HIGH AVAILABILITY

PROJECT RESEARCH REPORT

CIT ON-LINE RADIO

Mission statement: To design and implement a low cost, high availability virtualisation solution for Cork Institute of Technology radio society.

Prepared by: Philip O'Brien R00078671

Recipients: Jim O'Dwyer & Gemma Mac Sweeney

Date: 5th January 2013

Revision: A

Revision History	Date	Details of change
A	05/01/2013	Initial release

1 TABLE OF CONTENTS

2 EXECUTIVE SUMMARY

This was a very interesting and educational project to complete. It involved negotiating with a major supplier of virtual backup solutions and obtaining their agreement to supply a fully featured demonstration version of their software.

In addition to the provision of a high availability solution, it was necessary to future proof the reliability and operation of the station.

The selection of both the hardware and the applications, combined with the policies and methodologies applied ensure that all industry best practices are incorporated and implemented.

The selection of Vsphere as the virtualisation platform was based on the features available, the fact that the previous project used Vsphere, the team doing the project has previous experience with Vsphere and finally, when handed over to CIT radio, other members of staff will be able to assist in the upkeep of the system. This also provides a wonderful opportunity for future students to gain valuable, real world experience of a highly available virtual environment.

High availability systems are not cheap to implement. However, this project identifies and attempts to minimise the cost of implementing a high availability system while delivering the performance that listeners demand.

3 INTRODUCTION

Following on from the previous year's project, the provision of a high availability solution for the CIT Radio station seemed like a very logical way to conclude the continuity of service and bring it full circle.

At the heart of the previous project was a virtual machine that relayed an MP3 stream from the studio to the listeners. However as implemented, were the virtual machine webcasting the stream to fail, the station couldn't operate.

To minimise the risk of this happening, this project was suggested.

4 LEARNING OUTCOMES

At the conclusion of this project the following learning outcomes are expected to be achieved.

1) Selection of the correct hardware for the project to ensure its successful conclusion after analysing the requirements of the project objectives.
2) Selection of an appropriate backup/replication process to ensure that the loss of virtual machines is limited.
3) Determine a budget for the project to limit the cost and ensure the project goals are met.
4) Implement a working NAS storage solution to enable the successful conclusion of the project.
5) Implement a working backup strategy to prevent data loss.
6) Implement a "high availability" capability, to ensure that the station's server is not offline.
7) Successfully manage a technically challenging project on time and within budget.

