**SPCB(2020)Paper 66**
**26 November 2020**

# REMOTE VOTING UPDATE

## Executive summary

1. In August 2020, the SPCB approved the introduction of the remote voting system which was developed in a challenging timeframe over the short summer recess period. This was in response to changes in how parliamentary business is being conducted due to the impact of Covid-19.

2. The purpose of this paper is to update the SPCB on progress since its launch and the commitment made to report back to the SPCB following some issues experienced and the actions taken to resolve those issues. The paper sets out the work completed so far, our response to the issues experienced and the ongoing work to improve the remote voting system.

3. This paper does not require any decisions and the SPCB is invited to note progress and the intended next steps.

## Background

4. The remote voting system was first used in week commencing 11 August 2020. The remote voting system allows Members to vote whether they are in the Chamber or working remotely, as long as they have a viable network connection and a suitable device.

5. The remote voting system has been designed to be as flexible as possible so that it can be used on any phone, tablet, laptop or PC, on WiFi, ethernet or 3G / 4G. For this reason, the authentication is rigorous, and the design of the system has been through comprehensive security controls including ratification of the high-level design by the National Cyber Security Centre (NCSC).

6. Prior to launching the remote voting system, rigorous testing was carried out on both the technical and end user experience of the system. BIT and Chamber Desk Business Team colleagues facilitated extensive testing exercises by SPS staff. This focused on replicating live parliamentary business and voting scenarios. Members, the SPCB and SPS Senior Leadership members were briefed and given demonstrations of the system.

7. The remote voting system is secure and producing reliable results that would withstand legal challenge. However, the identified solution has taken time to bed in and there have been a number of issues that have resulted in disruption to business and a perceived lack of confidence in the system.

8. During a Stage 3 vote at the end of August 2020, the performance of the system became slow and Members had to refresh the application on their

devices to ensure voting could continue. While the incident did not impact on the vote results, this issue added a twenty minute delay to the voting process and resulted in reduced confidence, for some, in the remote voting system.

9. In September the PIN for the current agenda was changed from the advertised PIN (human error). This resulted in Members accessing the Agenda under different PIN numbers. Several Members notified the Presiding Officer that they were unable to vote and lacked confidence that the vote result had been accurately captured. The Presiding Officer suspended business for 17 minutes to engage with parliamentary officials on what had happened. The Presiding Officer informed Members that in order to establish that the vote was carried out effectively and robustly, business on that one amendment would be taken the following day. This was to allow time to investigate what had happened on this vote and to provide a thorough debrief.

10. In response to the issues experienced in August, a major incident was declared. This process ensures a co-ordinated approach to investigating the root cause and recovery of a service as quickly as possible. It can also make recommendations for consideration to improve the service.

11. The major incident process established quickly the approach to investigate, resolve and recommend improvements to the system. It specified three distinct areas to be addressed: The Chamber Wi-Fi connectivity and performance; the remote voting system code; and the commissioning of an external review of the technical design and build of the system. The Major Incident Report and the External Review Report are included in the annexes.

**Outcomes of the major incident review**

12. The key findings of the review are summarised in the following paragraphs.

<u>Connectivity and performance of Wi-Fi in the Chamber</u>

13. An investigation was carried out into the Wi-Fi focused on the Chamber connectivity and performance. Following analysis of the Wi-Fi logs and reporting there was no conclusive evidence that the Wi-Fi in the Chamber contributed to the incident.

Next steps:

- Whilst no evidence to suggest issues were due to Wi-fi in the Chamber, the planned project to upgrade Wi-Fi in the Chamber has been prioritised and scheduled for completion before the end of December. This project will reduce the possibility that poorer WiFi signal in some areas of the Chamber may have impacted access to the service.
- As part of BIT's standard support and maintenance activities, we will continue to monitor performance of the WiFi network in the Chamber. building further data to help with troubleshooting.

Remote voting system (code)

14. The approach for reviewing the remote voting system code focused on both a technical review of the system's code and testing the system using different business scenarios.

15. In response to Members feedback, the investigation specifically focused on investigating and testing different business scenarios that could impact the connection, flow and volume of data between the system and the end device being accessed. This was quickly identified as a possible cause preventing the service from running as effectively as it was designed to.

16. A review of the system's code and supporting documentation for the tool that enables the system to exchange data to end devices, was also completed. This technical analysis exercise also covered inspecting the system logs and available metrics. This contributed to identifying that the root cause of the issue was the handling of data, in terms of volume, being exchanged between the system and end devices.

17. BIT prioritised the need to address how the data being exchanged between the system and the endpoint devices was being managed. Although processing functionality was not impacted, limits to the amount of data allowed at any one time were being triggered. For example, where a Stage 3 can have a significant volume of votes this means a higher volume of data needs to be exchanged with the clients.

18. The impact of this volume limit being triggered is that data may not be delivered or delayed to the client. This accounted for the system not refreshing properly or the screen appearing to freeze.

19. Development work to resolve this focused on improving the transportation of data packages, ensuring management of the data was optimised and avoiding causing the system to freeze and the need to refresh when that happened.

20. On 2 September 2020, a thorough test of the changes put in place to address data exchange issues was successfully carried out. This involved over 120 SPS staff recreating a Stage 3 debate, with staff taking part both in the Chamber and remotely. Wi-Fi was also monitored during this period by BIT.

21. It is recognised and has been captured for any future development that whilst the system underwent a range of testing that included management of data for Stage 3 of a Bill, more emphasis will be put on testing performance, packaging and processing significant volumes of data.

