft Azure figured into ES&S resource decision making prior to Election Day 2018.

Recommendations

Recommendations to the State

On the basis of the investigation and this preliminary report, VSTOP offers the following recommendations to the Secretary of State.

Therefore, ES&S should:

1. Carefully review its internal quality control and testing processes to implement failsafe methods to prevent recurrence of the problems that occurred in Johnson county during the November 2018 election. Testing and simulation procedures should be reviewed to ensure that the load test results are closely aligned with the actual Election Day results.
2. Carefully evaluate its reliance on third party and cloud web services and explore alternative solutions.



3. Revise documentation production and retention processes and policies so such internal reports are available to the state and jurisdictions in case of future problems and investigations.
4. Revise and improve anomaly reporting processes so that anomalies and problems are reported to SOS and VSTOP within the legally required 48-hour period.
5. Be reminded that there is a requirement that all vendors submit modification requests when these are anticipated. A change in cloud services constitutes an infrastructure modification and warranted an ePB modification request to the State.
6. Review the process of communication with county customers so that counties have a high level of satisfaction with the support provided by ES&S. The vendor should have documentation of all assistance requests coming from a county client.
7. Thoroughly assess its pre-election and ongoing risk management and mitigation strategies to appropriately serve electronic poll book clients within the state of Indiana.
8. Comply with State and Federal guidelines concerning the twenty-two-month retention period for election related materials (e.g., logs, test results, etc.).

Recommendations to Johnson County

1. Should the County Election Board wish to stay with ES&S as a vendor, the vendor should be required to provide appropriate documentation of completed planning and load testing to mitigate the chance of similar future problems in Johnson County. Load testing results should be provided to the County well before the 2019 municipal Primary election period. VSTOP is willing to review and interpret this information for the County.
2. The Johnson County Election Board did not receive sufficient support and service from ES&S regarding the issues encountered on Election Day. The County has every right to be dissatisfied. Therefore, it is recommended that the Johnson County Election Board continue to expect, and require, appropriate levels of vendor service into the future regardless of vendor.
3. Future contracts for election equipment and/or election support services signed by Johnson County should include provisions for remedies (e.g., refund) in the event that equipment and/or support services are lacking and not to the County's satisfaction.
4. Johnson County should contractually require that the vendor provide table-top exercises which play out a number of scenarios and solutions for election day equipment-related crises. The scenarios should include failsafe options. The exercises should include county personnel involved in elections and involve an onsite ES&S team as well as a complementary system support team.



5. Johnson County reported that they had no training to address such an eventuality as that which occurred on Election Day. Therefore, the vendor should train county election personnel on how to effectively resolve such an issue or any other type of catastrophic failure. ES&S should provide its strategies for catastrophic failures and crisis management to Johnson County.
6. Unless already in place, it is recommended that Johnson County have its own election day checklist specific to the County and how elections are administered there. The checklist would be a living document and updated as needed in response to legal and technological changes as these occur.
7. The Johnson County Election Board should expect ES&S to provide a troubleshooting team to be present in the county during the spring 2019 Primary, the fall 2019 Municipal, the 2020 Primary and the 2020 fall General Election Day. Furthermore, this onsite team should be augmented by a complementary system support team.
8. VSTOP will be positioned to provide the Johnson County Election Board with information regarding future risk mitigation and problem prevention. The County should feel free to call on VSTOP as needed.

The Investigation Team

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

- Dr. Jay Bagga and Dr. Bryan Byers, VSTOP Co-Directors
- Ms. Jessica Martin, VSTOP Project Manager
- Mr. Mani Kilaru, VSTOP IT Specialist
- Mr. Adam Fox, VSTOP Student Worker
- Mr. Stephen Berger, Technical Consultant, TEM

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