5 FUNCTIONAL DESCRIPTION

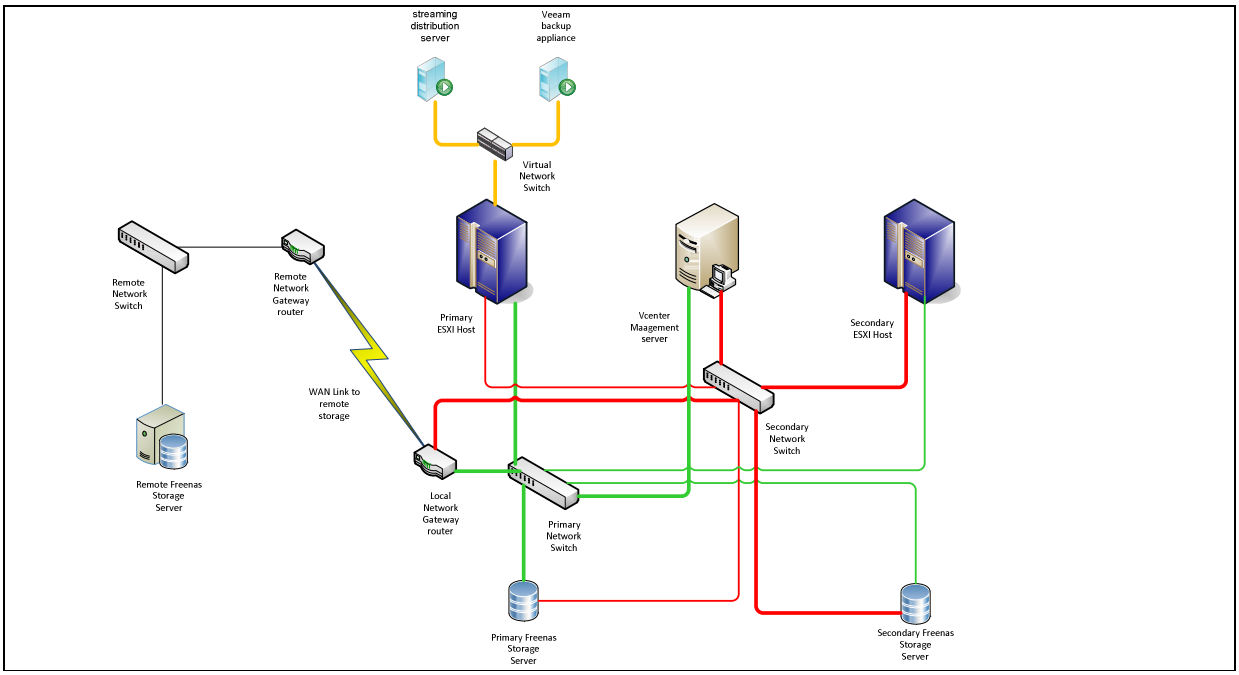

FIGURE 5-1 HIGH AVAILABILITY SYSTEM NORMAL OPERATION

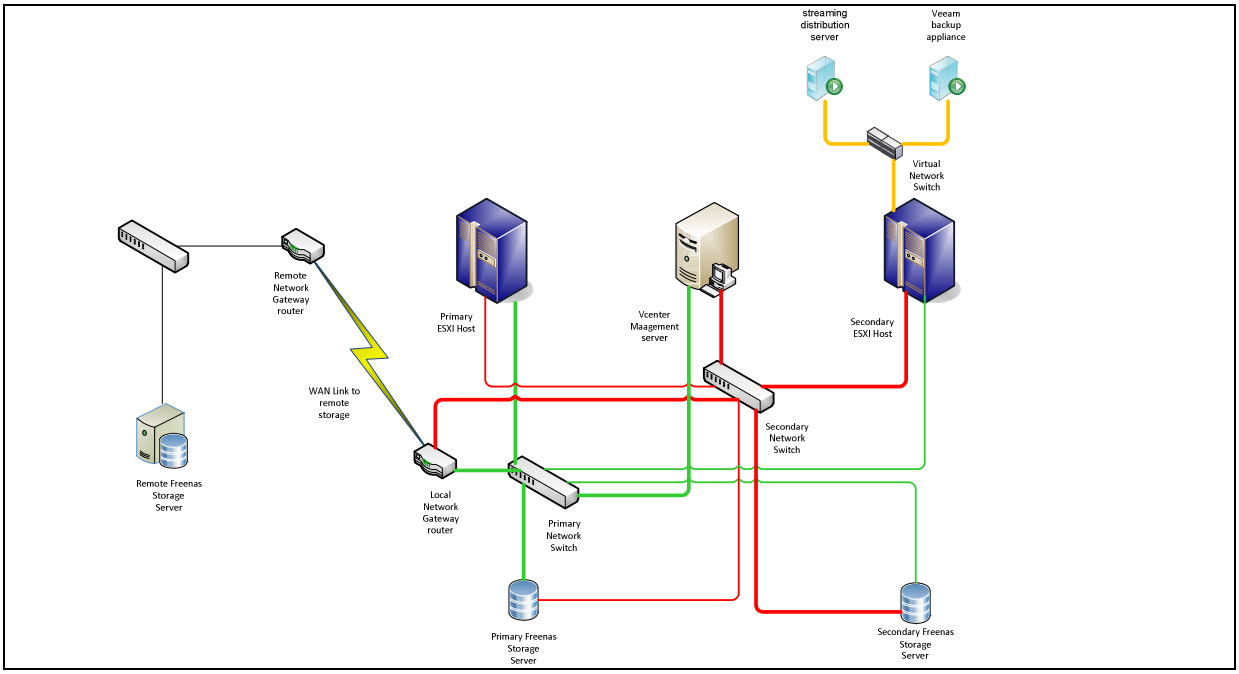

FIGURE 5-2 HIGH AVALIABILITY SYSTEM FAILOVER OPERATION

6 STORAGE SOLUTIONS

6.1 INTRODUCTION

The primary aim of the project is to provide a low cost highly reliable high availability setup for CIT radio. Sections of the SAN, Fibre channel and ISCSI discussions are taken from the CIT storage area networks module. [i][ii][iii]

The first point of any high availability system is its storage. There are three types of storage; host based storage, Network Attached Storage and Storage Area Networks.

Host storage is useful single hypervisor hosts. In this case the hypervisor host is running VM clients and making them available for use. There is no fail-over, no backup and no high availability capability. If the host server crashes then the data files that make up the VM cannot be accessed.

Network Attached Storage or NAS is independent storage that any host computer can access that is connected to the network.

Storage Area Network or SAN is a dedicated network of servers and shared storage devices. It features centralized storage and management as well as enables the sharing of storage resources across multiple hosts

These can be broken down into two types: Fibrechannel and IP based SANs.

Fibrechannel uses a dedicated protocol for communication where the IP based uses Internet Protocols to communicate. Fibre channel is used where speed and scalability are the paramount concern for the intended application.

6.2 IP SAN STORAGE

IP based SAN's are typically ISCSI based. ISCSI uses standard networking hardware and network links to enable storage to be accessed over LAN, MAN and WAN connections. ISCSI typically is 10 times cheaper to implement thus ensuring its broad appeal. Fibre Channel delivers the performance required for select applications, while iSCSI enables you to cost-effectively add new devices to your storage area network by utilizing existing IP infrastructure.

NAS (Network Attached Storage) is storage that has been set up on a network to act as a self-contained storage fileserver. It is file based unlike Fibre Channel and ISCSI which is block based.

