IMPLEMENTING A VIRTUAL DESKTOP INFRASTRUCTURE AT THE DISTRICT OF NORTH VANCOUVER

by

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Abstract

The District of North Vancouver (DNV) will be undergoing a district-wide desktop replacement project in 2012. This paper describes the technological and functional details of a virtualized desktop infrastructure (VDI) at DNV and analyses the expected alignment of a VDI implementation with DNV organizational goals relative to other strategic alternatives.

As VDI is found to be the most appropriate alternative for the desktop replacement project, VDI vendors and solutions available on the market are explored and recommendations are made on the most appropriate VDI solutions for the organization. The VDI vendor selection is determined by using DNV specific criteria that include financial and functional requirements of the organization. In addition to presenting a VDI solution, the paper presents an implementation plan overview that will aid in a successful VDI deployment and adoption.

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Glossary

Cloud computing	Cloud computing is a term used to describe the delivery of conventional infrastructure based software and services through a subscription-based model.
DNV	District of North Vancouver is the local government organization governing municipal affaires at North Vancouver District, British Columbia.
ERP	Enterprise Resource Planning refers to enterprise software used to manage the various business units and operations of an organization, such as payroll, accounting and procurement.
HA (High Availability)	HA refers to failsafe systems built into software applications that will allow redundancy between multiple implemented instances of the software with the goal of minimizing application downtime.
Hypervisor	The hypervisor is the software that allows virtualization of the hardware layer to conventional operating systems.
Malware	Malware refers to any form of malicious code or software that can run on a computer host. Examples are trojan horses, worms and viruses.
PC Image	In desktop computer terms, a PC image refers to a snapshot of a workstation's operating system and software customizations. PC images can be capture and then deployed to other computers, which will in turn have the exact same operating system and software settings.
SAN	Storage Area Networks or SANs are collections of storage disks managed independently by dedicated controller modules.
SCADA	SCADA stands for Supervisory Control And Data Acquisition, which refers to computers that control industrial control systems such as water pumps and valve systems.
Thin client	Thin clients refer to hardware devices that do not perform any of the processing and storage of data. Thin clients are simple computer terminals that display streamed content from the datacentre.
VDI	Virtual Desktop Infrastructure is the term used to describe a virtualized desktop implementation where an operating system instance is delivered to thin clients from the datacentre through a network.

Virtual hardware	Virtual hardware refers to the hardware that is emulated by a hypervisor. Virtual hardware is what the operating system sees and interacts with, rather than the physical hardware. The hypervisor interacts with the physical hardware instead.
VM (Virtual Machine)	A VM in modern computing refers to a virtualized instance of an operating system running on a hypervisor.
x86	x86 refers to the designation of a specific group of Intel based processor architecture.

1: Introduction

In 2012, the District of North Vancouver IT department will be tasked with a PC refresh project, which aims to replace all of the aging workstations in the organization. The project will entail a district-wide replacement of all workstations and an upgrade to the current Windows Vista operating system that is deployed in the organization. For this PC refresh cycle, the District of North Vancouver IT department has alternatives to a traditional desktop deployment. For the first time since the department began deployment of personal computers for the organization, there are choices that leverage new technological innovations such as virtual desktop infrastructures or VDI. This paper explores the District of North Vancouver desktop replacement project and analyses the viability of VDI and its strategic alternatives in order to make a recommendation on how to proceed with the project.

1.1 Organization Background

The District of North Vancouver (DNV) is an organization that provides services that serve the municipality of North Vancouver District, located on the North Shore of the lower mainland in Greater Vancouver, British Columbia. The municipality serves roughly 90,000 residents and has an administrative staff of approximately 500 employees. Public services being offered by DNV are comprised of typical local government offerings such as tax collection, fire services, libraries, recreation facilities and services, business license permits, property and home improvement inspections as well as fire inspections.

DNV shares a unique relationship with its neighbouring municipality of City of North Vancouver (CNV). Geographically, DNV covers a significantly larger land mass and expanse when compared to the CNV. While DNV's population is roughly half of that of CNV's, it is in

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the total areas covered by each municipality that a stark contrast can be seen: where the taxable area at CNV is about 600 hectares, the DNV's boasts roughly 15,000 ha. The relationship of the two municipalities is most evident in how the two entities share some of their public services. For example, DNV shares the costs and responsibilities of the North Vancouver Recreation Commission and the North Vancouver Library system with the City of North Vancouver. The bulk of the responsibilities of these shared services tend to lie on DNV, as the majority of the buildings are located within the boundaries of DNV (BC 2011).

The District of North Vancouver's corporate structure is divided in divisions and departments as depicted in Figure 1. The various divisions include Finance, Engineering, Planning, Bylaws and Corporate Services. Within the Corporate Services division, DNV runs an in-house Information Technology Services group responsible for delivering and maintaining the information systems requirements of DNV staff.
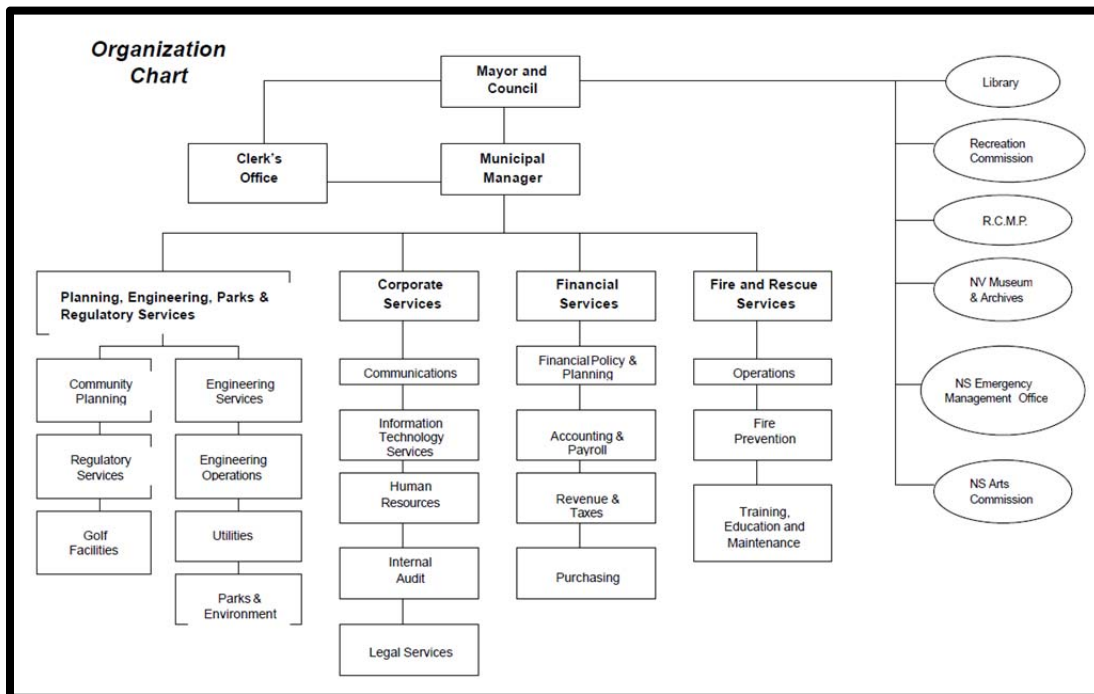
Figure 1 - District of North Vancouver Organization Chart

DNV has an integrated Information Systems department that delivers all of the voice, data and application requirements of the various business systems. DNV's information systems are connected through a fully managed IP network stretched between nearly 30 buildings. DNV provides service to approximately 500 desktops and 500 IP phones, while providing partial services to a remaining 300 desktops located at recreation and library facilities. The District of North Vancouver provides partial IT services to two shared North Vancouver municipal service organizations: North Vancouver Libraries and North Vancouver Recreation. Unlike most municipalities, North Vancouver is split between two municipalities: City of North Vancouver and the District of North Vancouver. DNV has the challenge of servicing a large stretch of land. The City of North Vancouver, on the other hand is a much smaller concentration of commercial and mid/high rise apartment buildings.

The Information Technology department at DNV is comprised of about 15 staff, including three managers, three business analysts, two network administrators, three help desk staff and five geographic information systems (GIS) analysts. The core network operations team includes the network administrators and the IT manager. The network operations team, the help desk staff and the client services manager along with the IT manager are the core group responsible for the implementation and operations of the DNV's desktops and workstations. Currently, the desktop systems are custom-built workstations provided by the now defunct Seanix Technologies, which was based out of Richmond, BC. The workstations are conventional PCs built in 2008 running Microsoft Windows Vista as their operating system. District of North Vancouver IT runs a series of both generic and specialized client/server applications on their systems. The client/server model of application delivery is supported by a server farm of about 100 servers. About 60% of the servers are virtualized and as older servers are decommissioned, they are migrated into the virtual server farm.

1.2 Technology Background

The concept of virtualization in computing originated in the 1960s when costly mainframe manufacturers, such as those developed by IBM, were divided into various virtual machines to allow parallel applications to run concurrently. The purpose behind the use of the virtualization concept was to maximize the utility of the expensive mainframe gear so that multiple concurrent processes – multitasking – could increase output (Singh 2004). With the emergence of x86 computing in the 1980s and 1990s and the drastic reduction of server hardware costs, mainframe virtualization was no longer a relevant technology. In 1999, a Palo Alto, California start-up called VMWare Inc. launched the first x86 based virtualization software. The initial VMWare product was a workstation-based hypervisor (virtualization software) that allowed a virtualized operating system to run within the host workstation's operating system (Allison and Waters 2007). Shortly after, VMWare entered the datacentre market with their server side virtualization products. The VMWare hypervisors allowed multiple virtual servers to be simultaneously run on the same hardware, independent of each other. This virtualization implementation took advantage of idle processing and available memory of the base hardware to maximize output (Vmware Inc. 2011)

Server virtualization advantages were not limited to leveraging existing hardware for increased output. Other important benefits of server virtualization include space consolidation, reduction in power consumption as well as reduced heat output. Another highly touted advantage of server consolidation through virtualization is reduced management overhead of physical hardware and uncontrolled server expansion – dubbed in the industry as server sprawl. As virtualization technology matured over the years, other firms emerged with their own version of server virtualization solutions. With increasing virtualization technology uptake, the competing firms introduced new features and functionalities in their virtualization offerings. Today, server virtualization frameworks tightly integrate modern datacentre hardware and enterprise-class

software solutions. Virtualization has become an accepted standard in the datacentres of medium to enterprise-sized businesses.

Several virtualization technologies have emerged over the past decade; however, the most notable are offerings from VMWare, Citrix and Microsoft (Singh 2004). These three vendors are constantly attempting to out-compete one another in features, price and ease of implementation and management. Being the pioneer in this space, VMWare is the market leader with nearly 50% of the virtualized market share (Dornan 2011). With the success of server virtualization, the firms behind this technology have recently focused their efforts on a different aspect of Information Systems infrastructure: the desktop. With the benefits of server virtualization fully realized and accepted in the industry, the concept of virtual desktop infrastructures, or VDI, is being heavily pushed by major virtualization vendors.

Virtual Desktop Infrastructures (VDI) as a concept also takes after the terminal to mainframe configuration of systems from the mainframe era. The concept is similar in that all user side processing and management is controlled at the datacentre and server side, rather than on the client workstation (Singh 2004). As with mainframe systems of the past, the VDI concept aims to centralize management, reduce hardware overhead and ultimately reduce operational costs. VDI however, differs from server virtualization in several ways and as such poses different challenges. Unlike server side virtualization, a virtual desktop environment will be more evident to the end user. Any performance issues in user interfaces, application performance as well as user experience degradation, for example watching a Flash video, would be easily spotted by an end user. Server virtualization, on the other hand, does not generally manifest performance problems directly for the end user. VDI performance and functionality issues would have a greater impact on the end-user than server-side virtualization

Another unique attribute of a VDI environment is that VDI specific hardware and software may be required at the desktop endpoint. On the other hand, in server side virtualization,

the same operating systems that would be running on physical servers are running in independent

virtual containers (Chou 2009). Beyond that, the operations, functionality and underlying delivery

of the client/server model in a virtual server environment does not change. For a VDI

implementation, the virtual operating system that the end-user interacts with, is the software that

is delivered to the users' endpoint devices where the physical thin-client or desktop that the user

is interacting with does not actually contain the desktop operating system software.
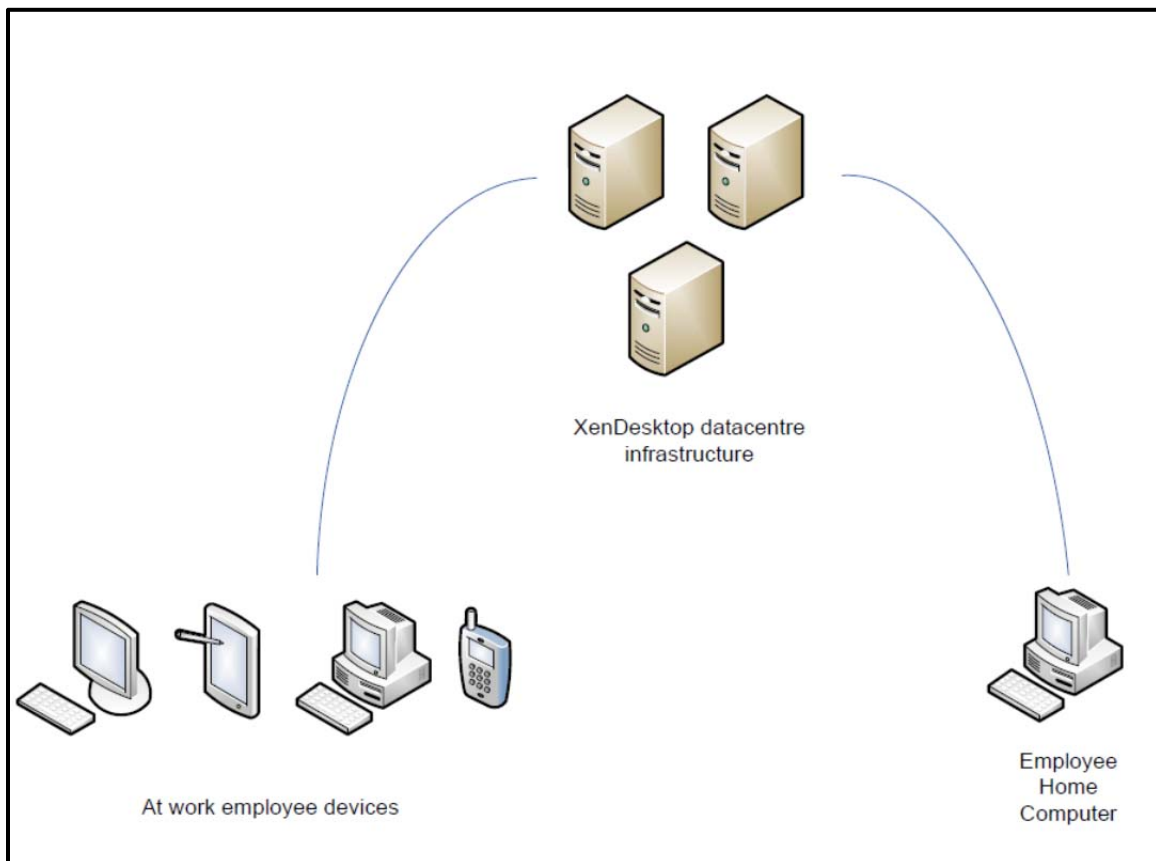
Figure 2 - Basic VDI Conceptual Diagram

Figure 2 presents an overview of desktop virtualization that portrays the core concepts of

"anywhere, anytime" access to corporate data that is brought on by application and desktop

virtualization. Figure 2 illustrates the fundamental VDI concept that the corporate desktop's

operating system can be delivered to the end-user in the exact state that it would be accessed at

work. It therefore makes sense that the aim of the major VDI vendors is to minimize the *virtual* impact on the end user. Ideally, the desktop user would not be able to discern any differences between a virtualized desktop and the traditional workstation. Unlike server side virtualization, adoption of virtual desktops has been somewhat less enthusiastic. Where a significant number of organizations worldwide have embraced server virtualization, VDI implementations are vastly fewer (Goodman 2009).

