THE CITY OF
CALGARY
CITY AUDITOR'S OFFICE

Virtual Desktop Information Technology

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Executive Summary

Virtual Desktop Infrastructure (VDI) is a technology that was recently introduced at The City, which shifts most tasks performed by a desktop computer to a server in the data center. The virtual desktop can then be accessed using a lower cost device known as a thin-client or a mobile device, such as an iPad. Apple's Siri is an example of shifting computer power, since voice commands given to iPhones are processed in a data center instead of by the phone. VDI benefits include supporting flexible working (Tomorrow's Workplace), mobile working, improved business continuity and cost savings.

Our audit objective was to determine if control processes exist to provide reasonable assurance that the VDI program will achieve the benefits described in IT's 2015 - 2018 budget submission. This assessment was performed using a just in time methodology to support the successful expansion of this technology.

VDI at The City, branded as myDesktop, was rolled out in three phases. First, IT quickly implemented this technology during the 2013 flood. This provided users that were unable to access their computer with a full desktop experience. The second phase, during 2014, involved operational upgrades on this technology and trials with business units. Operational upgrades focused on improved support and efficiency of the existing VDI infrastructure. Business units involved in trials were Transit peace officers, PDA inspectors and water emergency services. The third phase, which started at the beginning of 2015, will significantly expand the number of users this technology can support and will also implement the technology in IT's second offsite data center.

The results of our review noted an absence of effective controls to address two risk exposures, which may increase as the third phase of this project is completed. We have recommended mitigating controls as outlined in the table below:

Failing to Deliver Expected Benefits	Lack of System Availability
1. Total cost of ownership model 2. Defined benefits, measures and a plan for their achievement. 3. Stakeholder engagement and communication plans	1. Performance assessment and capacity plans. 2. Defined service levels 3. Documented configuration baseline

We believe it is important that these controls are implemented on a timely basis, since phase three of the project will significantly increase the risk associated with the technology due to the increased user base and expenditure on the technology. The risk associated with failing to deliver expected benefits includes fewer IT support cost savings, reduced business continuity and less flexible working, including the associated facility costs savings.

Management has agreed to the recommendations raised with plans to execute them before the end of the third phase.

1.0 Background

1.1 Explanation of the Technology and Benefits

Virtual Desktop Infrastructure (VDI) technology shift most computing tasks currently performed by a physical desktop computer to a virtual machine running on a physical server (host) in the data center. For example, applications, such as Microsoft Office, no longer reside on the physical desktop but instead are installed on the virtual machines in the data center. A single host would support many virtual machines. As much of the computing is now performed in the data center users do not need their traditional powerful desktop computer and instead can use a simpler device known as a thin-client. They can also access these VDI services using a tablet, such as an iPad. Apple's Siri is an example of shifting computer power, since voice commands given to iPhones are processed in a data center instead of by the phone. VDI within the City of Calgary is branded myDesktop.

> **What is a Virtual Machine?**
>
> A virtual machine (VM) is an operating system, such as Windows, installed on software that emulates a physical machine. This allows many VMs to a run on a single physical computer. More information can be found in the Virtual Server Security audit, issued Q1 2014. (AC2014-0162)

There are different options for virtual desktops (hosted, shared, pooled) and the choice of desktop impacts cost, level of customization and redundancy. The City will ultimately deploy a mixture of these types.

VDI is stated to provide:

1. Improved business continuity, since users are able to access a full desktop experience without requiring power to their building.
2. Supports flexible working, such as Tomorrows Workplace, as a user's desktop will follow them from device to device[1].
3. Cost savings reflecting the lower cost of thin-client and reduced IT support costs[2].
4. Reduced energy consumption.
5. Better security since data will only reside within the data center.
6. Improve support for mobile working due to the ability to reuse desktop applications on mobile devices and more reliable connections.

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[1] For example, a user could stop working on a document on their VDI in one location and log onto a VDI from a different device and continue where they left off.

[2] For example: (a) Issues can be resolved within the data center without the need to send a technician onsite. (b) A single pooled virtual desktop image is used by many users, avoiding the need to manually build and update multiple desktops.