Next steps:

- To increase our testing capabilities, improvements are being made to our overall test environment and procedures. This environment will be a

clone of the production environment and will enable greater testing functionality and result in increased capacity for testing.
- To continue to monitor performance and behaviours of the system and end users (Members and SPS staff – Business Team).
- To continuing to provide Members support for hybrid and remote working.
- To continue ongoing planned maintenance and support for the system.

External review

22. In early September a review of the remote voting system by external experts was commissioned. The remit was to carry out a post implementation review and deliver a report on how fit for purpose the new system is. The scope included investigation into the performance issues experienced and an analysis of the business, data, application and technology architecture. Recommendations for opportunities to further enhance the system were also included. The following provides further information on what has been reviewed:

- Business architecture – vote capture, user experience and business constraints.
- Data architecture – data storage, access and taxonomy.
- Application architecture – including system logic, integrations and development process implementation.
- Technology architecture – core components, throughput capacity and strategic benefits.

23. The External Review gathered evidence from direct observation of Chamber proceedings, an audit of documentation relevant to the technical design and build, and engagement with the system's development and delivery team. In addition, a statistical review was carried out of the data from votes, captured from the system's records, voting logs and an architectural review to check for potential false negatives e.g. multiple votes by the same Member. The report also recognised the changes that had been made to the system since its launch in response to the issues experienced and end user feedback.

24. The External Review has concluded that following extensive review of different features of the system, the general observation is that the system, both technically and from an end user experience context, does align with expected behaviours for web based systems.

25. Recommendations have been made to address opportunities for future development to enhance the system. The main themes captured focus on opportunities to enhance service monitoring and reporting functions. This would further support our understanding of the service status on the systems use, and performance and the monitoring of the system, and early diagnosis of potential issues with the system.

26. BIT have carried out a review of the recommendations and categorised them into any immediate actions or future actions as appropriate. This is in recognition that further development will require approval and resources. Also, in recognition that the system is generally functioning well as a result of the immediate fixes and improvements already delivered.

Next steps:

- To continue to manage and improve the overall service by managing and delivering the development backlog for continuous improvement for the remote voting system. The following are the next prioritised developments:

    - Inclusion of a confirmation message on the last vote cast to give confidence to members that their vote has been cast– planned December 2020
    - Introduce Failover for business continuity – planned December 2020
    - Additional client side logging to improve troubleshooting – planned December 2020
    - Improve reporting from audit logs – in planning stage
    - Improve dashboards for Business Team – in planning stage

- This will also be included in the scope of future intentions regarding sound and voting improvements in the Chamber. This is the responsibility of the service delivery team (BIT and Chamber Desk Business Team.
- To continue ongoing monitoring, analysis and engagement with Members to proactively identify issues and resolve within defined constraints i.e. cost and development backlog.
- To continue to learn from, and engage with, expertise in relevant fields to seek further assurance as required. The current prioritised activities are:

    - BIT are currently engaging with Microsoft for the purposes of a targeted review of the code, system logging and implementation of the Microsoft tool that enables the exchange of data from the system to end devices.

    - In addition, BIT are reaching out to other organisations who have implemented similar technologies, with a view to identifying shared learning, experiences, problems, and resolutions.

**Resource Implications**

27. At this time resources are being managed within the BIT project team responsible for the digital voting application and the Chamber Desk Business Team.

28. The cost of developing the remote voting system is approximately £81k (as at end of October 2020) with a forecast outturn of £89k on completion of planned development. Any demand for additional resources will follow the established governance route for approval, prioritisation and resourcing via the Digital Strategy Board.

**Governance issues**

29. Governance and management of risks currently fall under the agreed responsibility of the Project's agreed governance. This is managed within the Digital Strategy portfolio of programmes and projects.

30. The service delivery team (BIT and Chamber Desk Business Team ) have responsibility for managing this service and for any improvements with the overall service. This includes managing the development backlog either to be actioned or still to be prioritised. This service team report into Group Heads and senior leadership across BIT and Chamber Desk Business Team.

**Publication Scheme**

31. This paper can be published in line with the SPCB's Publication Scheme.

**Decision**

32. The SPCB are invited to note the progress to date and recommended next steps

BIT Office
November 2020

**Annex A**

The Scottish Parliament
Pàrlamaid na h-Alba

# Business IT Office

## Major Incident Report

## Issues experienced with the Digital Voting application 26 August 2020

**Report Author: Andrew MacGregor**

**Report Date: September 2020**

## Incident Team

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| Phil Bassett | Technical Architect | Business IT |
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Note: All BIT Managers involved, and full incident team should receive a copy of the final report. Monthly standing item at BIT Managers Meeting to review major incidents and ensure oversight of actions.

A copy of the BIT Major Incident Process can be found here

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## Executive Summary

1. The Digital Voting application was developed over the shortened summer recess in 2020, in response to changes to how parliamentary business is conducted due to the impact of Covid-19. Digital Voting allows Members to vote, whether or not they are in the Chamber, as long as they have a viable network connection and a suitable device.

2. At the first Stage 3 vote using Digital Voting, the application did not perform as expected, resulting in several Members having to refresh the application. Due to the number of Members impacted, voting was suspended for a period of approximately 20 minutes. This resulted in dissatisfaction being expressed by Members and a consequent lack of confidence in the application.

3. The investigation focused on several potential causes; WiFi in the Chamber, the application itself and the way in which the application was being used by Members.

## The Facts of the Incident

Incident: 26 August 2020

4. During a Stage 3 vote, the performance of the Digital Voting application became slow, resulting in the need for Members to refresh the application to ensure voting could continue. This resulted in a delay to parliamentary business.

5. While the Incident described above resulted in a major incident, there have been several issues with the Digital Voting application since then and the investigation and resolution of these have been incorporated into this report for full transparency.