NAS is used where:

- Costs are crucial
- Security management is essential
- File storage consolidation and sharing, over any network connection is fundamental.

The costs of implementing a Fibre Channel or any commercial IP based SAN solution will make the project un-viable. The typical costs for an IP based SAN are estimated to be well in excess of €10k. Fibre Channel as outlined earlier will have a cost multiplier of 10.

There are many commercial NAS implementations available including EMC's Islion NAS. This product has many features including the pooling of multiple nodes to form a logical cluster. Scale cluster performance and capacity by adding additional nodes to the cluster. However the costs associated with this product, make the project unviable. The typical cost for a basic Islion system starts at 18 TB of cluster storage. Just $6800 a TB [iv]. This pricing is mentioned to contrast the high costs of entry level professional storage solutions.

However there are two open-source projects that offer similar capabilities that will allow the project to operate with independent storage these are Freenas and Open-filer.

6.3 OPEN FILER - FREENAS COMPARISON

Both open-source projects offer the ability to use them to act as a simple and highly effective SAN solution. For demonstration purposes normally the SAN storage solution is implemented as a virtual machine. Using a VM as storage for hypervisors attracts performance overheads that would affect the efficiency of the project. As a result the installation of either open-source NAS solution will be implemented on physical hardware.

Functions supported	Freenas	Open Filer
LDAP and AD authentication	√	√
SMB/CIFS support	√	√
WEB server and FTP support	√	√
NFS support	√	√
SSH support	√	√
AFP support	√	
RSYNC	√	√
UNISON support	√	
UPS support	√	
SNMP support	√	√
iTunes DAAP support	√	
iSCSI Target	√	√
iSCSI Initiator	√	√
Open source technology	√	√
ZFS file system support	√	

FIGURE 6-1 COMPARISON: FREENAS V OPEN FILER

There is a cost element associated with Islion that the other NAS applications do not attract. Islion has multiple node capabilities, a powerful feature that has future potential and should not be discounted for other projects.