VDI implementations do provide significant operating advantages, but only in certain environments. As well, historically the cost of VDI projects would be quite high requiring significant investments in the datacentre (Sarrel 2010). The high datacentre capital and operating costs, as well as licenses and the purchase of thin clients on the desktop side, would refute the operational advantages of desktop virtualization. The more recent releases of VDI however, tout reduced or at least similar characteristics to traditional desktops regarding implementation and operational costs. The newer technologies also permit more user flexibility, both in terms of virtual desktop delivery, as well as multiple hardware platform support such as tablets and other mobile devices. With promises of lower total cost of ownership and management overhead, organizations are once again revisiting desktop virtualization (Goodman 2009).

As with any new technology implementation, organizations need to develop an acceptable business case for VDI while providing strategic alternatives to the new technology that would at least in part deliver on the requirements of the stakeholders. Some organization may not see benefits in a fully virtualized desktop environment or simply not have the capability of virtualizing every single workstation. Such instances would suggest an alternative of a mixed physical and virtual desktop environment. Though lacking uniformity in infrastructure, a mixed physical and virtual implementation would address instances where VDI is not quite ready to replace some physical workstations, such as high-end CAD and drafting machines.

Another alternative to a full VDI implementation on newly deployed thin-clients is the option of running virtual desktop software over existing desktop assets. In this case, the operating system is being abstracted from the underlying physical software as it is running in a virtualized container. This implementation of VDI over existing hardware allows for flexibility of desktop delivery and staged migration of users from a strictly physical desktop platform to a virtualized one. This alternative would permit the organization's IT department to maintain a mixed desktop hardware environment given the abstraction of the operating system and the physical desktops.

Today's IT trends are pushing early adopters into software clouds where software is provided as a service requiring little to no infrastructure on the organization's part. When considering alternatives to traditional and virtualized desktop instances, it is important to consider the cloud-based software delivery model, which eliminates the requirement of centrally managed workstations in an organization. Since both the software and the data used by end-users would be maintained and delivered through public and private clouds, organizations could even forgo the management and maintenance of desktop endpoints. The cloud-based software and application delivery model would permit innovative IT policy approaches such as bring-your-own-computer (BYOC) or bring-your-own-device (BYOD). In both instances, employees would connect to their corporate environment using personal devices and be able to gain immediate and transparent access to organizational business applications and software.

1.3 Project Aim

This paper explores the requirements of the District of North Vancouver's workstation users, and evaluates the viability of today's VDI products as potential solutions. The District of North Vancouver has a pre-determined technology life cycle for its desktop computers of 4 years, after which they are typically replaced by new hardware as well as whatever the most prominent desktop operating system would be at the time of replacement. The next desktop replacement will be in mid-2012. For the first time since the introduction of the traditional x86 PC platforms, the

District of North Vancouver will be able to consider desktop virtualization as a strong candidate for its desktop replacement project.

This report evaluates both the capital and operating cost benefits of a virtualized desktop implementation at the DNV against a conventional desktop hardware replacement and introduces other strategic alternatives for DNV employees' desktop requirements. The report aims to demonstrate the financial implications of a VDI implementation both in terms of direct and indirect costs of the implementation. Additionally, by comparing the management overhead associated with VDI, conventional desktop PCs and various strategic alternatives, this project outlines the potential long-term benefits and possible disadvantages of the available desktop technology options for the District of North Vancouver.

In order to identify the best-suited VDI technology for the District of North Vancouver, this project compares the offerings by today's leading VDI vendors. Additionally, new and emerging trends in the desktop virtualization industry are used to ensure that the selected VDI vendors will have the product road map that would take advantage of technological developments such as portable devices, including tablets and smart phones. In addition to evaluating between conventional desktop replacement and a virtualized one, this project will evaluate other alternatives that may meet the District of North Vancouver's requirements.

1.4 Project Scope

Recognition of library and recreation services is important in defining the scope of this project, given that the most beneficial desktop implementation at the DNV can be shared with the library and recreation IT systems. The primary scope of the project focuses on determining the viability of a virtual desktop infrastructure for the DNV; however, based on the decision criteria and the conclusions drawn, the recommendations and data acquired can be applied to both recreation and library services. Today's VDI technology is not limited to desktop replacement

and, as such, this project will evaluate the possible extension of a virtual desktop delivery to various platforms, from thin clients, to laptops, tablets and Macs. As such, the scope of this project will not strictly be limited to the equipment that is owned and operated by DNV. The scope will also include opportunities for teleworkers and remote access to DNV employees.

The individuals involved with the project include District of North Vancouver's network administrators, client services manager and the IT manager. Business analysts will also be consulted to address the due diligence needed to ensure business application functionality and compatibility during the project testing phase. The district has close relationships with several reputable hardware and software vendors with local representatives in Vancouver, BC. These vendors and consultants are used to source pricing and technical information.

1.5 Project Structure

The project begins by providing an analysis of the desktop replacement project at the District of North Vancouver. Past projects and results are evaluated to lay the groundwork for the introduction of a significantly different approach to DNV's desktop replacement. After providing problem details, an in-depth analysis of the various VDI solutions available on the market today is performed. The analysis includes operations, capital and management costs associated with a VDI implementation. The project further analyses the operational benefits and drawbacks of a fully virtualized desktop environment. Special focus is placed on on-going management of workstations and the need for training and staffing requirements. In addition to filling the requirements of conventional desktops, the VDI solution is evaluated for its alternative benefits, such as remote and teleworker capabilities in addition to possible multi-platform support. Post technology analysis includes an evaluation of alternatives to a full VDI solution, such as hybrid implementations that would allow for a mixed solution providing the best available technology options for the appropriate requirements.

Finally, the project provides recommendations based on the identified technologies, given DNV's requirements, budget and staffing capabilities. The recommendation includes whether a virtual desktop implementation would be cost effective while delivering improved functionality, management and end-user experience. Recommendations also include a chosen VDI vendor as the selected vendor/technology, should the District of North Vancouver decide to proceed with a fully virtualized desktop environment.

2: Development of Strategic Issues

The District of North Vancouver's corporate vision proclaims that "By 2020, we will be recognized among the most sustainable communities in the world as demonstrated through our environmental stewardship, strong network of neighbourhoods, a vibrant economy and community-driven growth and change" (District of North Vancouver 2011). To achieve such a vision, all divisions of the organization will need to align their divisional strategy with the corporate strategy. Doing so for the Information Systems group is no different. To align the IT strategy with the corporate strategy and vision, DNV's technologies, including the datacentre, workstations and even printer and copiers have been constantly upgraded or replaced for higher efficiency alternatives.

One of the selling points of VDI environments is the reduced consumption footprint that it can deliver when compared to conventional workstations. Consumption reduction is obtained through a light or thin endpoint client and better power management capabilities; for example, an idle device could consume as little as half of a conventional workstation's power consumption. Before further analysis of VDI technology can be made, an overview of DNV's corporate leadership, ownership, services, IT strategy and IT budget will set the groundwork for decision-making criteria.

2.1 Organization Ownership and Leadership

The District of North Vancouver is a local government organization, responsible for providing essential and community services to the residents and businesses of North Vancouver District. As with typical corporate entities, it is divided into divisions, each headed by their respective directors - equivalent to vice presidents at a private organization. As a local

government entity, the mayor and seven councillors act as the representatives of the public with respect to DNV services and offerings. The director team at DNV is led by David Stuart, the Chief Administrative Officer (CAO). Mr Stuart acts as the highest ranked member of the DNV municipal employees. As defined by DNV's public website, the CAO *"ensures Council direction is followed, keeps Council up-to-date on all matters and provides on-going policy advice. Through the Executive Committee of senior managers, the CAO leads all District employees, oversees all District operations and services, and sets the overall direction for long and short term goals and work plans"* (District of North Vancouver 2011). Rick Pratt, the current IT manager at DNV reports directly to Mr Gavin Joyce, the Director of Corporate Services, who in turn reports to the CAO.

All IT projects are supervised by Mr Pratt. Shayne Dunlop, the client services manager and Derek Olorenshaw, the business system's manager are responsible for their respective projects and report directly to Mr Pratt. Mr Dunlop's responsibilities include overseeing the client services and help desk operations and Mr Olorenshaw focuses on smooth operations, integration and new implementations of business systems applications such as the Enterprise Resource Planning (ERP) and Budgeting applications.

2.2 District of North Vancouver (DNV) Services

District of North Vancouver offers numerous public and internal services. Table 1 outlines the public and internal services offered by the organization. Public services that are directly managed through Information Technology services are denoted with an asterisk. Table 1 outlines the extent to which information technology services have been integrated in both the public facing as well as internal services offered by DNV. During the challenging economic climate of the past few years, DNV's departments have also faced budget cutbacks. Many of the services and projects of DNV's IT department have been focused on maintenance of core IT infrastructure and operational services. There has been less focus on dramatic changes in IT

strategy. With the emergence of concepts of cloud computing and specifically implementation of virtual private clouds in this case, new and innovative solutions are now available that would better align with the corporate IT strategy set at DNV.

Table 1- District of North Vancouver Services Overview (District of North Vancouver 2011)

Public Services
- Utilities
- Emergency and Public Safety
- Recycling & Garbage
- Library*
- Permits & Licenses*
- Building & Development
- Community Plans*
- Maps*
- Filming
- Parks
- Recreation
- Arts & Culture
- Social Services
- Animal Welfare Shelter
- Property Tax*

Internal IT Services
- Enterprise Resource Planning
- Desktop and Laptop technology
- Enterprise document management and archiving
- Internet and Enterprise email
- Internally managed IP fiber optics backbone network linking over 30 buildings
- Enterprise Voice over IP phone system
- Permits and Licenses management application
- Remote access/teleworker Citrix
- Virtual and Enterprise private server clouds
- Wifi at most buildings
- Smart phones - enterprise management (Blackberry)

Online Services
- Business License applications/renewals and Bizpal (generates business license requirements)
- Home Owner Grants
- Dog License application/renewals
- Ticket/Invoice payment
- Sophisticated mapping and property information system - GeoWeb
- Live and archive Council meetings
- Permits Online
- Property Information and Assessment
- 311 / problem reporting
- ROI - Request for Information

2.3   Corporate IT Strategy

District of North Vancouver's IT strategic plan describes the various business systems and infrastructure services that combine to provide the staff of the DNV with the tools to best service the residents of the municipality. A primary DNV IT strategy mandate is delivery of industry leading IT services while maintaining or reducing operating and capital costs. This has been achieved in the past through diligent vendor and product selection and an on-going maintenance and upgrade schedule of the services to maximize product benefits.

Table 2- Current Systems and Available Alternatives at Time of Project Deployment

Vendor Name	Product Name	Years in use at DNV	Industry leading alternative(s) at the time	Current state of alternatives	Future plans for product
Cisco Systems	Cisco Routers and switches	13	Nortel, HP, Bay Networks	Nortel and Bay networks no longer exist. HP only focuses on switching	Maintain/Upgrade network infrastructure with Cisco network equipment
Oracle	JDE Enterprise One (ERP solution)	11	SAP, PeopleSoft	PeopleSoft was acquired by SAP, Oracle/JDE as industry leader	Maintain/Upgrade ERP systems with future version releases of JDE Enterprise One ERP system
OpenText	eDocs Document management	12	MS Sharepoint	MS Sharepoint has just recently added features that allow it to compete with eDocs	Maintain/Upgrade existing systems, possibly look for cloud services alternatives in the coming years
Seanix Technologies	Seanix desktop computers	12	Dell, HP, IBM/Lenovo	Still market leaders	Seanix technologies has filed for chapter 11 bankruptcy and is no longer a business entity

Table 2 outlines the long-term commitment of the DNV's IT strategy to selected products that have proven functional for DNV IT services. Table 2 shows examples of proven IT technologies that have required significant capital investments to implement, but are constantly maintained to their latest version releases to ensure maximum return on investment and reduced

operational expenditures. The strategic plan behind DNV technologies that support its services is to ensure appropriate vendor selection that would reduce the chance of technology obsolescence and reduce the requirements for high capital expenditures caused by vendor or technology change. The desktop vendor, Burnaby BC based, Seanix Technologies is a notable exception. This vendor had been chosen based on their proven track record for support and services as a local PC manufacturer. With the downturn in economy, increased competition from major PC manufacturers and Seanix Technologies' ill-timed decision to purchase the failing A&B Sound electronic stores, Seanix Technologies had to file for bankruptcy and sell all assets two years ago. The choice of a replacement vendor would be an obvious one, if DNV were to ignore the shifting technological paradigms on how businesses operate and equip their employees technologically. The PC vendor selection however, will also include an evaluation of technological alternatives such as the VDI concept that is the topic of this paper.

In order for the District of North Vancouver to continue to align its IT strategy with its corporate strategy, appropriate considerations have to be made regarding the desktop replacement project that may include innovations such as VDI. Regardless of the technology decision being made, a "three S" framework as referenced in Figure 3, will need to be used as a guideline for corporate IT strategy alignment. The existing desktop structure will need to be replaced, and in doing so, the solution will need to fit the IT strategy and systems designs that are currently implemented in the organization.

A major challenge with a VDI implementation would be the support of existing systems that have been successfully deployed in the organization. Full support for business systems such as the JDE EnterpriseOne ERP, eDocs Document Management, email messaging, Permits, Bylaws, and property tax systems are imperative with the new solution. It is the deep integration and dependence of the organization's strategy, as well as its IT structure that require a diligent selection process that will result in adherence to the organization's overall strategy.
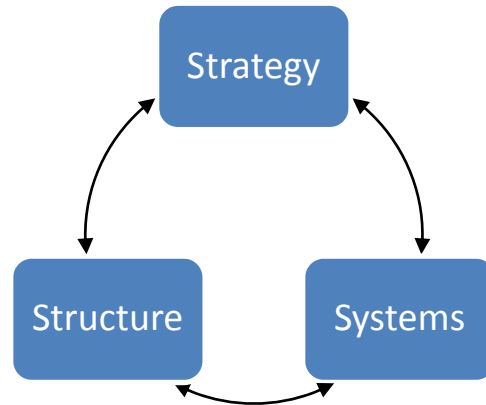
Figure 3- Concept of Strategy, Structure and Systems creating the core of a successful IT environment (Parent 2010)

2.4 Budget

For the past decade, the Information Systems department at DNV has strived to maintain a constant operating and capital budget structure. By appropriately identifying the lifecycle requirements of its systems, the ITS budget has been consistent in delivering the required services and functionalities to the DNV while maintaining and in some cases reducing the overall IT budget. Currently the approximate DNV ITS budget sits at just 3 million dollars for both operating and capital expenditures combined. The replacement cycle for desktops has traditionally been 4 years. The last desktop implementation project where Seanix Technologies sourced PCs were ordered, 450 units were ordered at about $1000 per unit (excluding monitors). This price included the hardware support and maintenance for the first three years of ownership.

The per-unit cost also provides a Windows Vista Professional license – the latest available
Microsoft operating system at the time of the desktop purchase. In addition to the capital costs of
obtaining and implementing the desktops, there are operational expenditures that include the Help
Desk and Network Administrative staff's involvement to ensure trouble-free day-to-day
operations.