1.2 Implementation of Virtual Desktop Infrastructure (VDI) at The City

The implementation of VDI technology occurs over three phases with the main rollout (phase 3) occurring in 2015. The three phases are:

1. Phase one was an emergency implementation during the 2013 flood. Consultants were brought in to provide a "turnkey" solution for approximately 1,000 users, which was implemented in two weeks. The purpose was to allow displaced employees to remotely access a full desktop experience due to the lack of power in downtown office buildings.

2. Phase two was undertaken in 2014 which involves making the phase one infrastructure more efficient and formalizing support arrangements. For example, it involved software upgrades and optimizing the types of virtual desktops in use.

3. Phase three is the main rollout. For this phase $2.9 million capital ($650,000 operating) was approved as part of Action Plan 2015 – 2018. It is expected to bring capacity to around 4,500 users and expand the infrastructure to our second data center providing redundancy in case of problems at one data center.

2.0 Audit Objectives, Scope and Approach

2.1 Audit Objective

To determine if control processes (policies, procedures and actions) are in place to provide reasonable assurance that the VDI program will achieve the benefits described in IT's 2015 – 2018 budget submission. Controls processes include measures to ensure benefits are realised, in addition to those related to the operation of the system.

2.2 Audit Scope

Review the control processes that were in place as at November 7, 2014 relevant to the VDI program.

2.3 Audit Approach

The audit timing was designed to provide management with information on the controls that should be in place before beginning phase three. We initiated the audit on October 15, 2014, and provided IT management an initial matrix of risk and controls on November 7, 2014. This was further revised based upon discussion with management and validation of existing controls.

COBIT 5 was the framework used to guide our audit approach. COBIT 5 is a framework for the governance and management of enterprise information technology. It provides a cascade from enterprise goals to the enabling processes (controls) that should be in place to support their achievement. We followed this cascade to identify controls, starting with five goals defined in the VDI projects 2015 – 2018 budget submission:

1. Improve staff productivity, customer and citizen service
2. Improve business continuity levels
3. Support a mobile workforce
4. Reduce energy consumption
5. Reduce support and sustainment costs with standardized equipment

COBIT was a significant input to a risk control assessment (Appendix 1) that was supplemented by interviews and the review of relevant documentation. These additional inputs were used to select controls based upon the risk and appropriateness of the control. Furthermore, we made the controls more specific to the nature of the VDI program.

3.0 Results

Although the focus of the audit was not on measuring the value provided by VDI, our informal interviews noted early results of the trials indicated high levels of user satisfaction. These trials were with PDA inspectors, transit peace officers and water emergency services. Also, IT rapidly rolled out this technology during the 2013 flood.

The main audit activity was developing a risk control assessment, which recognised as phase three of the VDI programme approaches risk associated with this technology will grow.   This reflects the larger user base and increased spending on VDI.

Key risk associated with the VDI programme falls into the categories of IT benefit enablement and availability. The first category is The City does not receive the expected benefits from its use of VDI, such as improved staff productivity. To mitigate these risks the following control processes, not currently in place, need to be established:

1. Total cost of ownership model.
2. Defined benefits, measures and a plan for their achievement.
3. Stakeholder engagement and communication plans.

Availability means that a system is reliable and responds to user requests in a timely manner. This has greater importance for VDI users, than regular desktop users, since they cannot perform any tasks when the system goes down. Furthermore, key business units such as 311 are considered potential VDI users. IT already has change management processes in place, which help ensure availability. However, the following control processes not currently in place need to be established:

4. Performance assessment and capacity plans.
5. Defined service levels.
6. Documented configuration baseline.

Upon receipt of the risk/control assessment IT readily acknowledged that, although planned, many of these controls were not fully in place. As a result, instead of following a traditional audit where controls were tested as in place and operating, we provided more advisory support in discussing appropriate controls that best addressed the needs of The City. These controls and the subsequent actions plans by management are documented under section 4.0, Observations and Recommendations.