6. In addition to the impact on Members, this incident also impacted the Business Team who have responsibility for the running of votes within the Chamber.

7. While this incident has been declared as closed, there are follow on actions to be delivered.

Incident: 08 September 2020

8. The PIN for the current agenda was changed from the advertised PIN. This resulted in Members accessing the Agenda under different PIN numbers. This led to several Members reporting they were unable to vote or lacked confidence that the overall vote result for one amendment was accurate.

## Business Impact

Incident: 26 August 2020

9. During a Stage 3 vote the Digital Voting application became unstable. This manifested itself for users in the following ways:

    - the vote did not appear on the device.
    - the vote would not clear after the vote closed.

10. It was necessary to suspend parliamentary business in order to reset devices via a refresh of the web browsers. This suspension lasted approximately 20 minutes and consequently introduced delays in business.

11. While the incident did not impact on the vote results, this added considerable time to the voting process and resulted in reduced confidence in the application.

Incident: 08 September 2020

12. Several Members notified the Presiding Officer that they were unable to vote or lacked confidence that the vote result had accurately been captured regarding motion S5M-22635.3. The Presiding Officer suspended business for 17 minutes to establish with parliamentary officials what had happened. The Presiding Officer informed Members that a thorough debrief was required to establish that the vote was carried out effectively and robustly. He ruled that the result on the amendment was outstanding and business on that vote would resume the following day.

## Root Cause

Incident 26 August 2020

13. Immediate investigation into the incident suggested that the probable root cause of the incident could have resided within the Digital Voting application code base. The packaging of messages to be sent via the messaging service, 'SignalR', had not been fully optimized.

14. This, in essence, resulted in a bottleneck within the application, causing messages to be delayed. There were also messages being lost/dropped, due to thresholds on SignalR being reached.

Incident 08 September 2020

15. Investigation revealed that the PIN was changed during the registration period. This had not been a tested scenario so staff were unsure of the impact of this change.

## Response

Incident 27 August 2020

16. The major incident process was raised, and a response team was mobalised within Business IT. The team were responsible for undertaking an investigation and identifying remedial actions to address the incident. The team reported into the BIT senior leadership team.

17. It was agreed that the root cause still needed to be confirmed following an initial run through of what happened. A multi-faceted approach was identified as the best way to identify the issues within as short a period as possible. The approach consisted of three distinct areas of investigation: Chamber WiFi, Digital Voting application code and external review of our approach. The summary of findings are:

**Wi-Fi response**

18. An investigation was carried out into the Wi-Fi cover in the Chamber. This focused on connectivity and performance.

19. Following investigation into the Wi-Fi logs there was no conclusive evidence that the Wi-Fi in the Chamber contributed to the incident.

**Digital Voting application (code)**

Incident 26 August 2020

20. The Digital Voting application operates within an 'Azure' cloud and is dependent upon 'SignalR', an open source software library for the Microsoft ASP.NET application development framework. 'SignalR' is used for messaging between client devices and the application on the server. This can run in the cloud as a service or embed the code directly. Using the service supports faster and higher scalability. The volume setting for SignalR Service is a unit value expressed from 1-100 and equates to the number of messages that are issued within a given time-frame.

21. As a result of the incident, a test environment was built with the purpose of recreating the incident observed by Members. One feature of the test environment was the ability to flood the application with high volumes of data. From testing it became apparent that some form of volume limit was being hit on processing of those messages when a simulated flood of activity i.e. multiple tens of thousands of messages were being sent.

22. Further testing using both the SignalR service and embedded code was carried out. The results were that only the SignalR Service encountered

these volume limits whilst the embedded code did not. This pointed to a behaviour in the SignalR Service that was responsible for the volume limits being hit.

23. The impact of this volume limit is that messages get delayed or lost and not delivered to the client side of the app. This accounts for behaviour when the app does not refresh or the screen freezes.

24. Further investigation confirmed the root cause was limit in data size being hit by the SignalR Service. When using SignalR code embedded in the application, all messages were sent/received as-is. They were not changed or adapted. When using SignalR Service, all messages were NOT sent/received as-is. Instead the SignalR Service broke the messages down into smaller sections and delivered them sequentially.

25. This behaviour did not affect the functionality of the processing however it did significantly incrementally increase the volume of messages and hence hit the limits within the processing engine.

26. This impact becomes more apparent as the original size of the message increases. During the Stage 3 incident we moved to Agendas that contains 50-60 votes on them. When these messages were distributed, which they were extensively in the application, these had to be broken down to the 2k limit and dramatically increased the message count. This differed from the previous two weeks, when the agenda size was much smaller, so the effect went unseen. Combined with volume setting being aligned at one (1) unit - this caused the limit to be hit this week.

27. Development work focused on the transportation of data packages within the application and in particular the optimisation of these packages. By reducing the size of the packages to below the SignalR limit of 2K, the packages no longer required to be broken down. This optimised the transfer of the data within the application.

<u>02 September 2020</u>

28. A large-scale test of the application was arranged to ensure that the fixes in place were effective in removing the identified issue and to confirm that the application was working again.

29. BIT and the Business Team facilitated a successful test with support from over 120 SPS staff participating either in the Chamber or remotely. This replicated parliamentary business of Stage 3 voting scenarios.

30. Wi-Fi was also monitored during this period by the Server Network Support team.

Incident 08 August 2020

31. This was traced to the incorrect positioning of the PIN change link which made it easy to accidently click on the link. Repositioning of the link would resolve this issue.