2.5 Management Overhead

2.5.1 Desktop Operating System Delivery

Costs and time associated with maintaining any IT infrastructure are not limited to the
initial purchase and continual upgrades of the system. The same goes with the PC software and
hardware management at any organization. At the District of North Vancouver, the ITS
department is responsible for the operations, management and maintenance of DNV's
approximately 400 in-service workstations. Managing workstations involves more than just
ensuring a functioning hardware and operating system. The list below itemizes some of the
common end-user workstation issues reported and resolved on a regular basis by the DNV IT
department:

- User profile issues/errors
- Network connection issues
- Document management application instability
- Hard disk failure
- Motherboard/network interface card failure
- PC malware infections
- Third party software instability (i.e. Adobe products)

There are documented methods in addressing known issues, but for new and unresolved
issues, the amount of troubleshooting that is dedicated is kept to a minimum. The justification
being that if an issue cannot be reproduced on other PCs, and it cannot be resolved on the

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reported workstation within a specific amount of time (typically half an hour), then it would be best to re-deploy or re-image the workstation using the standard DNV workstation image. The term *image* refers to a snapshot of the latest stable working state of the DNV's operating system, which includes all the latest operating system updates, patches as well as the latest suite of district software needed for the various business systems in the organization. The imaging process will require physical access to the workstation, where the technician will initiate the process by two keystrokes. Once started, the imaging process entails the workstation being instructed by a remote network imaging service to wipe its local hard drive, download a large image file, and apply the workstation image on the PC. The process takes about 45 minutes to complete (less than 30 minutes if the imaging is being performed on a Gigabit Ethernet link instead of 100 Megabit Ethernet links).

To save time, Help Desk staff prepare a newly imaged workstation at their lab and once ready, make an onsite visit with the replacement workstation where the problematic PC is replaced with the newly imaged one. In case of hardware failure, the same problem resolution applies, except since the problem workstation is likely non-operational, the on-site visit is expedited. Depending on where in the organization the problem PC exists, this process can require some travel time as well as arrangements with the PC user. Aside from the central municipal hall, most of the DNV buildings are scattered across the large land mass of the municipality. Travel requirements for some sites may take 20 – 30 minutes.

Various challenges and inefficiencies exist with the current desktop re-imaging process. First, it is possible to remotely reimage a workstation; however, the workstation image sizes are nearly 6 Gigabytes of compressed data (roughly equivalent to the size of a high definition movie). This amount of data travelling over the corporate network is not an ideal scenario. The high amount of data being put through the network may affect other users' experience by introducing network performance bottlenecks for the duration of the imaging process. Second, the process

takes substantial time. 45 minutes of downtime during the day, is undesirable customer service and causes too much interruption in the users' workday. Additionally the imaging process it not a *zero-touch* implementation. Zero-touch imaging means that no physical access to the workstation is necessary to commence and control the re-imaging process. This aspect is critical in providing functional remote administration of a PC. Third, it is desirable that imaging processes be automated or scheduled, so that *zero-touch* re-imaging can be scheduled to run at specific times. This form of functionality would permit system imaging to take place during out-of-band or non-working hours where network utilization and user impact would be minimal. These are some of the challenges and wish list items for improved workstation re-imaging. Third party software solutions are available that try to address these challenges, however since they need to interact with workstations that may be turned off, or in sleep mode or some state where they cannot be managed, remote operation challenges still remain.

2.5.2   Software and Hardware Management

The ideal desktop hardware implementation would be a series of identically built and configured PCs obtained at the same time from the same manufacturer. This concept is based on the idea that maintaining and servicing an identical batch of workstations is far less cumbersome than a mix of computers with differing specifications. District of North Vancouver's IT philosophy on standardization is what has allowed for three help desk and two network administrators to be able to look after over 400 workstations, 100 servers, 70 network switches and routers, 600 IP phones and 100 smartphones. In most organizations, a larger support environment would be needed to look after this many devices. A lack of standardizations between each device type would lead to inefficiency, repairs and troubleshooting. Even though standardized hardware has facilitated replacement and repairs, the process is still dependent on traditional PC hardware components. There are moving parts such as CPU and PC case fans and hard drives.

The same philosophy behind standardization of hardware is applied to the operating system and software that is present on users' workstations. If a particular piece of software is to be updated, it will be updated on all workstations in the organization, not just a select few. This aim for consistency results in reduced management and confusion should a workstation need to be reimaged. End-users and help desk operators do not need to be concerned with custom or specialized software on PCs when replacing them – as long as the newly imaged replacement PCs have the same operating and software images as the one being replaced. This approach is diligently followed at DNV, however the process of constantly updating the source image and deployment of new software to existing workstations does prove challenging at times. One major challenge with deployment of software to workstations remotely, is the inability to verify with certainty that the PC has obtained the new software. There are free and commercial tools available on the market that allow for software inventory information gathering and deployment. Table 3 provides an overview of some of the available solutions. With a conventional desktop deployment, a desktop and software inventory application would provide snapshot details of the desktop environment. Some of these management applications would also facilitate the process of managing application deployment to end-user desktops. Even though one or more of these solutions would be a beneficial addition to a fully virtualized desktop environment, their presence is a necessity in a decentralized physical desktop deployment.

Table 3 - Management Software Comparison Matrix

Software name	Vendor	Cost for DNV	Functionality	Currently used at DNV
Microsoft System Center Configuration Manager (MSCCM)	Microsoft www.microsoft.com	~$40/PC licence ~$600/management server license Total: ~$17,000	Provides remote management of PCs, including software deployment and reporting	No
Microsoft Group Policy Objects	Microsoft www.microsoft.com	Free with existing server and client licenses	Provides basic software deployment capabilities with no reporting	Yes

			functionality – difficult and time consuming troubleshooting	
Dell Kace	Dell www.dell.com	~$15,000	An appliance that provides software management and deployment for the desktops – subject to appliance maintenance and support costs	No
Spiceworks	Spiceworks Inc. www.spiceworks.com	Free	Provides passive data gathering on workstations that can be reached. Reports back on software and configuration of the workstations	Yes

Table 3 provides a sampling of free and commercially available solutions available on the market. The most popular solution is the MSCCM where both packaging and deployment of software is done through the management software Microsoft has provided for management of its operating systems. DNV IT has been using the free Group Policy Objects (GPO) alternative, where the network administrators package and deploy software to workstations using free Microsoft tools. This method is somewhat successful in pushing new software packages to workstations, however lacks the robustness to reliably wake from sleep or turn on from off the various DNV workstations. In addition, GPOs lack a comprehensive reporting module that would notify the administrators of the state of software installations for the deployed packages.

2.6   Operating Overhead

2.6.1   Staff Requirements

Management of workstations and their software requires technical knowledge to ensure smooth hardware operations and successful delivery of software packages. The District of North Vancouver's IT department has eliminated one on one and onsite visits for software installations. The use of replacement images has also reduced the need for having to troubleshoot a localize issue to a workstation. Staffing requirements are kept at a minimum for the operations; however,

the processes are still time consuming for existing staff and at times, require travel, development of complicated software packages and end-user interruption. Currently about 5% of the two network administrator's daily tasks and about 20% of the help desk's daily operations are dedicated to managing issues that relate to system imaging and software and application deployment.

2.6.2   Licensing and Software Requirements

DNV IT uses existing Microsoft sourced tools to manage image and desktop software deployments. These tools are all part of Microsoft suite of server and client side operating systems that provide the functionality required to manage a Windows desktop environment. The cost of operating system licensing is included in the desktops purchases. The server operating systems are purchased and paid for separately. The biggest client side licensing cost present at the DNV is the Microsoft Office suite applications cost. The Office suite of products is available on all of the organization's workstations. Additional licensing is applied to business system applications such as client and server licensing for JDE Enterprise One, Opentext's eDocs document management, Microsoft Exchange as well as Tempest and Tidemark Advantage applications pertaining to residential and business property and permits.

Most business applications at DNV have been in production through several desktop refresh cycles. These software packages are currently needed to operate business and end-user requirements and it is unlikely that these requirements and applications would change if different desktop technologies were put in place.

2.7   Summary

As a taxpayer funded organization, the District of North Vancouver is comprised of a traditional corporate leadership structure. DNV corporate structure includes executive and union staff who provide public services such as utilities, emergency management and garbage

collection. DNV also provides internal IT services to the employees of the organization including Enterprise Resource Planning software, a document management system, and management of workstations and laptops.

DNV IT focuses on aligning its Information Technology strategies, systems and structure with the strategy of the organization. DNV IT achieves this strategic alignment through selection and implementation of leading technologies while focusing on reduction of IT budgetary spending. In order to maintain and reduce IT costs, DNV IT focuses on reduction in IT administration and technology management tasks.

One important IT strategy used to reduce DNV IT management costs is standardization of DNV software and hardware. A standardized approach to hardware and software implementations ensures reduced complexity in maintenance and operations of IT services. Through technology standardization and efficient use of IT staff and tools, the District of North Vancouver IT department strives to achieve the strategic goals of the organization and deliver innovative technology solutions to DNV employees.

3: Situational Analysis

An IT infrastructure necessitates industry accepted hardware refresh cycles. In order to maintain a functional and reliable IT infrastructure, both hardware and software will need to be regularly updated to be able to meet the demands and growing business application requirements of an organization. The District of North Vancouver's IT department uses an industry-based hardware refresh cycle that includes recommended replacement periods for various technologies in use at the DNV. Various IT assets such as voice over IP phones, servers, switches, routers and end-point desktops are marked with their respective refresh cycles. The typical refresh cycle for desktops is four to five years. Beyond the five year period, there is an observed increase in hardware failure and reduced desktop performance. For the upcoming desktop replacement project in 2012, District of North Vancouver's IT department can evaluate emerging and potentially disruptive technologies for end-user desktops.

3.1   Traditional Desktop Implementations

As an integral part of the District of North Vancouver IT infrastructure, the endpoint workstations are the primary facility for end-users to access DNV's business applications and perform department-specific day-to-day operations. In 2012, DNV IT will need to outline its desktop PC refresh project. In the past, other options such as remote desktop application services offered by Citrix Systems (Citrix XenApp) had been evaluated as possible replacements to the physical desktop.

No solutions in the past have come close to fully replicating the desktop experience without degradation of the user experience. In fact, DNV IT completed its first Citrix XenApp implementation in 2003. The primary purpose of this project was to provide remote workers

access to the desktop applications that are normally available on employees' PCs. Despite its value to teleworkers, this technology was never deemed as a viable replacement to traditional desktops.

The new PC purchase process involves an RFP (Request For Proposal) and responses from PC vendors with pricing as well as features and services matching DNV's requirements. In the past, Seanix Systems of Richmond, BC was the vendor of choice, due to pricing, service and proximity to DNV. With Seanix Systems no longer in service, the upcoming PC replacement RFP would be won by one of the larger established PC manufacturing firms. Table 4 outlines the approximate pricing if similar specification desktops were being purchased today. These price quotes are obtained both directly from manufacturers and from District of North Vancouver's main value added resellers (VARs) such as Microserve Canada. The pricing is a preliminary quote and does not contain the final pricing at the time of purchase. The pricing presented is not specified for a particular volume of desktops; however, a 20% discount would be expected when a local government high volume (400+ units) order is placed. In order to obtain final pricing, an RFP (Request for Proposal) would need to be drafted to permit a vendor bidding process. The RFP for such a purchase would also include hardware support for 3 years after purchase to ensure usage continuity of the desktops for most of the ownership timespan. A new desktop rollout is not simply limited to publishing an RFP that includes technical specifications. Other requirements such as implementation and deployment processes are also proposed to the bidding vendors. One of the major milestones in an organization-wide desktop replacement is the actual deployment of the custom operating system – called an OS image – on all the workstations that are being delivered.

Table 4 - Traditional Desktop Vendor Pricing and Feature Matrix

Vendor	Key Specifications	Market price	MSO/Government pricing (-%20)
HP (www.hp.ca)	- Core i5 2500k Processor - 4GB Ram - 250GB or larger HD - Windows 7 Professional 64 Bit	$949 CDN HP Compaq 8200 Elite Small Form Factor PC	$760
Dell (www.dell.ca)	- Core i5 2500k Processor - 4GB Ram - 250GB or larger HD - Windows 7 Professional 64 Bit	$948 CDN OptiPlex 790 MT Fast Track	$758
Lenovo (www.lenovo.ca)	- Core i5 2500k Processor - 4GB Ram - 250GB or larger HD - Windows 7 Professional 64 Bit	$1,069 CDN ThinkCentre M91p	$855

The District of North Vancouver PCs contain a highly customized operating system image that would be sent to the hardware manufacturer ahead of deployment so that it is installed on the desktops that are to be delivered to DNV. In the past, this process was done easily with Seanix Systems, as they were a local supplier located in Richmond, BC. DNV IT staff had direct communication with the Seanix staff involved and could even visit the assembly plant in Richmond for greater involvement in the deployment process. The upcoming PC rollout would need to be done with the larger PC vendors like those outlined in the hardware comparison in Table 4. These vendors typically outsource the deployment and imaging process to third party IT shops or leave it up to the customer to manage it themselves. DNV IT has not made the decision whether to use in-house resources for customization of the operating systems on the new workstations; however, whether it is done in-house or subcontracted to another IT firm, additional costs would be incurred in the preparation and imaging of the workstations.

Once workstations are imaged and ready for deployment, the process of physical replacement of the workstations takes place over two or three weekends, where DNV IT staff will work for about 8 – 10 hours on the weekend to finalize the physical rollout of the workstations. Once the physical PC replacement has been finalized, there are custom applications and software that need to be pushed through the network to various users. This process is controlled by IT staff

and is done through Microsoft Windows' Group Policy Objects. This method has been used as a low cost alternative to using dedicated applications such as Microsoft System Centre suite of products to deliver applications to users' desktops. This method, though inexpensive, often proves somewhat challenging in being able to confirm the successful delivery of programs to the endpoint workstations.

The desktop implementation described is in keeping with the status quo of how end user workstations have been purchased, configured, deployed and managed. As with previous desktop replacement projects, it would contain newer hardware and software, including Microsoft Windows 7 Service Pack 1 release of Microsoft's most recent operating system offering. With Windows 8 not due out until late 2012 or early 2013 (Whitney 2011), Windows 7 would be the likely operating system. It should be mentioned that typically, the desktop replacement project is combined with an operating system replacement as well. The two are typically combined, given the logical approach to replacing the desktop hardware and software simultaneously. Since the past decade or so where PC desktops have dominated the corporate enterprise landscape, new questions can be raised as to the viability of a traditional desktop replacement, especially one that is meant to be the workstation of choice for the next four years. With the surging interest in cloud computing, both in private and public clouds, the premise of a VDI implementation – effectively in the private corporate cloud – raises new possibilities in addressing an old problem.

3.2 Virtual Desktop Infrastructure (VDI) Technology Analysis

VDI technology vendors have been promising significant increases in efficiency and a reduction in management and ownership costs of their software-based desktop offerings. As with any new technology, VDI has its strengths and weaknesses. There are clear advantages and hurdles in VDI adoption where an acceptable business case must be provided to warrant its adoption. An advantages-versus-disadvantages analysis can be helpful in determining an objective view of a VDI implementation to the status quo system implementation options. This

analysis will outline the strengths and shortcomings associated with such a switch in desktop

deployment and management at the District of North Vancouver.

3.2.1 VDI Advantages

A virtualized desktop implementation permits access to a conventional desktop's suite of

applications from any device with internet access. This includes all supported desktop and mobile

devices. Users will be able to gain access to their organization's content, applications and data

from anywhere in the world. VDI technologies use innovative methods of delivering access to

users' applications and productivity suite, through any mobile or desktop platform that is

supported. Employees can use devices such as mobile phones, tablets, laptops and desktops of

any flavour (i.e. Mac, Windows, Linux) to gain access to their corporate desktop workstations.

VDI systems do not only focus on remote employees and teleworkers, as they provide a cost

effective implementation for delivery of users' desktops within the organization. Very

importantly, a virtualized desktop environment has the advantage of providing the same desktop

experience for each employee, regardless of the workstation or thin client used to access his or

her corporate desktop.