6.4 RECOMMENDATIONS

It is recommended to use a hardware based RAID controller and drive platform utilising Freenas as it supports a broader range of hardware. It is also recommended to configure the Freenas system with 4gig of RAM or more to enable data caching for regularly accessed files on the server.

7 REPLICATION & BACKUP

7.1 INTRODUCTION (DISASTER RECOVERY)

Question:

- What is back-up?
- What is replication?
- Why are they so important?

Answer:

In order to protect users of a High Availability System from possible data loss, Business Continuity Planning and Disaster Recovery Planning need to be considered. In order to mitigate the risk of potential data loss, replication across multiple sites is required. To ensure that backups and replication are performed consistently and in a repeatable fashion, a backup policy and process must be implemented and monitored regularly to ensure compliance with the backup objectives as set out.

7.2 BACKUP POLICY

A backup policy is, according to [v] Andrea Mauro, a document that sets out a list of rules to achieve the required backup goals. This can vary from type of backup to frequency of backup. Consideration must be given to whether a full, partial or differential backup should be implemented, media used and the policies needed to utilise these media to minimise data loss, i.e. Media rotation.

Media rotation is used where tapes are utilised as part of a backup strategy. After a pre-determined period of time as defined in the backup policy, tape media is reused on a regular basis to manage the cost of backup media with the requirement to retain tape backups of data.

7.3 REPLICATION

Replication is a process of synchronizing backup processes to independent media over LAN, MAN and WAN connections. This process allows for the scheduling of backups to these independent storage locations automatically. The use of replication is needed to provide an off-site location to store data. This type of replication is aimed for high availability solutions where instant recovery is necessary to prevent service interruption.

There are two types of replication: Synchronous replication and Asynchronous replication.

Synchronous replication is the mirroring of disks so that they appear to operate as a single disk, while simultaneously updating copies of the saved data concurrently.

Asynchronous replication maintains distant copies of data between remote and central sites. Unlike Synchronous replication, minimal IP connections between these sites can be utilised.

Asynchronous replication handles the requirements for disaster recovery, business continuity and inter-site migrations if required.

The limitation with Asynchronous replication is that it is not an instant recovery or a fault tolerant solution. It is designed to act as a low cost disaster recovery option that supplements a high availability replication. Synchronous replication provides this capability. However to operate a synchronous replication solution, high capacity low latency links between the replication sites will be required.

The preferred strategy to ensure that data loss is minimised, is to have storage replicated between two data storage nodes linked with a high speed network connection to provide synchronous replication. This will be supplemented with an Asynchronous replication step to an off-site location. To ensure that the data is further protected at the off-site location tape backup with an appropriate media rotation policy would be recommended to minimise the risk of data loss.

7.4 PRODUCT COMPARISON

There are three competing technologies VEEAM, Zmanda and Datacore.

The following table compares each technology where commonality occurs.

Functions supported	Veeam	Zmanda	Datacore
VM backup on the fly	√	√	√
Centralised Management	√	√	√
MS Exchange support	√	√	√
Agentless backup	√		√
SCP support	√	√	√
Integrated storage management			√
My SQL support	√	√	√
Capacity planning and reporting	√	√ limited features	√
Open source technology		√ Built on Open-Source Technology	

Figure 7-1 Replication comparison

Datacore combines the high availability replication with the disk and data management in a complete and integrated solution. This method of data storage while highly desirable does not fit into the design of the High Availability system as envisaged with Freenas.

Zmanda is commercial offering based on the open-source AMANDA backup solution. It offers similar features to both Datacore and Veeam but lacks the detail forwarding planning tools needed to manage disk usage. The cost of implementing a Zmanda backup solution for both hypervisor servers is estimated to be $600.

Veeam is a commercial offering that is offered as a free and a paid for backup solution for hypervisor systems.