**External Review**

September 2020

32. A review of the remote voting system by external experts was commissioned. The remit was to carry out a post implementation review and deliver a report on how fit for purpose the new system is. The scope included investigation into the performance issues experienced and an analysis of the business, data, application and technology architecture. Recommendations for opportunities to further enhance the system were also included. The following provides further information on what has been reviewed:

    - Business architecture: vote capture, user experience and business constraints.
    - Data architecture: data storage, access and taxonomy.
    - Application architecture: including system logic, integrations and development processes implementation.
    - Technology architecture: core components, throughput capacity and strategic benefits.

33. The External Review gathered evidence from direct observation of Chamber proceedings, an audit of documentation relevant to the technical design and build, and engagement with the system's delivery team. In addition, a statistical review was carried out of the data from votes, captured from the system's records, voting logs and an architectural review to check for potential false negatives e.g. multiple votes by the same Member.

34. The External Review has concluded that following extensive review of different aspects of the system the general observation is that the system, both technically and from an end user experience context, does align with expected behaviours for web based systems. However, the report does recognise that technical changes were made to the system prior to the review (SignalR changes made by development team).

35. Recommendations have been made to address opportunities for future development to enhance the system. BIT have carried out a review of the recommendations and this will be submitted to the Group Head and BIT leadership team for approval.

## Lessons Learned

36. This issue would have been detected through the application of stress testing of the application during development and testing. While the application underwent a range of testing there was not enough emphasis put on the applications performance when high numbers of votes were being processed.

## Residual Risks and Issues

37. It is intended that as part of BIT standard project management, the project risk log will be assessed as part of project closure activities. Any outstanding risks and mitigating actions that may impact live service and any future development will be escalated to the PMO (BIT Resource and Governance Team).

38. The PMO will ensure that a record of this is captured as part of the usual standard process and supporting documentation. A decision will be made on any that need to be escalated depending on the nature, impact and urgency of the risk. Risks required to be added to the BIT RAID log will be agreed and actioned under the BIT Management Team meeting.

## Action

39. The action plan for connectivity and performance of Wi-Fi in the Chamber is:

    1. Whilst no evidence to suggest issues were due to Wi-fi in the Chamber, the planned project to upgrade Wi-Fi in the Chamber has been prioritised to be completed by the end of December 2020. This will reduce the possibility that poorer WiFi signal in some areas of the Chamber may have impacted access to the service. [**Owner: BIT**]
    2. As part of BIT's standard support and maintenance activities, continue to monitor performance of the system. This includes regular engagement with the Business Team colleagues. **[Owner: BIT Chamber Desk- Business Team]**

40. The action plan for the remote voting system is:

    3. To increase our testing capabilities, improvements are being made to our overall test environment and procedures. This environment will be a clone of the production environment and will enable greater testing functionality and result in increased capacity for testing. [**Owner: BIT**]

4. Continuing to provide Members support for hybrid working. **[Owner: Remote Voting system service team, BIT and Chamber Desk- Business Team]**
5. Continue to monitor performance and behaviours of the system and end users. **[Owner: Remote Voting system service team, BIT and Chamber Desk- Business Team]**
6. Ongoing planned maintenance and support for the system. [**Owner: BIT**]

41. The action plan for External Review

7. The service delivery team (Clerking and BIT offices) continue to manage and improve the overall service. This includes managing the development backlog of development either to be actioned or still to be prioritised. This will also be included in the scope of future intentions regarding sound and voting improvements in the Chamber. **[Owner: Remote Voting system service team, BIT and Chamber Desk- Business Team]**
8. Ongoing monitoring, analysis and engagement with Members to proactively identify issues and resolve within defined constraints i.e. cost and development backlog. **[Owner: Remote Voting system service team, BIT and Chamber Desk – Business Team]**
9. Continuing to learn from, and engage with, expertise in relevant fields (e.g. web apps) to seek further assurance as required. Prioritised engagement with Microsoft (planned for November 2020) [**Owner: BIT**]

Summary table of prioritised follow up actions up to end of December 2020

| Description | Status | Owner |
|---|---|---|
| Inclusion of a confirmation message on the last vote cast | Planned in December 2020 | BIT |
| Introduce Failover for business continuity | Planned in December 2020 | BIT |
| Additional client side logging to improve troubleshooting | Planned in December 2020 | BIT |
| Improvement to test environment and procedures | Ongoing | BIT |
| Improve reporting from audit logs | In planning stage | BIT |
| Improve dashboards for Business Team | In planning stage | BIT/Business Team |

| | | |
|---|---|---|
| Improvements to test environment and procedures | Planned in November | BIT |
| Wi-Fi upgrade in the Chamber | Planned to be completed by December 2020 | BIT |
| Engagement with external expertise: Microsoft – SignalR review of the code, system logging and implementation | Planned in November | BIT |

**BIT Incident Team**
**September 2020**

Annex B

# Digital Voting Post Implementation Review

## Digital Voting Service

## Scottish Parliament

Leidos Contract/Document Number: **327272**
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## Issue Record

The content of this document is wholly defined by the issue. The first published version is Revision 1. Draft documents are issued as, (e.g. 1.1, 1.2, etc., with a full version published as the next complete number, e.g. 2.0.) The document will be reproduced in its entirety when any change has been incorporated and approved.

| Revision | Incorporated By | Revision Date | Comments |
|---|---|---|---|
| 1 | Ben Lewis | 22 September 2020 | Original Issue |
| 1.1 | Ben Lewis | 25 September 2020 | Second edit |
| 1.2 | Roy Phillips | 16 October 2020 | Updated customer naming |

## Authorisation Notification

Authorisation applies to the current version of this document only.