VDI also promises reduced total cost of ownership by separating the physical PC or

laptop layer from the operating system that is being delivered to the endpoint computer. Desktop

productivity and operating system is no longer tied to the underlying hardware. Being hardware

agnostic, operating systems will be 100% compatible with the underlying virtual hardware. The

virtual hardware/hypervisor abstracts the hardware layer and trivializes requirements for

hardware compatibility. This is a key attribute of a virtualized operating system deliver method as

the organization is not continually forced to update its desktop operating system at the same time

a hardware refresh is about to take place or vice versa. The DNV IT department can focus on

performing an operating system update only when a valid business case warrants doing so. In

addition to separating the software and hardware refresh cycles, VDI provides a simplified

management of endpoint workstation operating system and software. Custom operating system images can be deployed from the datacentre and customized for each business unit or department. Endpoint workstations can be 'reset' or 'wiped' from the datacentre in a matter of minutes. This reduction in help desk management overhead provides a simpler process where desktops can be reset to original settings after a potential corruption due to user error, software bug or malware.

Similar to server virtualization, a VDI environment retains all data and information in a centralization location in the datacentre. This attribute not only provides high levels of control over data retention and backup, it greatly benefits a local government entity in regards to potential freedom of information (FOI) requests. With a VDI system, there is no longer a concern that intra-organization communication and documentation may have been stored on the local hard-drives of the many DNV desktop and laptops. Instead, the centralized system of managing desktops, the desktop applications and all the application contents ensures a tight control on any electronic form of data that has existed on the organization's desktops.

A virtualized desktop implementation opens the door for the possibility of changing organizational IT landscape by providing innovative solutions that empower local, remote and teleworkers to be able to access all of the organization's information technology programs and solutions from anywhere and at any time. VDI's software based desktop delivery solution permits the opportunity to change the way employees access DNV IT resources. Innovative concepts such as bring your own laptop/desktop/tablet can be implemented to permit significant flexibility in what type of devices employees use to perform their daily tasks. The flexibility concepts can be further extended to allow users to use new-to-market devices such as tablets and other mobile devices as potential viable replacements for end-user desktops. These devices can be particularly useful for roaming staff such as DNV inspectors (electrical, building etc.), bylaws, streets, and engineering staff.

3.2.2 VDI Pitfalls

As with any new technology, a proper business case is needed to ensure a return on investment can be attained. VDI technology is not a silver bullet for desktop solutions for all organizations. There are definite shortcomings and challenges to a VDI implementation that may make other alternatives a more appropriate solution. Virtual Desktop Infrastructures utilize relatively new technology with new implementation and operating challenges. The virtual desktop concept and products have been on the market for nearly a decade. The technologies and companies behind the products have matured and successful case studies and implementations are available; however, the challenges facing a VDI implementation are very different from those of a traditional desktop infrastructure. With new IT technologies, new challenges and issues will inevitably need to be addressed in areas of end-user experience, performance, IT staff training, capital and operating costs as well as vendor lock-in.

With VDI, initial infrastructure investment costs are diverted from the desktop endpoints to the datacentre. The total cost of ownership of a VDI implementation may be less than a traditional implementation over time; however, significant costs are associated with developing a datacentre that can support the seamless delivery of virtual desktops to the users' terminals (Sarrel 2010). Additionally, support, implementation training and consultancy will be required for a VDI implementation. In order to successfully deploy VDI in an organization, best practices and techniques will need to be used that may require the involvement of third party IT consultants. Even if implemented solely in-house, the support IT staff will need the necessary training to be able to implement, support and manage the virtual desktop infrastructure. Most of the IT training involved are specialized and provided by the respective VDI vendors, increasing the likelihood of vendor lock-in.

Another risk associated with VDI is a possibility of a degraded user experience. VDI solutions have significantly matured in being able to deliver a replica of typical desktop

experience, with full multimedia, and enhanced peripheral support. Even so, some challenges remain in being able to fully replicate the powerful physical desktop experience, i.e. smooth motion high definition videos, flash player applications and support of peripherals such as scanners and printers. Additionally, some workstations may not be replaceable: for example, workstations currently monitoring and connected to SCADA or high-speed scanners may need to remain as a traditional physical desktop. This would raise a further challenge of having to manage a mixed environment of virtual/physical endpoints.

A challenge with both desktop and server based virtualization is the need for compatibility with other hardware peripherals such as scanners and printers. Software packages that may not be suitable for a virtualized desktop environment would cause challenges for a VDI deployment. Any type of software application and hardware incompatibility with a virtual desktop environment would negate the adoption of such a technology. Once implemented, any compatibility barriers that present themselves due to the use of a VDI setup will nullify the many strengths and advantages of virtual desktop technology. In addition to compatibility requirements, the applications that are ported to the organization's private cloud are at risk of security threats to the VDI system. With a VDI setup, the end user PC's operating system and applications are no longer segmented from the rest of the user workstations. A virtualized desktop is part of the private cloud where it will be directly affected by any need for downtime due to security breaches and infrastructure failure (Sarrel 2010). Table 5 summarizes the advantages and disadvantages of VDI when compared to a traditional desktop environment.

Table 5 - VDI Advantages and Disadvantages when compared to Traditional Desktop Deployments

Summary of VDI Advantages and Disadvantages	
Advantages	**Disadvantages**
Innovative desktop management solution	New technology without widespread industry adoption
Operating system and application deployment agility and flexibility	Constantly changing technology introduces new challenges
Reduced long-term operating costs	Increased initial datacentre costs
A transparent user experience regardless of the device – user desktops are available anywhere, anytime	Possibility of underperforming, leading to a degraded user experience
Datacentre centralized management – reduced administrative labour required	May require training and certification
Abstracts or virtualizes the hardware layer of the desktop, focusing on software delivery	Possibility of reduced legacy and new hardware compatibility

3.3   VDI Vendor Analysis

There are several VDI vendors offering a full suite of VDI functionality delivered

through varying desktop delivery protocols. There are also two major concepts behind virtualized

desktop and application delivery. The two key methods of desktop virtualization are *client-side*

and s*erver-hosted* desktop virtualization. The main difference between the two is exactly where

the virtual desktop software resides. For client-side desktop virtualization, the *hypervisor* or the

virtual desktop software resides on the actual client device. Examples of this implementation are

products such as Microsoft Hyper-V, VMWare workstation or VMWare Fusion on the Mac.

Client-side virtualization is typically employed when the desktop user wishes to run an alternative

operating system, for example, when a Mac user wishes to run a Windows 7 virtual OS within

their Apple operating system (OS X). For DNV's desktop purposes, the VDI focus will be on

server-hosted desktop virtualization where the VDI processes and application reside on the

datacentre. More specifically, the VDI requirements will be a *Personal Remote Hosted VDI –*

RH-VDI (Henderson 2009).
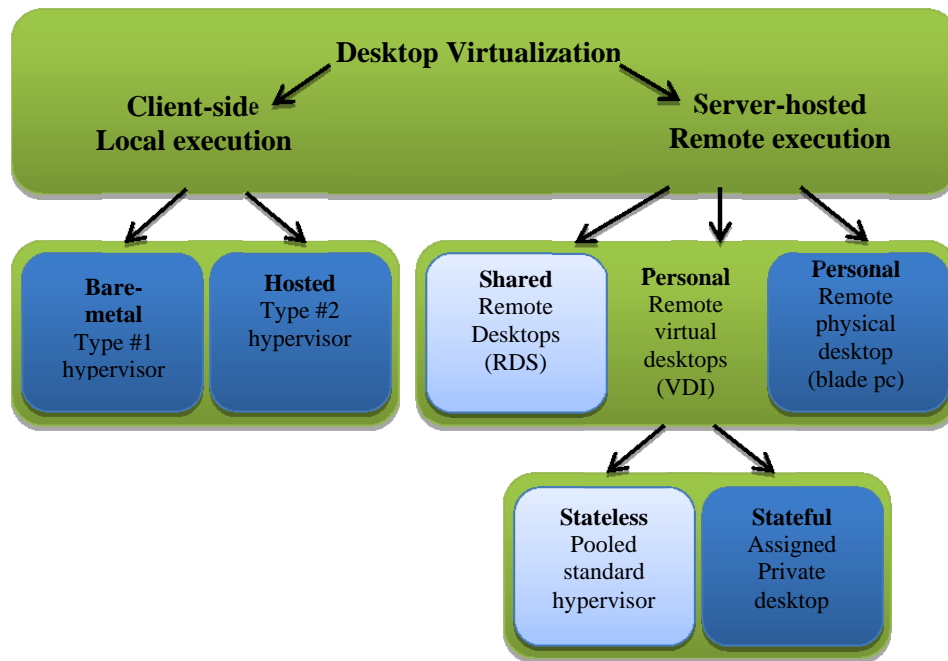
Figure 4 - Desktop Virtualization framework. The DNV VDI project focuses on
Personal Remote Virtual Desktops (VDI) (Spruijt 2011)

Three vendors are selected for the DNV VDI project candidates: Citrix XenDesktop,

VMWare View, and Microsoft VDI. The selection is made based on several criteria that include

market share, performance and peer reviews of the technologies; implementation cost to the

DNV; existing in-house IT technology and knowledge assets. Currently DNV's IT department

possesses infrastructure technologies from each of the mentioned vendors. In each instance, the

three vendors provide tie-in of their VDI solutions with existing DNV infrastructure products of

the respective vendor.

3.3.1   Feature Analysis

3.3.1.1   Citrix XenDesktop

One of the most significant products in the desktop virtualization space is Citrix System's XenDesktop offering. XenDesktop is somewhat more complicated than other solutions on the market. This solution requires a datacentre with an existing server virtualization environment. Citrix provides its own server virtualization platform in the form of XenServer. XenDesktop; however will function on competing virtualization platforms such as VMWare's vSphere and Microsoft's Hyper-V. The virtual desktop environment requires what is known as a *connection broker* that acts between the client and the VDI datacentre environment to broker a connection where the user is authenticated and then presented their virtual desktop. Citrix XenDesktop uses a Citrix specific remote content delivery protocol called ICA, which excels at delivering a desktop environment in low-bandwidth environments. A unique feature of the Citrix solution is the availability of its HDX technology. HDX enables the delivery of multimedia, 3D, VoIP, webcam and enhanced audio for the endpoint clients.

3.3.1.2   Microsoft VDI

Microsoft offers Remote Desktop Services (RDS) as a protocol used to allow the endpoint clients access to the datacentre hosted virtual desktops. As with the Citrix solution, Microsoft VDI requires a session broker, which authenticates the user and redirects their session to their respective virtual desktop environment. Microsoft has developed a multimedia enhancing technology similar to Citrix' HDX, called RemoteFX which facilitates the use of USB devices, 3D applications as well as high definition video and audio. One caveat of the Microsoft VDI offering is the requirement of using a Microsoft Windows 7 client to connect to the VDI session.

3.3.1.3   VMware View

VMware has gained popularity with its server side virtualization and in 2009 partnered with Burnaby, BC based Teradici for their display protocol that is developed especially for server-hosted VDI. Known as PC-over-IP (PCoIP), this protocol allows for significant enhancements to the end-user experience by delivering high definition video and audio as well as a seamless desktop experience (Valovic 2009). PCoIP can be delivered through integrated hardware such as LCD monitors with built-in PCoIP capabilities (i.e. not requiring any thin client or client workstation) or software based PCoIP. VMWare View acts as the software based PC-over-IP solution.

As an added benefit, VMWare View has the capability of a Local Mode for their virtual desktops. Local Mode allows the end users to

- Checkout a desktop from the datacenter to run on the client device regardless of network connectivity. Enjoy a full fidelity desktop experience with high definition and 3D support, full visual effects on Windows 7 as well as support for devices like web-cams and VoIP.
- Immediately get access to a replica desktop if the client device (e.g. laptop) fails or is lost.
- Availability of a variety of client devices that can be used to run VMWare View.

Each of the vendors has their own unique architectural design and in all cases, the vendor's incentive is to leverage the back-end server virtualization technologies they each offer. The virtualized private cloud is not limited to the servers in the datacentre. The three virtualization vendors described are competing for customer buy-in into their virtualization framework. It is important to note that each vendor offers compatibility of its VDI technology with a competitor's server virtualization technology, for example, it is possible to run a Citrix XenDesktop VDI system on a virtualized datacentre powered by VMWare's vSphere virtualization software.

There is also a consistent focus in trying to deliver a rich multimedia and 3D rendering for the end users. This is further indication that one of VDI technology's main drawbacks has been its traditional inability to provide a multimedia-rich experience to the endpoints. All three vendors also provide their own set of management suite and applications that help develop, maintain and deploy operating system images, user customizations as well as application delivery to the virtual desktops. Of the three, the Citrix XenDesktop and VMWare View manage to deliver an offline capability to the VDI implementation. Both vendors provide the ability for the endpoint client to be disconnected from the VDI datacentre while continuing to run on the virtual operating system. The virtual desktop settings are then synchronized back to the datacentre when the endpoint client regains network connectivity.

3.3.2   Cost Breakdown Analysis

The true cost of a VDI implementation is dependent on organization and business requirements. VDI is a drastic departure from the way physical desktops have been purchased, implemented and managed. For new firms interested in the technology, there will be unknown and surprise costs that will surface during the implementation. Comparing the pricing between the top three VDI vendors is also a challenging task. With constantly changing pricing and licensing models, it is imperative to contact the appropriate VARs (value added resellers) at the time of information gathering to perform a parallel pricing comparison.

Table 6 - Licensing and Pricing Information for VDI Solution - Obtained from DNV Value Added Resellers

VDI Vendor	Licensing	Editions	Selected Edition Pricing	District specific costs (OS license included)
Citrix Systems	- Per Device - Per User - Concurrent license	- VDI - Enterprise - Platinum	Enterprise - $295 per user	$400 if using existing hardware or 'bring your own computer' $1200 if using new thin client hardware
Microsoft Corp.	- Per user	- With software assurance - Without software assurance	Windows VDA – Virtual Desktop Access license pricing - $100/year/device	$200 if using existing hardware or 'bring your own computer' - $100/year/device after

			without software assurance	first year $1000 if using new thin client hardware - $100/year/device after first year
VMWare Inc.	- Per concurrent desktop	- Enterprise - Premier	Premier - $250 if not already using VSphere (not using VMWare for server virtualization) $150 if using VSphere already	$250 per concurrent desktop since DNV is an existing customer of VMWare VSphere (price includes Windows 7 License) $1050 if using new thin client hardware

The pricing outlined in Table 6 shows a simplified breakdown of a complex pricing structure that is associated with each solution. In all three instances, in addition to the cost of the VDI licensing alone, the cost of the Windows 7 Professional license, as well as a Microsoft virtual desktop 'tax' knows as VDA (Virtual Desktop Access) needs to be considered. This cost applies to all instances of Microsoft Windows running in a VDI environment. This VDA cost is waved if the organization has a *Software Assurance* agreement with Microsoft. The Software Assurance agreement is a 3 year commitment to pay a per device annual maintenance cost for Microsoft products. This allows the customer unlimited access to all Microsoft product releases during the three year period (Sturdevant 2009).

3.3.3   Product Lifecycle and Management

VDI offerings by Microsoft, Citrix and VMWare require annual maintenance payments for access to product support and upgrades. In most cases, the initial implementation cost includes the first year support and maintenance. Since VDI is a relatively new technology with a fast changing feature and pricing model, the product lifecycle process will be significantly different from that of traditional desktop deployment. With a virtual desktop infrastructure, it is no longer relevant to tie the desktop hardware and operating system lifecycle. If the organization wishes to move away from its current endpoint devices to a new and innovative product, such as tablets or capable mobile devices, the flexibility of a virtual desktop will facilitate the transition.

Consequently, if the organization wishes to shift their desktop operating systems to a newer version release of the operating system, or a different operating system vendor altogether, rapid delivery and flexibility of a VDI system will facilitate the change.

VDI vendors have frequent updates, patches and major version releases of their products. A significant difference in moving the desktop environment into the datacentre is the need for a highly available and reliably virtual desktop delivery model that will not permit for any virtual desktop downtime for users. The high availability and redundancy systems are built into the various VDI offerings and are particularly robust for VMWare View. Being a pioneer in the virtual server space, VMWare has perfected the high availability (HA) and fault tolerance needs of the enterprise for both server and desktop virtualized instances. Both Citrix Systems and Microsoft offer their own HA capabilities, ensuring virtual farm uptime.