4.0 Observations and Recommendations

Observations 4.1 to 4.3 focus on risks associated with benefit realization from the VDI investment. The remaining observations (4.4 – 4.5) focus on availability risks.

4.1 Total Cost of Ownership

Models for identifying, measuring and predicting costs associated with the virtual desktop environment were not in place. Establishing such a model is important for three reasons:

1. An expected benefit from virtual desktops is reduced support costs for standardized equipment. Without a model it will be unclear if these savings were realised, met or exceeded.
2. There are different types of virtual desktops (hosted shared, pooled and dedicated). Costs associated with dedicated desktops are expected to be the greatest and hosted the lowest. Understanding these costs will help optimize the deployment to ensure the greatest cost savings are realized.
3. IT charges back the cost of computing services to business units, ensuring responsible use of IT resources. Understanding services costs ensures these rates are set appropriately.

The lack of the complete model likely reflects the emergency implementation of the initial virtual desktop infrastructure during the 2013 flood.

Recommendation 1
IT should establish a model that identifies, measures and predicts total ownership costs for each virtual desktop type (hosted shared, pooled and dedicated) and traditional desktop environment. Furthermore, establish a schedule for reviewing the model to ensure it continues to reflect actual experience.

Management Response

Action Plan	Responsibility
Agree. IT will develop a total cost of ownership model for traditional desktops, as well as each type of Virtual Desktop Infrastructure (VDI). A process for reviewing Virtual Desktops will be established and cost models will be reviewed annually. The cost models will provide a framework for variables that will be determined in recommendation 6, specifically load testing capacity.	Lead: Manager IT Operations Commitment Date: May 31, 2015

4.2 Defined Benefits and Measures

Specific measurable benefits for the VDI programme were not defined and documented. Presently, benefits are defined in general terms such as "Improve business continuity levels", which cannot be easily measured. Without clear definition of benefits, and a plan to achieve them, the VDI initiative may fail to deliver its expected benefits. Also, it will be difficult to attribute benefits to this project compared with other initiatives.

This situation likely reflects the fact the initial Phase I implementation occurred as an emergency deployment during the 2013 flood. Furthermore, the recent phase II upgrades were operationally implemented without formal project governance.

Recommendation 2
IT should:

1. Involve key stakeholders to develop a detailed business case for the programme. This documents a complete understanding of the expected benefits, costs (recommendation 1) and how they will be measured.
2. Develop a benefits realisation plan that will be managed throughout the programme to ensure that planned benefits always have owners and are achieved, sustained and optimised. This plan will involve the creation of a benefits register to track benefits and a process for updating it throughout the implementation and rollout period.

Management Response

Action Plan	Responsibility
Agree. IT will develop a detailed business case to implement Virtual Desktop as a service offering. The business case will include detailed costs per recommendation 1, outline the benefits of using virtual desktops, and evaluate performance measurements. Benefits of the Virtual Desktop process will be documented in a repository, achieved, and reviewed annually by the owners of the assigned benefits.	Lead: Manager IT Operations Commitment Date: June 30, 2015

4.3 Communication and Engagement

Presently stakeholder communication and engagement is informal and limited. This likely reflects the small VDI user base and its emergency deployment. Phase III of the VDI programme will significantly expand the user base, requiring more structured stakeholder engagement and communication processes. These processes support the realization of broader benefits, beyond reducing IT costs, such as improved citizen services.

Stakeholder engagement establishes the desire to change by gaining commitment from key players. Tomorrows Workplace (TW) see themselves as a key stakeholder but have had limited programme involvement to date. For example, our discussions with TW, found they were not clear on the different virtual desktop types and had not seen a project plan. TW could be a key champion of the technology for administrative users.

Communication and proof of concepts will provide business units outside IT with the vision of VDI's potential. Although, proof of concepts are underway they still need to be finalized and documented.

Recommendation 3
IT should create a Stakeholder engagement plan that:

1. Identifies key stakeholders.
2.   Assigns responsibility for managing the relationship.
3. Includes actions for managing the relationship throughout the lifecycle of the project.