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## Hold Table

This table contains details that are not available at this time but will be added in future revisions of the document.

| Hold No | Section | Description | Responsible |
|---|---|---|---|
| N/a | | | |

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# Figure(s)



# Table(s)

No table of figures entries found.

# 1 Management Summary

Following the recent creation and deployment of the new Scottish Parliament Digital Voting Service (DVS), a request was made to Leidos to assist in a post implementation review. This review was driven by investigations into recent performance issues, a desire for a post implementation analysis and recommendations for improvement opportunities.

Initial investigations from the major incident - 649636, relating to the performance of the DVS in the chamber, identified a number of application changes as part of a package of efforts to improve end-to-end user experience. After an intense period of review of the many different aspects of the DVS, the general observation is that the application is now performing well, however there is opportunity to improve the service monitoring and reporting functions which can support the team with Service and Customer feedback. This will provide important Management Information on service status for added confidence in application use and performance, and equally information and data for support teams to improve service monitoring, and diagnosis of any future issues.

The review has gathered evidence from direct observation by witnessing chamber proceedings, soft audit of the supplied documents and discussions with the delivery teams. We observed the number of MSPs having issues during a vote, a statistical performance review of data from actual votes via time stamps in voting logs and an architectural review to check for potential false positives i.e. multiple votes by the same MSP.
Questions around specific supporting infrastructure limitations, including Wi-Fi, are currently unanswered due to an inability of the Service to corroborate MSP session details with connectivity logging data. As a result, further advice and guidance for future connectivity monitoring is included in this report.

It is important to note the limitations in time and scope of this review, and therefore this report to directly or indirectly witness MSP experience for more complex voting scenarios, especially as new changes have been implemented since the last complex vote rendering past data and experiences a less reliable set of inputs.

One future recommendation would be to witness a longer chamber voting session(s) where there are multiple voting amendments made in the agenda.

The report takes the form of a review of the DVS business, data, application and technology architecture with relevant observations and recommendations recorded.
Finally, specific questions raised by the application solution architect are answered later on in this report.

# 2 Introduction

Leidos and the Scottish Parliament agreed a short notice, short-term review of the Scottish Parliament DVS. The motivation for this review is to address the concerns around the service for the MSP community as well as an interest in external service quality assurance, roadmap verification and service improvement suggestions.
There have been some ‘early life’ issues which are being remediated through code upgrades as well as some reinforcement in infrastructure, both of which are being addressed and are out of scope for this review. This review was undertaken through an on-site visit conducted by a Leidos ‘external to account’ Senior Solution Architect with the aim of providing impartial guidance to the Scottish Parliament Service team.

# 3 Scope of the Review

The scope was to review the Scottish Parliament DVS to provide a rounded set of observations and recommendations for solution improvements and developments. Included in the scope of discussions were:

- ► Business architecture – vote capture, user experience and business constraints;
- ► Data architecture – data storage, access and taxonomy;
- ► Application architecture – including system logic, integrations and DevOps implementation;
- ► Technology architecture – core components, throughput capacity and strategic benefits.

For each area, there were discussions with specific SMEs or team leads and in some cases analysis of data, review of underpinning documentation (architecture specification) and recognition of provided or witnessed user experiences.

# 4 Business Architecture

The DVS has a number of requirements generated by the lead Business Analyst for the Scottish Parliament; these are currently stored in JIRA and used as the basis for development tasks.
Business Architecture extends to the processes involved with running the Agenda and the interactions with MSPs and the Presiding Officer.

## 4.1 Observation

For the most part the requirements try to follow the historical chamber voting procedures with some allowance made for new 'Digital' ways of working such as remote members and session attendance rules managed through an agenda PIN.

# 5 Process Interactions

## 5.1 PIN

For the vast majority of MSPs the application consistently delivers a functional and performant experience. Whilst PIN registration is a new layer of authentication required for session monitoring, as opposed to MSP authentication, the need for it is clear and, bar early day confusion over late entry for attendants and testing roles, it works well with little need for further remediation.

## 5.2 Location

Setting of the location as part of the voting registration is useful for analytical and historical purposes. The ability to register voting location is elective and lacks any validation due to client limitations and general policy constraints.
The opportunity to change this would require MSPs to authorise their browser to access location settings which represents some cross platform challenges such as those that do not have positioning functionality within them.
Any changes here would require a wholesale platform rethink with difficult end Customer conversations and little benefit.

## 5.3 Voting

The voting function works as designed but represents some issues due to the nuanced approach of the political apparatus. The options effectively available to MSPs, are - **Yes / No / Abstain / Not vote (not vote being an MSP action rather than an option within the DVS).** This represents a particular challenge for the developers and service management team as there is uncertainty over MSP intent.

Whilst an affirmation of ‘yes’, ‘no’ or ‘abstain’ shows a deliberate interaction, the acceptance of ‘not voting’ as a formal act means that application managers can never be sure of voters’ experience. For end-to-end assurance to the Scottish Parliament, that the service is available at ‘point of need’, the service manager needs to be able to recognise the number of people who are intending to vote and reconcile MSPs actual responses against it. Without this critical information, it is impossible to completely provide service assurance to senior stakeholders.

# 6 User Experience

Having had a real-time system in the past with a physically connected voting system, the digital voting service technology capabilities and design should be considerate of previous user experiences.
As a point of principle, it is important to recognise the ‘near real-time’ constraints and ensure design equivalence is in place. This has partially been met with on screen messaging during voting, however there is scope for additional messaging for the Presiding Officer and MSPs where lack of haptic feedback can be replaced via ‘digital assurance’ through the voting lifecycle.