3.4   Aligning DNV Corporate Strategy with VDI Vendor Functionality

A recurring question with virtual desktop infrastructures is the net benefit of such a project for an organization. VDI Vendors tout cost savings in both capital and operating expenditures as major drivers for VDI adoption. With the continual reduction in hardware costs and increased hardware reliability, it is difficult at times to justify the potentially significant capital expenditures required to implement a successful VDI project. Most importantly, an organization needs to evaluate its needs for a VDI implementation. In some cases, virtual desktops may be a solution searching for a problem. If an organization does not have the need for multi-platform support, remote teleworker full desktop access and reduced endpoint management operating costs, a VDI solution may not be needed.

The District of North Vancouver IT strategy has been focused on cost reduction and efficiencies in the organization's IT infrastructure. Even though capital cost savings may not be an immediate benefit of a VDI environment, the benefits of operating efficiencies and a reduction

of endpoint issues and incompatibilities cannot be ignored. Additionally, with the introduction of tablets and cloud based computing concepts, end-users will have a greater demand for DNV software application availability anywhere and at any time. It can be argued that DNV IT is currently delivering anywhere/anytime application availability through its Citrix XenApp farm; however, in practice, the Citrix XenApp and user desktop environments are regarded as very different entities by both DNV IT and the DNV employees.

The multi-organizational facet of DNV, with library and recreation services running as shared services, allows a unified virtual desktop infrastructure to leverage the network connectivity between the three organizations to provide a flexible and centrally controlled desktop system. One significant challenge to this would be the process of centralizing IT services for the DNV, library and recreation facilities. As of today, the three IT entities are run independently when it comes to endpoint desktop management and implementation.

Currently DNV IT has technology investments with all three VDI vendors. DNV's desktop and server operating system as well as the Office suite of products are Microsoft software. The District's remote application access is based on Citrix' XenApp software while VMWare powers the DNV's virtual server farm of 60 virtual machines (VMs). As far as vendor lock-in is concerned, any of the three vendors has a presence in the organization's IT infrastructure. The two key standouts however are VMWare and Citrix. Since VMWare already powers the virtual server back-end of the datacentre, there will be significant cost savings if DNV IT choses VMWare's VDI solution.

3.5 Summary

As with previous desktop refresh cycles, DNV IT will be carrying out an organization-wide desktop replacement project in 2012. This year, the DNV IT department has the choice of selecting a VDI solution provider as the desktop infrastructure technology. A VDI solution

provides advantages such as reduced long term operating costs and increased desktop operating

system deployment agility. VDI may also pose adoption challenges due to high initial capital

costs and IT staff training requirements.

Three server-hosted desktop virtualization solutions logically emerged as potential

vendors for a DNV VDI implementation. The chosen products are Citrix System's XenDesktop,

Microsoft Corporation's VDI, and VMware Inc's View. The three VDI solutions differ in terms

of features and functionality but are priced competitively with one another. DNV IT will need to

examine the available VDI technology solutions and ensure that DNV corporate IT strategies

such as cost reduction and enhanced remote worker access are addressed with the chosen desktop

replacement technology.

4: Problem Alternatives and Cost Comparison

The District of North Vancouver's IT Department's strategy of delivering world class IT services to its employees while striving to reduce IT infrastructure capital and operating costs will require adoption of innovative and strategic technology decisions. A virtualized desktop environment nets a lower electrical consumption footprint and reduces on-site IT support for remote buildings, minimizing the need for inter-building transportation. These and other attributes of VDI discussed in this project highlight the advantages of a virtualized desktop environment at the District of North Vancouver; however, discussion of a VDI implementation project will need to include viable solution alternatives.

A VDI implementation is a dramatic departure from a traditional implementation and may be a costly project to implement. When considering problem alternatives, other similarly innovative approaches can be taken to address DNV's IT Desktop requirements. The goal of the problem alternatives is to evaluate existing and emerging technology trends that can be leveraged to solve the desktop replacement project needs of DNV.

Virtualized desktop products have been available on the market for several years; however, businesses have not been universally keen in the uptake of VDI technology. That said, some organizations are beginning to see the benefits of this technology, just in time for new innovative desktop trends to gain momentum in enterprise IT. Some examples of emerging trends in corporate IT include delivering software-as-a-service based products, renting desktop and server environments through third party clouds or allowing employees to use their own personal computers and mobile devices for work. There are numerous problem alternatives available to a VDI implementation. The goal is to decipher the advantages of each alternative and outline its strategic fit into the District of North Vancouver's short and long-term desktop computing needs.

4.1   VDI and Traditional Desktop Strategic Alternatives

A successfully implemented Virtual Desktop Infrastructure adds flexibility and greater adaptability to an organization's desktop IT infrastructure. A VDI solution however, is not an appropriate solution to every organization's desktop strategy. Clearly, alternatives need to be considered that permit variations of traditional, current and emerging trends in desktop management, deployment and application delivery to the desktop users.

Just like their private sector counterparts, public sector organizations have been under pressure to implement and manage an electronic work environment (IT-Observer 2006). With the emergence of a mobile workforce and new generations of technically competent employees, public sector organizations such as the District of North Vancouver need to provide a technically innovative work environment. Employees now have higher expectations of a mobile work environment where all of the organization's e-business services and content are provided in a readily accessible fashion, from anywhere and anytime. It is this need for an always available and portable IT delivery solution that necessitates DNV's desktop strategy to include alternatives such as: cloud based software delivery, incorporation of greater application virtualization without the need of desktop virtualization, innovative policy initiatives such as bring-your-own-computer, or mixture of high-end physical and lower specification virtual desktops addressing average desktop computing needs.

4.1.1   Organization-wide VDI Deployment

The District of North Vancouver's IT department project strategies aim to ensure simplicity and consistency in systems design. A good example of a more out-of-the-box approach would be the JDEdwards ERP implementation. The goal of the ERP software implementation was to ensure that it is kept as close to a standard deployment as possible. Even though it is possible to apply code-based customizations, the DNV business analysts have been resolute in

maintaining a simple, out of the box setup for the ERP software. This approach has helped reduce product support issues and allowed for trouble-free upgrades.

In an effort to reduce support calls, DNV's IT management group strive to implement standardized hardware and software within the organization. For example, all of the organization's networking equipment is manufactured by Cisco Systems, or all of the smart phones are Research In Motion Blackberries. This consistency in hardware and software implementation has proven to reduce support and management overhead for IT staff. Likewise, the current production desktops in the organization are over 400 workstations that are identical to one another in both hardware and software settings. This allows for easier troubleshooting and support consistency resulting in significantly reduced IT support overhead. If a problem is detected on one workstation, it would likely be reproducible on another and as such, the resolution for one PC would be applicable on all workstations.

The same strive for a consistent infrastructure can be used for the first strategic choice available for DNV IT's VDI project. A DNV-wide replacement of all of the current physical workstations in favour of virtualized instances of the operating system would ensure a consistent desktop landscape for the entire organization. The support staff would only need to be aware of support issues related to one platform of user desktops. As well, the physical thin clients deployed to end-users would all be identical hardware with similar specifications and warranty contracts. The one-time switchover approach of replacing all desktops with VDI counterparts would ensure a fully virtualized environment that indicates a complete adoption of the virtualized desktop model.

There are of course, challenges with an all or nothing VDI implementation. A fully virtualized desktop environment may not be suitable for all of the organization's business requirements. For example, streets and utilities engineers who are heavy graphical and CAD (Computer-aided design) users may suffer with potentially lower-performing virtual desktops

when compared to their outgoing physical workstations. The Finance department may not have sufficient system response and performance to ensure reliable and efficient processing of their financial and analytical models. Another significant challenge with a full-VDI implementation is the potential lack of end-user acceptance and adoption. If the switchover is unsuccessful and triggers any productivity outages, the organizational acceptance of this project would be in jeopardy.

In order to ensure a smooth virtualized desktop transition, the project team needs to provide sufficient time during the pre-rollout testing phase in order to identify the deficiencies of the VDI system for the business applications in the organization. By securing end-user buy-in through demonstration of VDI features such as the anytime/anywhere availability, lower power consumption footprint as well as easier and lower cost management, the VDI implementation team will be able to significantly improve the success rate of the project.

4.1.2   Mixed VDI and Physical Deployment

Although it would not achieve a consistent desktop ecosystem, a mixed environment of virtual and physical desktops would permit flexibility for DNV employees. For end-users who do not require significant performance from their desktop, the VDI option would be suitable; whereas for power-users who require high performance computing systems, traditional physical desktops would be provided. This approach would result in a mixed hardware and software vendor environment with multiple sets of management tools, licensing and warranty service contracts.

The mixed environment approach would net a higher capital and operating cost due to a lack of a pricing advantage over a standardized deployment approach. Aside from the evident requirements to purchase two or more sets of desktop hardware for end-users, support and maintenance tasks would be further complicated due to the heterogeneity of the desktop

environment. Support staff training and education costs would also increase given the need for intimate familiarity with two different sets of technologies. This solution would ensure a greater level of end-user satisfaction as the desktop products provided would be customized for the user; however, the additional cost and strain associated with supporting and maintaining a non-standardized system such as this will be high.

4.1.3 VDI over Existing Hardware

All three of the VDI vendors chosen for analysis in section 3.3 are capable of running their respective VDI technologies on conventional "fat" clients. The term fat client refers to typical workstations, similar to the ones that are to be decommissioned next year at the District of North Vancouver. For the first three years of ownership, the Seanix Systems supplied desktops at DNV have had an average failure rate of 2%. This accounts for roughly six desktops per year that have required repairs and parts replacement by the remnant services of the now defunct Seanix Systems. During the last 6 months, however, warranty calls have no longer been answered by the remaining support staff at Seanix and it appears that the last (4th) year of warranty service will not be honoured. This leaves DNV IT with the choice of a unique strategic approach to the VDI deployment.

It would be possible for the VDI project team to use the existing Seanix fat client hardware as the intended "thin" clients to host the virtualized desktops' end-point requirements. Essentially, the VDI project would be deployed normally, except that there would be no need to acquire new endpoint thin clients. All three of the short-listed VDI vendors could run their respective virtualized desktop instances on the existing DNV fat clients. This approach would result in significant cost savings in terms of hardware purchase and would focus all financial and technical resources in maintaining a robust and redundant VDI datacentre. This datacentre would be able to serve the hundreds of virtualized desktops being delivered to the existing endpoints.

While using somewhat dated, out of warranty hardware would provide significant cost savings, it would introduce complications when desktop failure rates continue to rise beyond the annual 2% average. One possible strategic solution to this problem would be replacement of the out of service fat clients with newly acquired thin-clients designed specifically for a VDI environment. This approach would have the advantage of only replacing the hardware that needs to be replaced. Since in a VDI environment, an end-user desktop will look and function the same way, no matter what endpoint hardware is used, there would be no disruption to the end-users when their endpoint hardware would need to be replaced.

This alternative would introduce a mixed endpoint hardware environment requiring maintenance of two sets of hardware. The difference between this strategy and the one mentioned in section 4.1.2 is that since the warranty support is already unavailable on the Seanix workstations (turned thin-clients), there should not be any need for support and maintenance overhead for these devices. As the old Seanix hardware begins to fail, it would be replaced with a standardized thin-client model. The cost of the thin client purchases would be procured out of an annual desktop capital budget.

4.1.4 Software as a Service through the Cloud

Although VDI can add a significant level of flexibility in the enterprise, it will require high initial capital costs, management adjustments and staff retraining. Traditional desktops on the other hand, provide a proven endpoint deployment and management model that poses little risk and delivers the steady state functionality expected by the organization's employees. One area of corporate IT that is gaining some momentum – at least a marketing backed one – is cloud computing. The concept of delivering software as a service through an external public cloud has been around from the early days of web-based services such as Hotmail or AOL. The cloud computing designation further extends the availability of services and functionality outside of the enterprise and into infrastructures developed and managed by third party IT services

organizations. Today, with the assistance of marketing campaigns, traditional software and IT services vendors are pushing their cloud-based solutions that can deliver features and functionalities that have traditionally been only available within organizations' IT infrastructure. With the continual development and advancement in internet availability and performance, as well as advancement of web technologies and services, running essential business services in public clouds is becoming a viable alternative.

DNV's desktop applications range from web browsing, office productivity including email messaging, documents and records management, intranet and content management, permits and bylaws management application, a sophisticated ERP (Enterprise Resource Planning) implementation, property information and management, fire services and inspection database and various other services that are delivered all in-house to the end-user's desktops. In total, over 30 types of applications and services are currently provided to the DNV employees. It is unlikely that all of the applications can be easily moved to a software-as-a-service (SaaS) model in a public cloud. However, some services, such as email messaging, document and intranet content management can be adapted to a cloud delivery model. The challenge facing this form of software delivery is as with any other cloud-computing platform. There are content security concerns as well as high availability of the services (outlined in Service Level Agreements) and for some organizations, the location of the datacentre housing the organization's data (i.e. whether it is in Canada or the US).

Cloud services would address the need for location-independent service delivery where remote and teleworkers can gain access to content just as easily as in-house employees would. Currently this functionality is addressed by the Citrix XenApp services being offered by the District of North Vancouver. Cloud based computing is also intended to provide a cost advantage when compared to in-house delivery of applications. If cost savings are not reached for the same level of features and functionality on cloud based alternatives when compared to the in-house

service delivery model, the advantages of the former become significantly diminished. The SaaS and cloud-based service vendors rely on renewable monthly and annual service payments by their customers. Depending on the organization's long-term financial strategy, a recurring *leasing* model of service payments would be undesirable. On the other hand, if the pay-as-you-go model is perceived as providing a stable capital and operating expenditure model for the organization's IT services, then the advantages of cloud-based services would be further amplified.

Given DNV's IT software and services, it is clear that not all of the IT offerings would be moved to public clouds. The organization's requirements for complete data ownership and management of its financial, procurement and payroll services for example, would not be met in public cloud offerings – no matter what the cost differential. As with VDI, a cloud-based delivery model would not be a silver bullet for all of the services, however a hybrid approach could offer the best of both implementations. The challenge with this alternative is that regardless of the chosen solution, user endpoint devices would still require access to cloud based offerings. Most importantly, in a hybrid cloud/internal software service offering, there would be no change to the need for a new desktop deployment. In fact, having low-cost lightweight PCs would be the most economically sound solution; however, an organizational management of the PCs would still be a requirement.

4.1.5   Extended Private XenApp Cloud with Bring-your-own-computer

The concept of bring-your-own-computer (BYOC) has gained some traction and various organizations are embracing the idea of allowing employees to utilize their personal computers as their work PCs (Padmanabhan 2011). The benefits of this strategy are that the costs of maintenance and management of endpoint computers are now removed from the DNV's IT department. This solution would only be viable if DNV IT has technology in place that could leverage a private or public cloud offering of applications to end-users personal computers. This solution is an interesting option as all cloud software delivery models could be a suitable

complimentary fit. For example, if DNV IT provided a full Citrix XenApp virtual application delivery environment, or a VDI, or public cloud SaaS model of service delivery, the option of BYOC would be a viable one.

Challenges with a BYOC model would include union and finance approval of a subsidized or allowance-based model for personal computer purchases. Since computer purchase allowances would be considered taxable income, employees and the employee union would likely disapprove of the BYOC model. As well, the lack of DNV IT support for end-user devices would not be accepted by all employees. As such, the BYOC model would have little buy-in and face resistance from DNV employees.

A notable issue with a BYOC model would be the increase of the security risk scope associated with the DNV network that would include unmanaged personal workstations. It would be imperative that this model allows for a clear demarcation and separation of content and potential malware from the employees' personal computers and the IT software services offered by DNV. As with any traditional desktop alternative solution, the key would be alignment of this project with the strategy, systems and structure of DNV IT. If the IT strategy is to increase endpoint flexibility, reduce both capital and operating cost of maintaining end-user workstations, then the systems and infrastructure must be in place to allow delivery of streamed and web-based applications to the end-users' personal computers.