Management Response

Action Plan	Responsibility
Agree. IT will create a stakeholder engagement plan that will identify stakeholders, as well as outline communications and engagement activities to formalize commitment to the project. Regular meetings with stakeholders will provide time for validating the user experience as well as gathering information for improving the service.	Lead: Manager IT Operations Commitment Date: May 31st, 2015

Recommendation 4
IT should develop a vision communication and marketing plan, in consultation with key
stakeholders, to address the core groups, their behavioural profiles and information
requirements, communication channels, and principles.

Management Response

Action Plan	Responsibility
Agree. IT will develop a communication and marketing plan with consultation from key stakeholders defined in the stakeholder engagement plan from recommendation 3	Lead: Manager IT Operations Commitment Date: July 31st, 2015

Recommendation 5
IT should conduct formal documented proof-of-concept initiatives to test different use cases
for VDI, identify any issues, and determine whether further implementation or roll-out
should be considered.

Management Response

Action Plan	Responsibility
Agree. IT will communicate and share the proof of concept designs with stakeholders, target audiences, and other business units to test customer needs for Virtual Desktops. Results will be documented.	Lead: Manager IT Operations Commitment Date: April 30, 2015

4.4 Availability

Availability means that a system is reliable and responds to user requests in a timely manner. This has greater importance for VDI users, than regular desktop users, since they cannot perform any tasks when the infrastructure goes down. Furthermore, key business units such as 311 are considered a potential group of VDI users. Currently, IT is addressing this risk by provisioning more capacity than is required and building redundancy into the design. However, to address this risk going forward IT needs to: (1) implement processes to assess performance and plan for capacity (2) formally define service levels. Neither of these processes are currently in place.

Assess Performance and Plan for Capacity

Performance and capacity assessments of the VDI infrastructure have not been completed, since the tools currently in place are not VDI compatible (IT expects to have suitable tools in place next year). These assessments identify the number of users and tasks VDI can handle, without performance degradation. Once these assessments are complete IT management can use the results in capacity planning, to ensure sufficient capacity is available to meet business requirements.

Formally Define Service Levels

Documented VDI service levels options were not defined in the IT service catalogue. This reflects the fact that VDI was not widely rolled out to many users and its emergency implementation. It is important to define service level so users understand availability limitations for their choice of VDI service. For example, dedicated VDIs will only be housed in a single data center, but pooled VDIs will exist in both data centres. If one data center was unavailable pooled users could continue working but the dedicated users would have to wait until their VDI was manually restored to the operational data centre.

Recommendation 6
IT should perform load testing to assess the performance and capacity of the VDI infrastructure. Results of this load testing, along with business requirements, should be incorporated into a documented capacity plan. In addition, establish a process for reviewing the capacity plan on a regular basis.

Management Response

Action Plan	Responsibility
Agree. IT will perform load testing of the VDI environment. A process will be established for load testing, documenting testing results, and incorporating findings into a plan to manage capacity. Frequency will be established as part of the process for assessing performance and capacity.	Lead: Manager IT Operations Commitment Date: October 31, 2015

Recommendation 7
IT should document VDI service level options in the IT services catalogue. These service levels capture availability, continuity, security and compliance requirements.

Management Response

Action Plan	Responsibility
Agree. IT will create and publish service level options as part of the IT service catalogue. Definitions will also include availability, continuity, security and compliance.	Lead: Manager IT Operations Commitment Date: November 30, 2015

4.5 Documented Configuration Baseline

Phase II VDI configuration and design decisions were not documented and stored in a configuration repository. Documenting this information facilitates the day to day management of the VDI environment, assessing the impact of changes and responding to service incidents. Ultimately, proper configuration documentation helps ensure the availability of the VDI system.

Recommendation 8
IT should ensure VDI configuration and design decisions are documented in a configuration baseline and stored in a repository.