## 6.1 Recommendation

Introduce additional conformational or status messaging such as ‘last vote cast’, as there was some concern from MSPs that votes had not been registered during the course of the sitting.
Provide statistical data pre, during and post vote for chamber members and Presiding Officer. This may extend to a dashboard showing:

- MSPs logged in by party or location;
- Expected attendance vs actual attendance;
- System health check status preventing the need for testing other than member confidence;
- Average response time.

Much of the reporting and statistical information required for business assurance can be shown on dashboards within PowerBI.
Work with Party ‘Business managers’ to agree a process on which to build an ‘intention to vote’ log to positively correlate received votes against.

# 7 Data Architecture

The DVS data architecture identifies voting outcomes using ‘last vote’ recorded in the Vote table.
Some data is ‘pulled’ from the ‘Common Services’ table held on parliamentary systems which is periodically refreshed. Other datasets include Agenda, Exclusion list and logging tables that manage voting controls, participation and history, as shown in Figure 1 below.

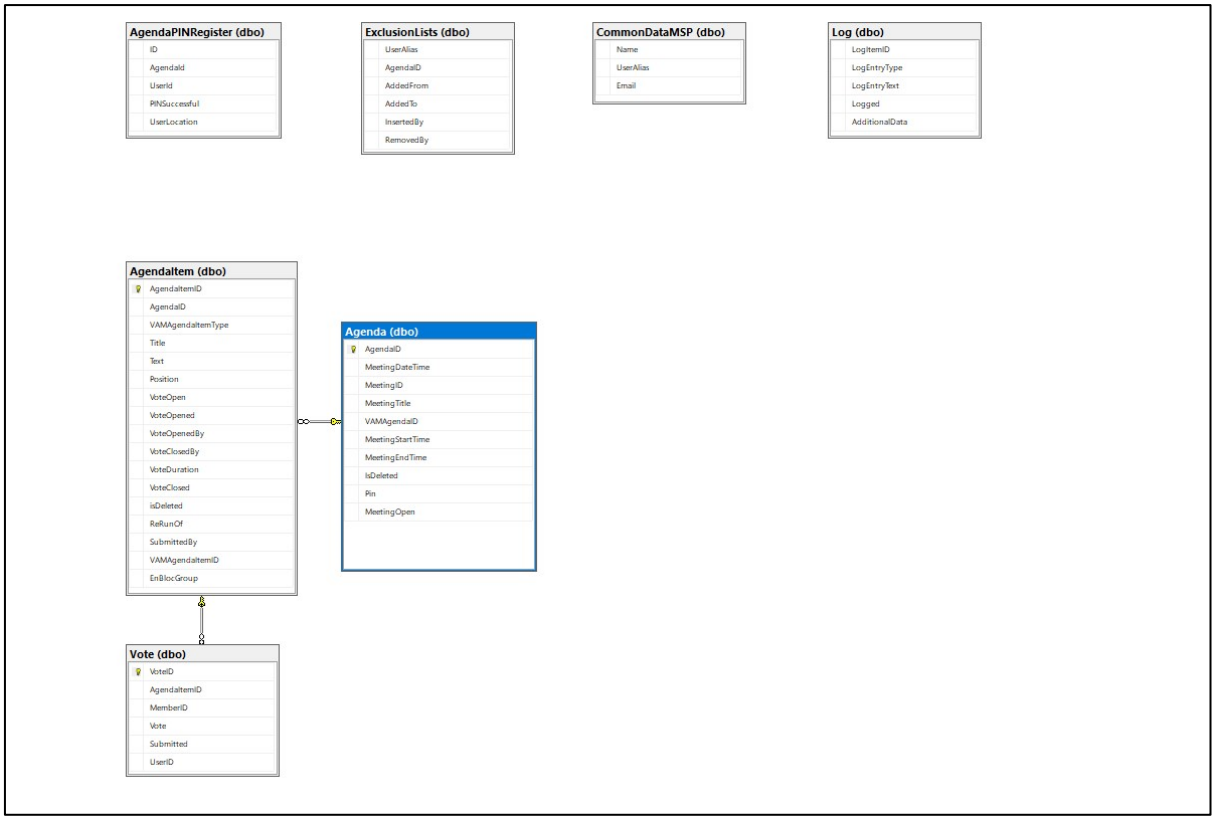


*Figure 1 – Datasets*

## 7.1 Observation

The data architecture appears 'fit for purpose' with strength through a relatively simple structure. During the course of the review, there were some specific discussions around data provenance; in particular, use of dual devices to record votes. This may create additional issues around vote 'race' conditions if the MSP tries to record votes on more than one device. In this race condition example, a device which has a slower connection may be overwritten by a device that has a faster one. An example of this would be an MSP recording a vote on a laptop over LAN and then changing their mind on a separate 3G connected device. In this scenario, there is a potential for the laptop vote reaching the service AFTER the 3G device and recording the wrong vote.

There is already some effort underway to create some indicators to enable greater levels of separation for testing purposes to introduce some session attributes enabling a replication of the end user experience.

## 7.2 Recommendation

If there were a desire to make the architecture more resilient, then a minimal impact / cost response would be to replicate the database to an alternate zone with a lower performance configuration. The performance of the secondary DB would be increased through run books or physical change to settings in the event of failover. If there's an intent to provide some reporting, then it would be best served with a separate statistics database to reduce any capacity issues on the primary one. This approach can also lesson a security burden, by only exposing data through a single directional gateway. This would assist in statutory reporting.

There has been some discussion as part of the wider challenges to look at 'stored voting' to assist in circumstances when connectivity is less stable for remote users. Whilst this is contingent on voting policy, it would require some additional architecture to support MSP voting intent on either local devices or secondary tables.