4.2   Solution Analysis and Cost Comparison

Given the rapid advancements in consumer computing expectations, it is important for organizations to not only take advantage of the capabilities of end-user devices, but to empower their employees with the flexibility to work on or off-site. Given the four-year PC refresh cycle at the District of North Vancouver, and the current changing trend away from simple desktop PCs and towards portable devices such as tablets and smart-phones, it behoves the organization to re-

evaluate DNV IT service delivery. Although relatively inexpensive and proven, a traditional

desktop implementation may not be able to address the flexibility and changing trends of

organizational IT in the coming years. A VDI implementation, although initially costly and

unfamiliar to the DNV IT department, would allow for flexibility in order to deliver a private

cloud based virtual operating system to the DNV endpoints. VDI would permit the flexibility to

deliver the same in-house desktop operating system on any platform whether it is a PC, Mac,

Linux, tablet or a mobile phone. As discussed, there are some drawbacks to implementing a VDI

solution and it may not be suitable for all organization types. The comparison matrix in Table 7

outlines DNV specific requirements and advantages that a VDI system will be able to provide.

Based on the information provided in Table 7, it is clear that a VDI implementation

would be advantageous in terms of operating and capital expenses strictly from an

implementation cost perspective. Other cost savings of a VDI system would be further realized in

a reduction of IT support and management. Despite the need for training, the VDI alternative

would require reduced support hours in the long term.

Table 7 - VDI and Conventional Desktop Cost Comparison Matrix – obtained from quotes from DNV VARs

Desktop Technology solution	Capital Costs	Operating Costs	Management	Training
Conventional desktop	$400,000	Included in purchase	Existing free solutions – purchase of $15,000 management software suite	None needed
VDI	$250,000 if using existing endpoint hardware – $300,000 if thin- clients used	$20,000 / year licensing	New Management Suite as part of implementation	Required for Network Admin and Help Desk Staff
Mixture Conventional and Cloud	$400,000	$45,000 / year depending on software being used	Existing free management solutions	None needed

5: Balanced Scorecard Analysis

An organization is comprised of various departments with differing immediate projects and goals. The ultimate objective for each department and division's strategy should be alignment with the overall organizational strategy. This strategy congruency is not measured without tools that would allow for both a quantitative and qualitative comparison metric. A before and after comparison of the organizational benefits that can be obtained from a project is needed to outline the potential opportunities and risks involved.

A Balanced Scorecard can help bring focus to the organization's strategy and outline the goals needed to obtain its strategic vision. Although the Balanced Scorecard is typically applied at the organizational level given that it helps foster the strategic alignment between departments, the IT department can benefit from a dedicated scorecard to itself. According to David Norton, one of the co-creators of the Balanced Scorecard, the main difference between an IT specific Balanced Scorecard and one that is applied at the organizational level is that the "customer" is an end-user within the company itself and not an external consumer (Berkman 2002).

5.1 DNV VDI Balanced Scorecard

For the DNV desktop replacement project a Balanced Scorecard can weigh the attributes of a VDI implementation and help identify the strengths of this project with respect to the end-user benefits and the organization's overall strategy. With a project Balanced Scorecard, the project's net gains can be analysed and assessments can be made regarding the potential outcome of various project goals. The Balanced Scorecard will allow for an in-depth assessment of the VDI project, highlighting key facts beyond simply outlining the numbers and costs of the project,

instead, showing what the key stakeholders, including the organization, as a whole will stand to gain or lose from the project.

Table 8 details the DNV desktop replacement project Balanced Scorecard and is broken down into the traditional Balanced Scorecard perspectives of Finance, Internal Business Processes, Learning and Growth and Customer. In this case, however, the customer perspective will be the DNV end-users (the DNV employees) – as they will be the consumer stakeholders of the desktop replacement project. Table 8 provides metrics needed to conclude a strategic recommendation on DNV's desktop replacement solution. The VDI route or any of its strategic alternatives are weighed against the criteria set out by the Balanced Scorecard. Each section of the four Balanced Scorecard perspectives is assigned a weight percentage that reflects the degree of importance of the section. The section weight values were assigned based on the discussion results with the DNV IT management who are the ultimate decision makers to the direction of the desktop replacement project. It was concluded that the desktop replacement project's Balanced Scorecard would need to focus on the financial, customer and process perspectives. The DNV VDI Balanced Scorecard's weight breakdown emphasises the importance of operating and capital costs savings while delivering excellent customer service experience through improved endpoint management desktop processes.

Table 8 - Desktop Replacement Balanced Scorecard

DNV Desktop Replacement

Project Scorecard Matrix

Scorecard Perspective	Objective	Measure	Target	Priority	Initiative	Data Source and Sharing	Weight (100% total)
Financial	Maximize ROI while minimizing cost on desktop replacement project	Spending within or less than the approved $400,000 budget	< 10% at project end - cannot go over budget	High	Issue Request For Proposals and cost and service based vendor selection	RFP and financial documents created in eDocs document management system - include eDocs document numbers	15%
	Minimize operating costs of desktop solution	Reducing the operating costs of desktop solution below 20% of project capital expenditures	< 20% of capital project costs to be annual operating costs	High	Review RFP and operating costs for the various solutions	RFP and financial documents created in eDocs document management system - include eDocs document numbers	20%
Customer - DNV end user (DNV employees)	Stakeholder Expectations	Level of expectations managed	+ / – 5% variance	High	Customer surveys show approval of new desktop solution	Meeting minutes and emails from customer feedback	10%
	Technology Security	Increased or decreased security risk exposure and scope	< 10% increase in security scope	Med	Security audit to assess scope of security exposure	Audit reports and security team meetings	5%

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	Support for customer devices such as mobile and tablets	Percentage of platform support such as mobile, tablet and operating system such as Microsoft Windows, Mac OS X, Linux, iOS and Android	100%	Med	The desktop replacement solution should also include a platform agnostic support for business and productivity applications	Platform testing trials results reviewed in department meetings	10%
Internal Process	Desktop problem resolution	Mean resolution time	< 4 hours	High	Implement desktop issue-resolution improvement process and technology	In-house issue tracking system and customer emails	10%
	Desktop deployment	Mean deployment time	< 1 hour	High	Implement an improved desktop image deployment system	Reports from help desk technicians during weekly Wednesday meetings	10%
	Software deployment	Mean deployment time	< 1 hour	High	Implement a rapid application deployment system	Reports from help desk technicians during weekly Wednesday meetings and end-user follow-ups	10%
Learning and Growth	Team Training	Percentage of team members trained	100%	Med	Create training timeline	Training schedule, training session documentation	5%
	Team Certification	Percentage of team certified	> 50%	Low	Schedule certification sessions	Training schedule and certification material	2%
	Team expertise in functionality	Use advanced technology features of the implemented desktop system	> 50%	Low	Attend user conferences (online and offsite) to learn advanced technology features	Reports from post conference sessions	3%

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5.2   Balanced Scorecard Analysis

From a financial perspective, it is evident that a full VDI implementation will incur less capital cost than a DNV-wide conventional desktop replacement. The degree of capital expenditure reduction will depend on the extent of virtualization of the end-point devices. For example, the mixed VDI and conventional desktop option produces little capital cost reduction when compared with the VDI, SaaS or BYOC alternatives. Inversely, the strategic alternative that retains as much of the status quo, will net a lower operating cost due to the elimination of the need for training, certification and subscription expenses.

The DNV IT end-users need a desktop infrastructure that delivers stability, performance, functionality, ease of use and mobility. The full VDI environment holds promise in delivering on these values. A full VDI alternative poses the risk of not being able to address the performance requirements of power users. Pre-implementation testing would be necessary to ensure adequate virtual desktop performance is available for these special desktop users. Several strategic alternatives provide options for mixed, public, and private cloud-based services. As outlined in the Balanced Scorecard breakdown, a mixed VDI and conventional desktop environment would help address end-user requirements that cannot be met by a VDI solution.

Additionally, private and public cloud offerings would need to be thoroughly tested to ensure acceptable user experience and functionality. Interestingly, the BYOC (Bring Your Own Computer) option would be the most polarized alternative. For more technically inclined users, the option of using computers that they have selected and with which they are the most comfortable, would be an excellent choice and provide maximum freedom. For less technical employees who do not have a work computer preference nor wish to manage the support of a personal computer for their work environment, this option would be unacceptable. The premise of

end-users managing the hardware and maintenance of their work computers would likely result in lower customer satisfaction levels.

The security implications of the various alternatives presented needs to be assessed. Given DNV's existing centralization of corporate data and secured content, migration from a physical desktop environment to a virtualized one would not require additional security considerations. Additional security systems would have had to be implemented, had remote access via Citrix XenApp technologies not been implemented already. Given the existing security infrastructure there is little change needed to configure a VDI system within the same security structure. Alternatives such as BYOC or SaaS-based application delivery would increase the scope of devices and networks where data breach and malware risk could occur. For these two alternatives, additional security risks and increased exposure to infections are more likely.

Internal processes involving application and desktop deployment benefit from a software-based management approach, as provided by a virtualized desktop system. To be able to simply "reset" or redeploy an end-user desktop due to corruption or virus infections for example, is a major attraction of a VDI implementation. Virtualized desktops allow for an immediate application delivery process. For example, if an end-user requires access to Microsoft Project on their desktop, a simple phone call to the Help Desk and a few minutes would be all that is needed for the new application to be made available to their virtual desktop. The time saving promise of a VDI environment regarding application and desktop delivery clearly portrays the advantages of a fully virtualized desktop implementation.

As with any new technology implementation, training and certification will be needed for in-house staff to ensure efficient and problem free operations. A VDI implementation will require DNV IT staff to become well versed in the capabilities and nuances of a non-physical desktop infrastructure. Compared to a conventional desktop system where the IT staff members have previously developed specialization and gained valuable management experience, a VDI solution

will necessitate the need for training and knowledge gain. The familiar conventional desktop system has a distinct advantage over any new technology with respect to IT and end-user training requirements.

5.2.1 Organization-wide VDI

From the financial perspective of the Balanced Scorecard, a completely virtualized desktop environment would require significant investment in infrastructure. The costs of upgrading the back-end datacentre as well as endpoint devices to thin clients would be close to that of a full physical PC replacement. Even though initial capital cost savings would not be achieved by a full VDI implementation, the long term cost benefits and reduced total cost of ownership (TCO) would be advantages of the virtualized desktop platform. The reduced cost of ownership has high merit from the IT management's perspective and is an attribute of the VDI system that makes the project even more attractive.

An organization-wide VDI solution would better address stakeholder expectations. The VDI solution would allow for a more rapidly deliverable and customizable end-user desktop experience while facilitating a simpler and more effective management suite for IT support staff. With new endpoint hardware and software-based virtual operating system delivery, a full VDI setup ranks high for the customer service perspective in being able to deliver user desktops on multiple platforms from anywhere in the world.

Due to the existing centralization of DNV data at the datacentre, a full VDI implementation would not expose the organization's secured content more than a conventional desktop system. As well, for employees, accessing their virtual desktops from offsite locations, no additional security issues would exist. When accessing a virtual desktop remotely, an employee would still be accessing an operating system and data that only exist on DNV's datacentre. Furthermore, the established connection between the remote employee and DNV's

VDI infrastructure would be using an encrypted tunnel similar to the current Citrix XenApp remote access technology that is available to DNV employees. Additionally, the VDI architecture has the security benefit of creating silos for each employee's virtual desktop customizations and as such safeguards against the spread of malware and viruses between virtual desktops and the core VDI infrastructure in the datacentre.

Internal IT processes of desktop management, customization, repair and troubleshooting would benefit from a rapidly deployable software-based operating system solution. The full VDI solution delivers on the promises of quick desktop image deployment, while enabling IT support staff to reset end-user desktop environments in the case of malware infections or software corruption. The premise of empowering IT workers to dynamically modify and deploy the operating system and business application to endpoint devices is a beneficial attribute of the full VDI project, one that is reflected in the weighted scores in Table 9.

Being a new technology implementation for the DNV IT, the VDI solution will present new learning and management challenges that would require training and certification on virtual desktop technologies. As with most vendor-sourced technologies, it is also recommended that the IT support staff obtain certification in how to best manage and operate the virtual desktop infrastructure. Less weight has been placed on learning, certification and expertise for this technology in the Balanced Scorecard by the DNV IT management staff. Even though VDI would be a new and innovative technology implementation, the DNV IT staff members have the capacity to rapidly familiarize and develop expertise in the technology.

5.2.2   Mixed VDI and Physical

Unlike an organization wide VDI implementation, a mix of physical and virtual desktops would be a compromise made by the DNV IT management to safeguard stakeholder satisfaction. By allowing those end-users who require the performance benefits of a physical workstation to

retain their physical desktop, this alternative would allow for an ideal compromise from the end-user perspective. The major challenge with this alternate would be increased capital and operating costs as two very different desktop systems would have to be acquired, configured and managed. This alternative also negates the IT support cost savings associated with a standardized desktop solution.

As outlined in Table 9, the mixed desktop approach would address stakeholder expectations of providing what the end-users believe to be the best fit for their desktop computing needs. However, a mixed physical and virtual desktop approach maintains the challenges and costs associated with a VDI implementation as well as those associated with a traditional desktop infrastructure.

5.2.3   VDI over Existing Hardware

One of the major advantages of a VDI system is the possibility of using a mixed endpoint hardware platform to be used as thin-client hosts for the virtual operating systems. It is possible for the DNV IT group to retain the existing old hardware in the organization and use the out of warranty desktops as thin client endpoints for running the Virtual Desktop Infrastructure. This approach would address the high initial costs of a VDI implementation by removing the need to replace endpoint devices. This alternative would provide the operating cost advantages of a virtualized desktop environment along with the same IT process improvements that a full VDI implementation would deliver.

Though operationally and financially advantageous, VDI over existing DNV desktop hardware would pose a challenge in how to manage the out-of-warranty Seanix desktops being used as thin-clients. One possible solution would be to replace any defective old workstations with new thin-clients. This approach would result in a mixed endpoint hardware environment that would pose the same IT support challenges as a mixed VDI and physical environment would

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create. Although scoring high in the Balanced Scorecard in Table 9, this alternative would also add to end-user frustration and fail to maintain stakeholder expectations given an increased endpoint failure rate. This alternative scores high in the VDI Balanced Scorecard (Table 9), and provides most of the advantages of a full-scale VDI implementation. The lack of new endpoint hardware replacement, however would introduce risks and challenges in an otherwise ideal VDI implementation.

5.2.4   Software as a Service through the Cloud

DNV IT management should not ignore the current trends in cloud based computing where infrastructure costs are diverted from the organization and into cloud service providers such as Google and Microsoft. Cloud based business application delivery is still at its early stages and it will take some time for cloud based services to be able to replace most in-house software deployments. With the upcoming desktop replacement project at DNV, it would be possible to take advantage of the new business application cloud based offerings and attempt to migrate some DNV applications away from the in-house datacentre and into third party cloud services.

Given the infrastructure sunk costs and investments, migration of over 2 million DNV documents and several million database records of enterprise data over to third party solution providers would prove to be an extremely costly endeavour. Additionally, given the sheer volume of data managed by DNV IT, the perpetual usage fee of cloud services would result in very high operating costs. The DNV IT management team aim to reduce IT operating costs and are encouraged by the organization's CFO to focus IT expenditures on initial capital costs while minimizing recurring operating expenses. The financial perspective of the Balanced Scorecard does not favour cloud-based business application delivery given the very high capital and operating expenses involved.

The software-as-a-service (SaaS) alternative obtained high scores in customer satisfaction, as it would deliver functionally identical applications through third party cloud services for end-users, making the services available anywhere and at any time. Since cloud-based applications would be web-enabled, users could also use mobile and tablet devices to access the resources. As most consumer applications are now web-based applications, such as Google Docs, Hotmail or Gmail email services, DNV employees would likely adapt well to cloud-based application delivery.