There are a number of restrictions on the free version of backup and replication. Some of the key restrictions are:

1) Only one VM can be backed up at a time.
2) Cannot index Windows file system.
3) Does not support Instant VM recovery.
4) Does not support VM replication.
5) Only supports a single backup server and proxy server on the same machine.
6) Does not support remote backup repositories.
7) Only supports partial Hyper V backups.
8) No power-shell or command line scripting.
9) No Enterprise manager interface.
10) Limited technical support.

For a complete list of supported features in the free version of backup and replication please see the Veeam Product Bulletin (Veeam_backup_and_replication-free_vs_full.pdf) attached as an appendix to this report.

There are a number of restrictions on the free version of Veeam One (the monitoring suite). Some of the key restrictions are:

1) No advanced deployment option.
2) Performance monitoring restricted to 24 hours.
3) Monitoring console restricted to previous 7 days.
4) No advanced monitoring reporting and capacity planning.
5) Partial email reports for alarm situations.
6) No change tracking in free version.
7) VM sizing reports, Idle VM reports powered off VM reports limited to 3 VM's.
8) Dashboards limited to 1 dashboard. Predefined performance dashboards for VM's and datastores not available in the free version.

For a complete list of supported features in the free version of Veeam One please see the Veeam Product Bulletin (veeam_one_free_product_bulletin_en.pdf) attached as an appendix to this report.

As part of the comprehensive research for this project, contact was made with a Veeam sales representative to establish the accuracy of the information gathered and to establish the costs thereof.

The licensing costs for this are attached as an appendix to this report. [vi]

The backup and management tools needed are licenced on a per CPU basis. Veeam offer the solution on 6 socket package. As each hypervisor server requires a licence, two licences will be required. This totals the licencing costs of the Veeam backup solution to €2,300.00, if the product was to be licenced commercially. If it were to be licenced by the Institute then a 40% Educational discount applies reducing the licencing costs to €1,380.00.

As part of the discussions when speaking to the Veeam representative, the testing of the full suite of Veeam tools was discussed. This was to demonstrate the High Availability functions as part of the project. To avoid the costs of the Institute licencing the solution from Veeam, the utilisation of fully licenced demonstration version was suggested.

7.5 RECOMMENDATIONS

Backup is a key process of any IT system. The consequences of data loss can be high apart from the loss of reputation of the station with its listeners.

As a result selecting the lowest cost backup solution may not provide the security that may be required both in the medium to long term.

The recommendation for a commercial implementation of the project is Veeam Essentials. It provides an easy to use, easy to manage and easy to maintain backup & replication solution. The Veeam offering best suits the needs of both a commercial implementation of the project and a practical implementation going forward. However it is recommended that the use of demonstration licences be utilised during the implementation phase of this project.

It is recommended for a low volume High Availability implementation, that a virtual machine appliance be utilised for this project. Please see forums.veeam.com [vii] for further details.

8 HIGH AVAILABILITY AND FAULT TOLERANT SOLUTIONS

8.1 INTRODUCTION

The objective of the project is to "to provide a "high availability" capability to CIT On-line radio with a focus on implementing the project with as minimal a cost as possible" [viii].

To fully realise the future potential of this project, and help SME's reach a worldwide customer base, low cost, highly available systems are essential to facilitate their customers in purchasing goods and services.

Utilising these technologies, SMEs can benefit from highly available systems, while reducing the costs of implementation to a manageable level for these businesses. Previously highly available systems were only cost effective for large organisations. Utilising virtualisation and lower cost storage options, SMEs can compete with larger organisations. As the needs of the SME grow, the scalability of the system can also increase to match the requirements of the organisation.

Question:

- What is High Availability?
- What is Fault Tolerance?
- Why are they so important?

Answer:

According to the VMware Vsphere configuration document [ix], a highly available system is one that is continuously operational for a long length of time. High availability refers to a system or component that is continuously operational and can be measured relative to 100% operation or never failing.