This would shift some of the governance needed for data management from server to end client side. It is worth spending a little time reviewing the constraints and potential approaches for that scenario.

# 8 Application Architecture

The core application (VoteHub) is a cloud based asp.Net solution hosted in Azure using Signal R web services to deliver dynamic forms to MSP devices.
There are a number of functions sitting alongside the application, including DB for storage, tables for ETL services, security services, Public gateway, etc. The application has been developed using some Azure DevOps components.

## 8.1 Observation

The application has a low number of moving parts once the MSP has authenticated via AD and accessed the service.
This means that there is little lag in the application itself with most votes being recorded (written to database) within a short window of <5s. There were some scenarios discussed for potential issues such as vote validation, time syncing and multi-device challenges. Time syncing is an example of an area of concern as it could introduce a scenario whereby an MSP has less access due to client-managed timers allowing vote responses after the voting window has closed. Whilst this race condition is a risk, there is no evidence to show it has occurred. Figure 2 below shows timings of votes recorded to the database.

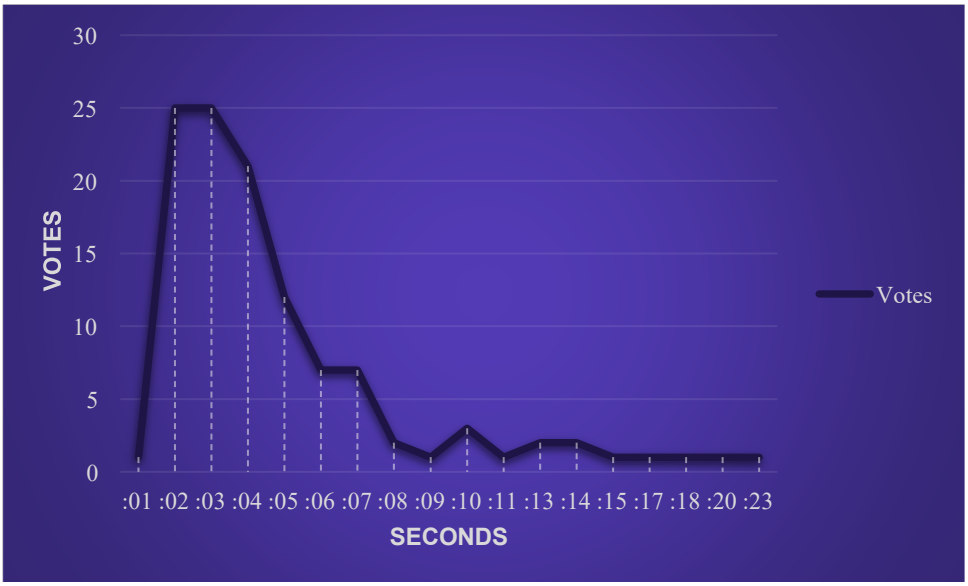


*Figure 2 – Voting database time stamp*

## 8.2 Recommendation

Scaling the application is not an issue due to the configuration options available in Azure, however performance within the application needs to be monitored and published in order to provide assurance that resource is managed in line with desired levels of performance. This should extend to all areas of the application.
Resilience is a key concern born from issues experienced from an unusual Microsoft Azure regional issue (9/14 RCA - Connectivity Issues - UK South (Tracking ID CSDC-3Z8)), however the frequency of similar events is low and duplicate infrastructure would be costly. It would be worth investing in reserved multi-instance CI/CD pipeline capability, which would redeploy the environment in an alternate zone. Whilst this approach may appear slightly protracted, it would benefit Scottish Parliament by improving the organisation's Agile practice 'pipeline development' capability and general application resilience experience. A suggested approach could include:

- Failover to secondary zone through URL configuration;
- Auto build 2nd zone on connectivity failure;
- Low interval, replicated snapshot DB.

Logging at the application level is relatively comprehensive but could benefit from client end console monitoring. This would require some toggling of device log settings for sympathetic MSPs and a dedicated set of functions to initiate the request.
Application synthetic transactions running pre, during and post voting is recommended in order to provide some statistical and functional assurance to the delivery team that end-to-end services have been benchmarked and are running as intended. Products such SOAP UI, Robot Framework, Selenium and Test studio can all run multiplatform testing. It would be beneficial to have a standalone service invoke this continuously from within the chamber.

Create a separate statistical 'stat' server for running performance queries and dashboard integration.

Consider a review of the DVS against 'Microsoft Azure Well-architected Framework'. This may have been in scope for the 'code review', but given the extent of the framework, it may work better log as an independent action. The scope of a 'Well-architected Framework' review would include:

- Cost optimisation;
- Operational excellence;
- Performance efficiency;
- Reliability;
- Security.

# 9 Technology Architecture

The core part of the application resides in Azure on the latest commodity cloud resources. The service is dependent on internetwork connectivity both inside and outside the chamber and can take a variety of routes for connection. These include:

- Public network – Voting App;
- LAN – Public network – Voting App;
- VPN – Public network – Voting App;
- VPN – LAN – Public network – Voting App.

As the service is web based any number of devices can provide connection to the web service. The MSPs tend to connect via a mobile phone and occasionally a desktop browser.

## 9.1 Observation

One of the major challenges is no simple set of reporting that provides an end-to-end view of connectivity performance metrics. This means that any drop in performance or user experience is subject to a scatter gram approach to root cause analysis. As discussed in application architecture there should be some effort made to understand end-user experience traversing the infrastructure.

## 9.2 Recommendation

Extend to end-point devices in the Chamber to undertake routine performance analysis. Included in this could be PTRG windows based monitoring devices reporting to the event management suite to give:

- URL performance / responsiveness;
- Wi-Fi / LAN performance;
- UI performance (local browser dependent i.e. Chrome, Explorer, Edge).