Management Response

Action Plan	Responsibility
Agree. IT will document VDI configurations and design decisions and store these in a repository.	Lead: Manager IT Operations Commitment Date: April 30, 2015

Appendix 1: Risk Control Assessment

#	Audit Objective	Council Priority / Strategic Action	Risk	Cause of Risk	Overall Risk (L,M,H)	Recommended Control	Control Currently in Place
1	IT Benefit Enablement (Business Receives Value from IT Investment)	W2	The replacement of traditional personal computers with virtual desktops fails to result in significant reductions in overall IT costs.	Virtual desktop offers three methods of deployments (hosted shared, pooled and dedicated). Under a dedicated scenario costs could be higher than a traditional desktop.	H	IT Management establishes a model that identifies, measures and predicts total ownership costs for a virtual desktop and traditional desktop environment. These costs are reflected in chargeback rates to service users.	N
2		N3, H2, W2, W3, W6, W9	Adoption of VDI technology fails to realize expected benefits of increased staff productivity, business continuity, workforce mobility, energy usage and support costs.	Expected benefits are not clearly defined and are not measured.	H	Program governance is established that: (1) Involves key stakeholders to develop a detailed business case for the programme. This documents a complete understanding of the expected benefits and how they will be measured, (2) Develops a benefits realisation plan that will be managed throughout the programme to ensure that planned benefits always have owners and are achieved, sustained and optimised. (3) Updates and maintains the business case and a benefits register to identify and define key benefits arising from undertaking the programme.	N

#	Audit Objective	Council Priority / Strategic Action	Risk	Cause of Risk	Overall Risk (L,M,H)	Recommended Control	Control Currently in Place
3		N3, H2, W2, W3, W6, W9	VDI technology is not widely adopted resulting in a failure to realize expected benefits, wasted funding and increased ongoing operating costs.	IT clients will not be required to adopt the technology although it will be the default option upon lifecycle replacement..	H	A Stakeholder engagement plan is created that captures how they will be identified, analysed, engaged and managed through the life cycle of the program. Effectiveness of stakeholder engagement is measured through the programme. The stakeholder engagement plan helps establish the desire to change.	N
4						Develop a vision communication plan, in consultation with tomorrows workplace, to address the core groups, their behavioural profiles and information requirements, communication channels, and principles.	N
5						Conduct proof-of-concept initiatives to test different use cases for VDI, identify any issues, and determine whether further implementation or roll-out should be considered. Partner with tomorrows workplace for trials involving administrative workers.	N
6	IT Operations and Service Delivery	N3, W9	Users are unable to access key applications or performance of the VDI is slow, thus degrading employee productivity.	Insufficient capacity of the system. Lack of organizational knowledge of the capacity constraints of the system due to limited capacity testing of the VDI technology at The City.	M	Assess availability, performance and capacity of VDI to ensure that cost-justifiable capacity and performance are available to support business needs and deliver against SLAs	N

#	Audit Objective	Council Priority / Strategic Action	Risk	Cause of Risk	Overall Risk (L,M,H)	Recommended Control	Control Currently in Place
7		N3	VDI does not provide the necessary availability levels for users with critical business continuity and availability requirements.	Lack of communication between IT operational groups and business users.	H	Documented VDI service level options are outlined in the IT services catalogue. These service levels capture availability, continuity, security and compliance requirements.	N
8				Changing requirements for the VDI infrastructure as new users are on boarded.		Plan and prioritise capacity and availability of new or changing business requirements.	N
9		N3	Consistency of the VDI environment configuration "drifts" over time leading to a loss of availability.	Design and configuration decisions are not documented and rely on knowledge of individual IT operations employees.	H	VDI configuration and design decisions are documented in a configuration baseline and stored in a repository	N
10				Unauthorized or inadequately tested changes are made.		Changes to the pooled and hosted shared desktops follow a change management process with appropriate testing before promotion into the production environment	Y
11		N3	Confidential data is exposed to malicious actors or the integrity of information is damaged.	Data is downloaded onto an external device.	M	Citrix security policies prevent users from downloading files outside the VDI environment.	Y
12				Data is intercepted in transmission		VDI is encrypted using secure socket layer (SSL) for users of external and internal access gateways.	Y