SaaS implementations present an inherent risk to an organization's data since that data would no longer be hosted or managed by the organization. DNV business applications and data that would be hosted by third party application (SaaS) providers would be at risk of the same security threats affecting the SaaS provider. In other words, DNV IT would no longer have direct control in mitigating security risks and threats against its own organizational data, once that data is transitioned to the application cloud. The transfer of data from within DNV's datacentre to web-based application hosting providers would place the data at higher risk of being compromised than a conventional or VDI environment would.

Ultimately, the high initial and on-going costs associated with SaaS or cloud services along with the challenges and security implications of data migration would negate the potential benefits of this approach. The SaaS alternative received the lowest weighted ranking in the Balanced Scorecard due to high expenses, likely data migration and process change complications as well as the need to replace existing desktop systems.

5.2.5 Extended Private XenApp Cloud with Bring-Your-Own-Computer

Using a Bring-Your-Own-Computer (BYOC) policy in an expanded private cloud is an innovative organizational policy-driven approach to addressing DNV's desktop strategy. By expanding the existing DNV XenApp private cloud, DNV IT would be able to deliver all of the

organization's application services to DNV employees' personal computers. This alternative is heavily dependent on organizational policies. The financial implications of this alternative would vary depending on the degree to which the organization would be willing to contribute computer allowances to its employees. The capital costs of this alternative would likely be equivalent or higher than a VDI or conventional desktop implementation. Without major capital cost savings, this alternative would provide some reduction in operating expenditures since no end-user desktops would need to be supported by DNV IT.

A major shortcoming of this alternative would be the impact on customers. From the end-user perspective, this strategic alternative would have a polarizing effect where some employees would have complete buy-in for the BYOC idea, whereas some would not welcome the idea of managing their own personal computers for work purposes. Without official DNV IT support for end-user devices, some DNV employees may feel lost and helpless in accessing the organization's electronic resources. Another challenge with allowances is that they are considered taxable benefits from the end-user perspective since the value of allowances is added to the employees' taxable income.

Aside from end-user technical and financial challenges, allowing employees to use personal computing devices for work purposes increases the security risk levels and expands the scope of devices that could be compromised or infected with malware. The risk mitigation abilities are also further reduced, since DNV IT security protocols and practices would not apply to employees' personal computers being used in the BYOC arrangement. Even though secured connection tunnels would be established between end-user devices and DNV's private XenApp cloud, there are no control mechanisms and security measures that can be enforced on employees' personal computers. The increased unmanageable security exposure on DNV employees' personal computing devices adversely affects this alternative's security attributes.

The BYOC and XenApp expanded cloud alternative would facilitate simplified application delivery for DNV IT staff and reduce the workload of managing end-user desktops; however, it would likely introduce dissatisfaction for end-users and provide little capital cost savings. Most importantly, the organization's approval of this policy would likely be the biggest challenge as it would be a far departure from the conventional role of Information Technology in supporting end-users with all their work-related technology needs.

Table 9 summarizes the various technologies and alternatives presented, against the Balanced Scorecard objectives. This allows for strategic analysis of the choices available to the District of North Vancouver and for the DNV IT department to select the recommendation that can maximize benefits to the organization's overall strategy. The weighting system provided in Table 8 in section 5.1 is used to calculate the weighted score of each of the sections of the VDI Balanced Scorecard for the respective strategic alternative. Table 9 outlines the VDI strategic alternatives presented in Chapter 4: against the VDI project Balanced Scorecard perspectives and requirements. The VDI strategic alternatives are compared for each of the financial, customer, process and growth perspectives of the VDI project Balanced Scorecard

Table 9 - Balanced Scorecard Comparing the VDI Strategic Alternatives rated from 1 to 5 (weighted values provided in brackets based on percentages provided in Table 8)

Scorecard Perspective	Objective	Organization-wide VDI (section 4.1.1)	Mixed VDI and Physical (section 4.1.2)	VDI over Existing Hardware (section 4.1.3)	SaaS through Cloud (section 4.1.4)	Private Cloud with BYOC (section 4.1.5)	Conventional Desktop
Financial	Maximize ROI while minimizing cost on desktop replacement project	3 (9%)	2 (6%)	4 (12%)	2(6%)	1 (3%)	3 (9%)
	Minimize operating costs of desktop solution	5 (20%)	4 (16%)	5 (20%)	1 (4%)	4 (16%)	4(16%)
Customer - DNV end user (DNV employees)	Stakeholder Expectations	3 (6%)	4 (8%)	3 (6%)	4(8%)	4 (8%)	4 (8%)
	Technology Security	4 (4%)	4 (4%)	4 (4%)	3 (3%)	1 (1%)	4 (4%)
	Support for customer devices such as mobile and tablets	5 (10%)	3 (6%)	5 (10%)	4 (8%)	4 (8%)	4 (8%)
Internal Process	Desktop problem resolution	5 (10%)	3 (6%)	2 (4%)	4 (8%)	2 (4%)	3 (6%)

	Desktop deployment	5 (10%)	3 (6%)	5 (10%)	3 (6%)	4 (8%)	3 (6%)
	Software deployment	5 (10%)	3 (6%)	5 (10%)	3 (6%)	3 (6%)	2 (4%)
Learning and Growth	Team Training	2 (2%)	2 (2%)	2 (2%)	3 (3%)	4 (4%)	5 (5%)
	Team Certification	3 (2%)	3 (2%)	2 (1%)	4 (2%)	5 (3%)	4 (2%)
	Team expertise in functionality	2 (1%)	2 (1%)	2 (1%)	2 (1%)	3 (1%)	5 (2%)
	TOTAL	84%	63%	80%	55%	62%	70%

6: Recommendations

This project recommends an organization-wide implementation of a virtual desktop infrastructure (VDI) for the District of North Vancouver. Based on the data presented, a conclusive decision can be made on the direction of the desktop replacement technology, having considered the systems, structure and long term strategy of the District of North Vancouver's IT initiatives. A VDI system presents a new way of managing an organization's desktop infrastructure; however, it also introduces new implementation challenges. Even though the VDI approach can significantly increase the productive potential of end-users, the project implementation will need to be carefully planned to ensure a smooth implementation with organization-wide buy-in.

The flexibility of a virtual desktop system will place DNV IT's desktop infrastructure in an adaptable position in an environment of fast changing computing technology. There is no doubt that the future of IT in the workforce will permit higher mobility and reduce the relevance of desktop platforms and hardware. It is to this changing IT landscape that a dynamic, software-based VDI desktop delivery model will be best suited. Given DNV's current IT infrastructure, the potential future direction of its strategy and the analysis in section 3.3, this paper recommends two VDI vendor products for proof of concept testing: VMWare View and Citrix XenDesktop.

6.1 Implementation Challenges

A VDI implementation, even one using Citrix XenDesktop or VMWare View, will pose challenges in the planning, implementation and post implementation management and support. Ideally, a systematic approach involving a gradual uptake of the solution department by department would help successful adoption of the technology. The most significant challenge

would involve the end-user experience. As with any endpoint system upgrades, the goal is to eliminate any risk of downtime, while ensuring that the end-user experience is in no way degraded as a result of the new technology deployment. Additionally, a successful implementation in this case would enhance the end-user experience by providing a more robust and easier managed desktop environment. Should an end-user's virtual desktop become infected, the IT support personnel would then be able to rectify the problem quickly, or in the case of a stateless desktop, the user would simply have to log out and log back in to the workstation for their desktop environment to be reset to its original state.

A planning challenge is to decide whether the physical desktops will be replaced all at once, or if a phased desktop replacement will be used. Even a mass replacement of the desktops will need to be divided into phases, since sufficient resources are not available to replace all workstations in all of the DNV buildings at the same time. A phased deployment on the other hand, will take longer to complete, however will ensure that any problem areas not identified during the testing phase can be resolved before affecting the entire organization's productivity.

In order to overcome departmental specific desktop requirements, the testing or early deployment phase will need to utilize specific testers from various departments. The designated department testers will be responsible for reporting any problem areas and issues that they would encounter during the VDI testing phase. The purpose of this approach would be to eliminate issues that are business unit process specific prior to mass deployment of the virtual desktop technology.

Post planning, and during the datacentre implementation stage, challenges with integration of the XenDesktop technology with existing system infrastructure may arise. These include incompatibility or performance issues related to the implementation of XenDesktop in a datacentre comprised of a VMWare based server virtualization. Even though XenDesktop

technologies are tested to operate not only on Citrix' own XenServer hypervisor; they will also need to be able to operate in a VMWare datacentre virtualization backbone.

Additional challenges will arise due to the need for a highly redundant VDI implementation; one that may introduce significant complexity in its implementation. Thankfully, most of the redundancy needed on the client endpoint connections can be met with DNV's newly acquired network load balancers, which are coincidentally manufactured by Citrix Systems. The Citrix Netscaler Load Balancers will be an integral part of the back-end infrastructure to be used for the XenDesktop framework.

A sizable challenge will involve the training of both the network administrators and the help desk staff in managing and maintaining service and support levels for the end-users. The network administrator team will be heavily involved in developing the VDI core image and the repertoire of applications that will be either part of the core image or streamed individually to the endpoint virtual desktops. This process will prove to be time consuming since the majority of legacy and existing applications will be needing testing and fine-tuning to ensure smooth operation in the VDI environment. The help desk staff will in turn need to be trained by the network administrators in the daily operations and maintenance of the VDI endpoint environments.

6.2   VDI Vendor Selection

Based on the VDI vendor analysis presented in section 3.3, the recommended vendors for proof of concept testing for DNV's VDI project are Citrix Systems' XenDesktop VDI suite and VMWare Inc.'s View VDI solution. This recommendation is based on the features and functionality as well as the existing familiarity and hardware investment of the District of North Vancouver with both Citrix and VMWare. DNV IT currently has existing infrastructure resources invested with both vendors, which include Citrix' XenApp, and VMWare's vSphere server

virtualization. DNV IT will need to perform proof of concept testing with both VDI solutions, as there are DNV-specific benefits in choosing either VDI product.

An advantage of selecting Citrix' VDI solution is that DNV IT recently acquired a Citrix Netscaler network and web application load-balancing appliance. The Citrix Netscalers help load balance and ensure redundant usage of the District's existing email and XenApp infrastructure. This appliance is also a key component of a Citrix XenDesktop VDI implementation acting as the broker and load balancer between virtual desktop clients and their back-end datacentre.

In addition to the existing Citrix applications infrastructure at DNV, it is the capability of the XenDesktop applications to leverage both stateless and state-full virtual desktops as well as a highly flexible form of streamed application delivery to the thin-clients. This functionality allows for a lightweight virtual desktop delivery model with minimum storage and processing requirements in the datacentre.

The VMWare VDI solution, on the other hand would leverage DNV IT's existing investment in the VMWare server virtualization (vSphere) family of products. The VMWare View VDI solution presents an attractive alternative to traditional desktop deployment given its robust thin client hypervisor; however, it is a rather inflexible VDI implementation for application delivery. VMWare View lacks the ability to stream applications to endpoint devices. One notable feature of VMWare View is the integration of the VMWare VDI solution with Teradici's proprietary PCoIP (PC over IP) protocol (Madden 2008). This functionality is unique to VMWare View and allows desktop virtualization to be implemented and delivered to any end-point device, such as LCD monitors or wallet-sized thin clients using PCoIP.

Microsoft's VDI solution is not recommended for the DNV VDI project. This is mostly due to Microsoft VDI's requirement for a fat client (physical workstation) at endpoints, as well as its minimal mobile device compatibly. Both Microsoft Remote Desktop Services and Citrix' XenDesktop have the capabilities of a mixed mode of streamed and virtualized desktop (stateless

or stateful) deployment. The Citrix Solution has a much more compelling and robust VDI

solution than the Microsoft one where virtualization is still very heavily focused on Microsoft

operating systems only. Even though the DNV's IT department has a significant deployment of

Microsoft business applications and technologies, ensuring that the desktop infrastructure strategy

has less vendor tie-in is important. This distinction can be achieved through either the

XenDesktop or the View VDI solutions.

6.3   VDI Implementation Plan

An effective implementation of new technology in any project involves numerous critical

success factors and key performance indicators that have to be met by the project implementation

team and the customers alike. Replacing a traditional desktop environment with a virtualized

desktop infrastructure introduces radical concepts as to the nature of the back-end technology of

desktop delivery for both the IT support team and the end-users alike.

The fact that end-user desktops no longer exist on the physical thin-client that is placed

on their desks alone would undoubtedly introduce confusion for all but the more technologically

well-informed end-users. Even the DNV IT help desk team who has received years of training

and experience in managing traditional desktop systems will be challenged with the concept of a

centralized deployment and management of what has always been end-point managed devices.

These points only speak to the operational aspects of a VDI implementation.

Another major challenge to the VDI project is the datacentre hardware and software

requirements as well as an implementation process that will ensure minimized downtime and

cost. A successful IT project implementation is comprised of milestones that include a valid

business case, correct *vendor selection*, appropriate *requirement mapping*, correct *configuration*,

system *validation* and a final *implementation* (Parent 2010). Both the business case and vendor

selection have already been covered and precluded the implementation plan. Figure 5 outlines the various implementation milestones and their completion requirements.
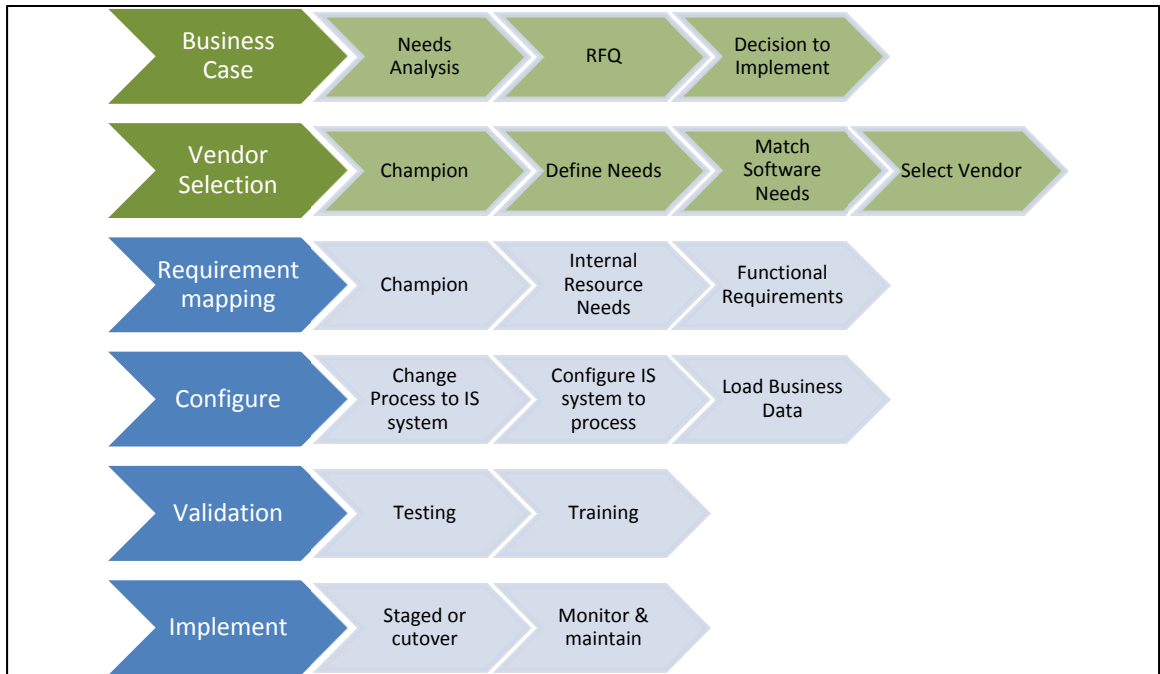

Figure 5- Ideal IT implementation plan – the green chevrons indicate implementation milestones already covered (Parent 2010)

6.3.1 DNV VDI Datacentre Implementation

A virtual desktop infrastructure is a datacentre focused desktop technology implementation, where anything but a highly redundant, easily scalable and efficient datacentre back-end would place the implementation at jeopardy. The District of North Vancouver's IT infrastructure vision has always focused on providing a highly available and redundant system to deliver core IT infrastructure while maintaining cost advantages over out-sourced versions of similar services. By maintaining and educating a highly technical staff, the DNV IT department ensures high levels of business continuity and uptime given its robust technology implementations.