Use end point agent collection logging tools such as Wireshark to capture detailed data around the Digital Voting experience
Undertake some network segregation and apply QoS rules for routing to the application via the application URL.
Consider device connectivity rules to reduce application operation burden for session management, certificates or single sign on activities.

# 10 Specific application architect questions

The following is an extract from questions raised by the application architect overseeing the service from a development standpoint. Much of this has been addressed above, the following is for specific assurance: **1 – Platform Architecture/Configuration** Scaling:

- Currently only 1 scale unit on application service based on assessed need, and subsequent observations;
- SignalR service set to scale to whatever we need - currently ramped up to 20 units, but likely will go back to 5, with a view to scheduling automated scale in/out in-line with service window;

*A: Service performance is more than capable of meeting DVS vote registration requirements. Changes to the code to simplify message payload has reduced the need for concurrent content distribution.*

Resilience:

- Microsoft SLAs aligned with NFRs (see spec) - deemed acceptable for now. The solution is deployed to single region at this point. The timescales ruled out anything beyond this, but is there anything else we might consider in the short term to achieve a higher level of resilience on the platform itself?

*A: Multi-region provisioning may be considered in the longer term, in the meantime the next most critical realtime components are the AD integration and voting database.*

*- AD (plus connectivity) is reasonably resilient however a federated local-to-application instance may help.*

*- The database is only at risk of corruption which could be mitigated with periodical snapshots and validation of the restore process.*

Recovery:

- The recovery plan for the application is yet to be defined, but we currently have:
  - Build pipeline for application service component;
  - SQL database project under source control;
  - No platform configuration under source control at this point, but we are looking at:
    - Backup of application service within azure;
    - Reverse engineering platform configuration to ARM templates (or similar) ;
      - Defining process (automated or manual) to rebuild based on the above.

*A: Recovery options through a multi-zone CI/CD capability have been discussed above utilising an activeactive database. The ability to document through configuration export is useful for rebuild analysis, although the preference would be to build through runbooks if possible.*

Monitoring & Logging:

- Application service errors logged in Azure Application Insights;
- Custom logs (stored in database tables) to record user actions (e.g., open/close vote etc);
- Azure log analytics for all gateway traffic and firewall rule alerts;
- Metrics on individual components (application service, database, SignalR service) to evaluate performance;
- Implementing alerts on all of the above logging.

*A: A brief review of the application's dashboard and performance metrics used in determining original code issues would be recommended. It would be useful to have event management configured for it, but this would need to be on areas such as; session counts, and processing performance. A stats log / server has been discussed in the main body of this document as well as the use of network monitors inside and outside the chamber.*

**2 – Use of SignalR**

Use of Azure SignalR Managed Service, as oppose to application-embedded SignalR.
The extent of our use of SignalR which is not only used to inform voting clients of an open vote but also used by the client to send a vote, and for some of the clerk functions.
Should we undertake a code review focussing on SignalR implementation including:

- Resilience, could we improve on our handling of some scenarios? e.g:
  - Loss of internet connectivity, recovery when connection becomes available;
  - Confirmation to/from both server/client on critical actions (e.g. sending a vote), is there anything we could improve on here?
- Are we efficiently managing SignalR connections when internet connection is lost/regained? e.g. could we do more to clear down redundant connections?
- Are we doing enough to failover e.g. to request/response model, should SignalR connectivity fail?
- Are we doing enough to avoid excessive signalR connections e.g. on page refresh, to avoid new connection(s) being created?
- Are we doing everything we can to authenticate and authorise incoming signalR messages?
- Would relying on an http post where a response code is part of the protocol, rather than SignalR message, be a more robust way of recording a vote?

*A: A code review and detailed analysis of Signal R was not undertaken as the end-to-end system observations seemed more pressing. Given the low cost of Signal R as a service and the recommended approach to treat it as a microservice outside of the code itself, there may be little value in redeveloping the approach. Challenges around persistent connections are probably dealt with through minor configuration changes such as shorter timeouts alongside some post voting analysis i.e. sessions consumed versus votes recorded. The voting database suggests that the session concurrency is working well.*

# 11 Summary

The current solution appears to be consistently performing to expectant levels for users in a range of locations, on multiple devices and with varied voting agendas. The application is cloud native by design with reasonable levels of resilience and scalability, relevant to the DVS. The overarching observation is that responding to user feedback and perception is particularly challenging without the appropriate performance related data. Whether the concern is connectivity, voting registration or general performance, the DVS support team would benefit from having MI data so that it can validate a known baseline against a perceived user experience. Examples of this have been covered in the report. Simple statistics for user performance are worth analysing for trends. In one report we were able to capture the response times for each voting MSP over the course of multiple sessions; our analysis suggests that remote users took longer to record their vote which may be due to the lag in voting announcements over Bluejeans.

Engaging with MSPs proactively using performance related data may aid Business Managers and improve service perception whilst providing some assistance in triaging future issues or changes. However, over investment in the development of the application itself is likely to have diminishing returns with little opportunity for improvement in end user experience.

## 11.1 Wider Review (follow-up to initial review)

A question was raised on a wider, more detailed review, some of which was briefly covered during this one. There is scope for further support in the development of the DVS configuration in areas such as; toolchain, pipeline and test cases.
In particular, there was interest in a review of solution architecture and the potential for any improvement. Leidos recommend reviewing the option to migrate other closely coupled applications such as Voting Application Manager (VAM).

In addition, we have provided various recommendations throughout this document and these should be revisited to understand them in more detail and progress with actual design and implementation plans.