The current *server-side* virtualization technology employed at the District of North Vancouver is the VMWare vSphere 4.1 family of private cloud server virtualization. The vSphere technology is using Hewlett-Packard based BL6000c blade server chassis running the latest 6th generation of HP blade servers for the VMWare virtualization farm. The blade chassis and servers are the basis of the virtual machines' (VMs) processing and memory resources. The VM farm uses the Hitachi Data Systems' (HDS) industry leading virtual storage platform in the HDS AMS2300 line of adaptive modular storage area networks (SAN). To outline a recommended implementation plan, an HDS white paper presents the ideal design structure; a design that should be leveraged by the DNV IT department. Luckily, all the design elements require complements that are currently available to the DNV IT infrastructure team (Clark 2011).

The HDS white paper recommendations outline the need for nearly an entire blade chassis in order to serve roughly 500 end-user virtual desktops. Another notable recommendation is also the need for a 1Gbps (Gigabit per Second) high-speed reliable network between the datacentre and the desktop end-points for the best user experience. Even though the District of North Vancouver IT employs 1Gbps and 10Gbps back-plane connections within the datacentre, the network speeds to the end-point desktops are currently limited to the 100Mbps (Megabit per second) speeds. If a 1Gbps end-point speed requirement is in-fact needed, then a DNV-wide upgrade of the access-layer Cisco network switches will need to be performed. A staged Cisco switch upgrade from the current 100Mbps access layer switches to the 1Gbps variants would be the ideal approach.

Fortunately, most of the building wiring can remain intact for a 1Gbps delivery, as the majority of the wiring is certified and capable to deliver this higher bandwidth. Additional costs will need to be considered should a systematic upgrade of the access-layer switches be required. Extensive testing is needed to verify whether the existing 100Mbps connection speeds are sufficient for the VDI implementation.

6.3.2   DNV VDI User Involvement

It is well understood and documented that employees' involvement in the design and implementation of new information systems will undoubtedly instil a sense of technology control and ownership for the end-users. User buy-in is created by ensuring that end-users are involved in the design, testing and portions of the implementation process because after-all it is possible to "… [provide users with] the most wonderful system in the world and they would not have been happy because they were totally excluded from its design." (Leonard-Barton 1998).

The DNV VDI project would also require end-user involvement and project champions to ensure a successful uptake and appreciation of the advantages of a virtualized desktop environment. For custom developed IT software implementations, high levels of user collaboration are paramount. For the DNV VDI project, an off-the-shelf product would be implemented with organization-specific customizations that best fit the needs of the end-users. The degree of user contributions would likely be less than other projects undertaken by the District of North Vancouver. For example during the original JDEdwards EnterpriseOne implementation and its subsequent upgrades, a significant number of project champions and power-users were involved in the testing, development and staged implementation of the product. The degree to which the ERP solution is integrated with the various departments' business applications, requisites a thorough and prolonged period of testing and problem solving, before it can be opened to the entire organization.

One major difference between a business application upgrade and the VDI project is that the latter is meant to deliver new features and functionality, while maintaining the same end-user desktop environment and user experience. This last statement is both the advantage and disadvantage of a VDI implementation plan. The fact that end-users should experience a transparent desktop experience similar to that of a conventional workstations environment is a message that is constantly being pushed by the major VDI vendors. The bulk of a VDI system's

advantages are the ease of management, increased ROI, reduced total cost of ownership as well as quicker problem resolution for the end-users. These attributes may imply a lack of necessity for due diligence on the part of the VDI project team; where in fact, end-user testing and involvement will be necessary to ensure that the virtual desktop experience is indeed equivalent and ideally better than a traditional desktop one.

Four modes of user involvement may be used to encourage end-user participation and adoption of a new software system (Leonard-Barton 1998). These modes can be used for the DNV VDI project as well; these include *delivery, consultancy, codevelopment* and *apprenticeship*. The different modes range from the degree of end-user involvement for the project at hand. Figure 6 shows the two stakeholders' (end-users and project implementation team) level of responsibility.

For the DNV VDI project, the team cannot simply rely on a *delivery* model where the end-users are given a new system overnight and left alone to learn the new VDI system's features and nuisances. As well, the VDI implementation should not require a deep level of user involvement to the extent of requiring apprenticeship and co-development. Instead, a mix of regular user consultancy and co-development with departmental test user groups will be sufficient in ensuring a smooth user uptake of the new technology while providing sufficient collaboration with the end-users to allow for an on-time delivery of the final project.
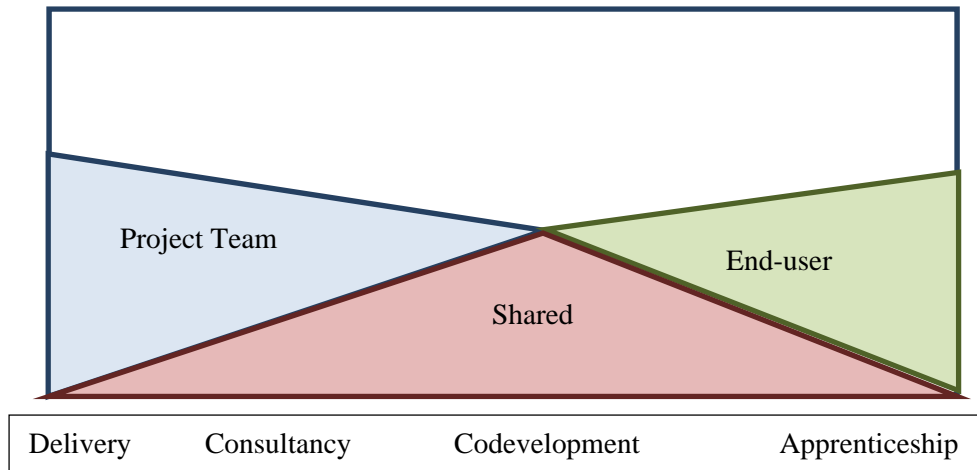
Figure 6 – Responsibility of VDI project team and end-users in the four modes of tool implementation (Leonard-Barton 1998)

6.3.3   DNV VDI Configuration and Validation

A conventional desktop implementation cannot begin until a standardized or "base" operating system image (the default operating system configuration of the workstation) has been created and thoroughly tested. The same approach will need to be undertaken with a VDI system with some key differences. In a conventional deployment, after days of testing and ensuring correct functionality, the base images are created and then "burned" or copied to the 400+ workstations that are to be deployed to the organization. For a VDI system, a single base image is created and is retained at the datacentre level. The image software itself does not ever have to be copied to any other location other than its source in the datacentre. Since a VDI desktop image is *streamed* to the end user's thin client terminal, no software ever needs to actually be stored or retained on the client side.

The process of desktop delivery in a VDI setting does emphasise the need to ensure an equivalent end-user experience to that of a conventional desktop. In terms of performance criteria, system slowdowns and any form of under-performance will need to be scrutinized by the

testing team. For this reason, a major disadvantage of testing with a datacentre-centric desktop infrastructure versus a separated, independent set of workstations is that high system load testing becomes necessary. If during the test phase, only a small sample of test users are using the VDI system, it is unlikely that any system performance issues would be reported, as such, it is imperative that high system load tests are performed or at least the VDI datacentre hardware resources are overleveraged enough to ensure high performance operations in a full-scale deployment.

Referring to Figure 5, the validation phase of a successful project would require the business process and the new IT technology to be complimentary in driving the business strategy forward. The DNV VDI system would need to be able to perform for different types of end-users, ranging from administrative and clerical to power users such as design engineers and CAD technicians. Additionally, the VDI system will need to fit the IT business processes of rapid problem resolution and response to problem solving from the IT support staff. Processes such as delivering a newly requested application, such as Microsoft Project 2010, should be readily accessible to the IT support staff.

Some DNV business process changes need to be implemented to take advantage of VDI technology: emphasis on remote support and a lack of necessity for on-site visit – especially for remote buildings – will need to be included in the desktop support process. As well, due to the datacentre-centric nature of a VDI desktop deployment, the VDI supporting IT staff needs to adjust their problem solving processes to be focused at the datacentre level. For example, if an issue is identified by an end-user, the IT staff needs to quickly identify and categorize the problem as an end user system profile issue or a system-wide datacentre sourced issue. The need to correctly identify and escalate potential system-wide anomalies to higher tier IT support staff will be paramount.

As DNV's Information Technology department will be tasked with effective operations of a virtualized desktop environment, adequate training and specialization will be needed within the department. Typical approaches to new technology training in the past for the District of North Vancouver have included vendor sponsored training classes, as well as expert third party consultancy used to create an implementation plan. Given the familiarity of DNV's network and system administration team with Citrix XenApp and VMWare vSphere technologies, it is recommended that the implementation team only receive XenDesktop training and not hire a consultancy team for the implementation.

Even though the testing phase of the Citrix XenDesktop VDI project can be performed in stages, i.e. various test groups with different business application requirements; the final implementation will need to be performed as a "cutover" and not a staged process. A cutover style implementation is recommended, given the high levels of application and systems integration of DNV's various business systems. Once the testing phase is completed and approval is obtained from the various stakeholders, a short cutover timeline would be the recommended VDI deployment strategy.

6.4   Strategic Plan Recommendations

There are rapidly changing trends in both consumer and business information technology. From innovative consumer devices to application and software services delivered to businesses through third-party clouds, the landscape of organizational and consumer technology is undergoing drastic shifts. New technologies and dominant designs no longer take decades to become established. The rate of mobile device development is significant to the point where each mobile generation lasts less than two years. As well, the fate of enterprise IT's dominant players is uncertain. Will Microsoft continue to retain its dominance in business, or will the recent consumer trends towards Apple and Google force major shifts in the way enterprise systems are managed?

The District of North Vancouver IT needs to position itself to be able to adapt to changing stakeholder demands. Realizing the current enterprise trends to move towards cloud-based computing where the software becomes the middle-layer between physical infrastructures and business applications, DNV IT must position its server and desktop assets to have the flexibility of operating within any core infrastructure. Today, third party clouds may prove too costly and inefficient for DNV's desktop and server hosting. However, migrating DNV's core IT server and desktop infrastructure into virtualized *private* clouds run on VMWare and Citrix virtualization platforms will enable the organization to have the flexibility to adapt to changing enterprise IT technologies.

A virtualization desktop and server infrastructure will also allow DNV to prepare its enterprise IT services for the mobile revolution. DNV employees would gain access to all of the organization's e-services and business applications through any device, on any platform from anywhere in the world. A virtualized or software based delivery of desktop operating systems (whatever the operating system platform may be) enables DNV to serve its end-users with the latest tools in e-government management.

As mentioned at the beginning of this chapter, it is the recommendation of this paper that the District of North Vancouver's Information Technology group embrace desktop virtualization as the organization's desktop replacement solution. A VDI implementation would provide the flexibility needed to support DNV's business applications on existing and upcoming conventional and mobile devices. Most importantly, the VDI implementation will provide DNV with the freedom to alter the virtualized desktop model to complement the organization's needs.

Quoting technology evangelist, Robert Cringely: *"The trend is clear from 'the computer is the computer' through 'the network is the computer' to what's next, which I believe is 'the data is the computer'"*, the data is indeed the computer and cloud-based computing is the only way to

separate the data from the physical computer. A virtual desktop infrastructure is yet another step

towards abstracting data from the physical layer and into the cloud, albeit, a private one.

Appendices

Appendix A

Table 10 - Detailed Balanced Scorecard of the VDI Strategic Alternatives

Score-card Perspective	Objective	Organization-wide VDI	Mixed VDI and Physical	VDI over Existing Hardware	SaaS through Cloud	Private Cloud with BYOC	Conventional Desktop
Financial	**Maximize ROI while minimizing TCO on desktop replacement project**	$400,000 includes new thin clients ($200,000), datacentre upgrades ($50,000), Software and Licensing ($150,000)	75% VDI, >$300,000 cost based on full VDI pricing - > $100,000 physical	$200,000 for datacentre and licensing	Replacement requirement for desktops <$400,000 - Lower powered desktops can be purchased	$100,000 datacentre upgrades, $1000 per employee BYOC requirement (one time cost over 4 years). >$500,000 total capital cost	$400,000 – just under $1,000 per desktop unit
	Minimize operating costs of desktop solution	$40,000 annual operating licensing cost- 25% operating reduction	$30,000 annual operating licensing cost – 25% operating reduction	$40,000 annual operating licensing cost- 25% operating reduction	Increased operating, average of about $250 per user per year - >$100,000 annual operating	Significant reduced operating from lack of desktop maintenance - ~33% operating reduction	No change in licensing or operating costs
Customer - DNV end user (the DNV employees)	**Stakeholder Expectations**	Customer satisfaction levels unknown, would need trials	Unknown satisfaction, but with physical mix safeguard	Customer satisfaction levels unknown, would need trials	Customer satisfaction levels unknown, would need trials – some application may not be SaaS portable	Customer satisfaction with hosted apps likely positive – response to BYOC is unknown	Status quo or improved customer expectations
	Technology Security	Consistent with conventional desktop security scope	Consistent with conventional desktop security scope	Consistent with conventional desktop security scope	Increased security scope and exposure due to third party/off site cloud and data storage	Increased security scope and exposure due to addition of personal computers to organizational IT systems	Conventional desktop security – status quo exposure and scope levels

	Support for customer devices such as mobile and tablets	Yes – best: desktop portability on all devices	Yes – better for VDI users	Yes – best: desktop portability on all devices	Yes – for SaaS application – would still need private Cloud i.e. Citrix XenApp	Yes – no desktop replication or VDI but Citrix XenApp application delivery	Yes, but with existing XenApp implementation – no desktop replication experience as with VDI
Internal Process	**Desktop problem resolution**	Significantly faster than conventional desktop – much less than 4 hours	VDI advantage for VDI users only	Significantly faster than conventional desktop, however hardware repairs an issue	Need to wait for SaaS vendors for bug fixes – same issues with user workstations as conventional desktop	No repairs/support for end-user devices – increased user frustration, least operating impact on DNV	Slower desktop hardware and software resolution than VDI – about 4 hours
	Desktop deployment	Significantly less than 1 hour – should be achievable <10 minutes	Fast deployment in about 10 minutes for VDI, Conventional desktop over 1 hour	Significantly less than 1 hour – should be achievable in <10 minutes	Conventional desktop imaging >1 hour for deployment	No operating system deployment needed, just application deployment – 0 deployment time, end user desktop issues will cause user frustration	~1 hour deployment time for desktop operating system
	Software deployment	Can be done immediately for configured software - minutes	Can be done immediately for configured software – minutes for VDI – desktops longer (reboot required)	Can be done immediately for configured software - minutes	Dependent on SaaS processes and delays	Can be done immediately for configured software – minutes – as long as user computers are configured correctly	Longer than VDI, requiring reboots ~1 hour
Learning and Growth	**Team Training**	100% of team need to be trained on VDI	100% of team need to be trained on VDI	100% of team need to be trained on VDI	Training needed on app management for SaaS	Minimal training – using existing XenApp cloud	Minimal to no training, familiarization with new hardware
	Team Certification	Half of team need to be certified	Half of team to be certified	Half of team to be certified – also need for certification on new	No certification needed unless required by SaaS vendors	No certification needed as using same XenApp cloud	Minimal certification – may be needed for new hardware support

					hardware	
Team expertise in functionali ty	Minimal to none	Minimal to none on VDI	Minimal to none	Minimal	Adequate due to existing Citrix Private Cloud	Significant

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