As part of a High Availability system, fault tolerance must be also considered. Fault tolerant systems are computer systems or components that are designed so that, if a component fails, a backup component or procedure can immediately take its place, without loss of service.

Examples where high availability and fault tolerance would be mandatory are

1) Ecommerce websites using OS Commerce.
2) Telephony services using Asterisk PBX.
3) Virtual Desktop Infrastructure using XenDesktop or VMware View.

High availability needs to be designed into any solution at its inception, to ensure maximum effectiveness. Key factors when designing for availability are:

1) What level of availability is required?
2) The identification and elimination of single points of failure.
3) Protect data required.

8.2 SYSTEM AVAILABILITY

When deciding what level of system availability is required, the following table should be considered. This table is taken from the VMware install configure and mange document.

Level of Availability	Downtime Per Year
99%	87 hours or (3.5 days)
99.9%	8.76 hours
99.99%	52 minutes
99.999%	5 minutes

FIGURE 8-1 LEVEL OF AVAILABILITY DOWNTIME PER YEAR

The target that has been selected is the 99.99% level of availability. This provides the best trade-off between availability and the capabilities of the proposed system.

8.3 VIRTUALISATION TECHNOLOGIES

There are three types of virtualisation technologies. These are:

1) Full virtualisation
2) Partial virtualisation.
3) Para-virtualisation.

Full virtualisation almost fully mimics actual hardware to allow applications that operate a hosted operating system to run without and modifications to the hosted operating system.

Partial virtualisation mimics some but not all of the required hardware. As a result, hosted applications will need to be modified in order to operate correctly.

Para-virtualisation does not mimic any actual hardware in order to operate. Hosted applications are operated within insulated environments and appear as if they are operating on a separate guest. Guest applications will need to be altered to operate in a Para-virtualised environment.

However care must be used when creating VMs for Fault Tolerant settings. According to virtualizationadmin.com [x] Para-virtualised SCSI hardware cannot be used in a VMware setting. It is not clear if there is such a restriction on a Para-virtualised hardware using Xen.

8.4 VIRTUALISATION COMPARISON

There are many technologies that provide virtualisation and high availability. These include IBM's Power VM suite of products, Microsoft Hyper V, Citrix Xenserver, VMware ESXI/ VCenter and Oracle Virtual Box.

To reduce the time needed to compare each virtualisation technology, the costs of each proposed technology and its suitability for the project were taken into consideration when selecting the short list of products for comparison. As a result, four leading virtualisation products will be selected for a features comparison. This comparison is based in part on an article written

by Rick Vanover written for searchsytemschannel.techtarget.com [xi], a document prepared by the International Technology Group for IBM entitled “Value Proposition for IBM Power Systems” [xii] and a white paper prepared by IBM entitled “A Comparison of PowerVM and VMware Virtualization Performance” [xiii]

VMware Vsphere Advantages

- **Broadest vendor support:** When it comes to virtualizing programs and services, users need to choose options that will be supported by the largest number of software programs and systems. VMware's market dominance gives customers the most flexibility when it comes to designing and implementing virtualized environments that will have the broadest support options.

- **Most features:** Vsphere products, especially VCenter Server allow virtualisation architects to design highly-available virtualised infrastructure with advanced management features. SMEs and not just larger enterprises demand that highly available virtualisation applications be available. ESXi, VCenter Server and other VMware products can be utilised to provide these benefits for large organisations and SMEs.

VMware Vsphere Disadvantages

- **High entry costs:** The wide range of features in Vsphere requires a large initial investment when licencing the product. Different features are offered at different price points but the required features are only licenced in the more costly versions of Vsphere. When the “per-processor cost” of core virtualization components is determined, Vsphere is more expensive at face value than its competitors' products.
- **Hardware incompatibility:** Other virtualisation technologies offer broader support for hardware. The prime example being Microsoft’s Hyper-V offering. However VMware update the “Vsphere Compatibility Matrix” that maintains an official supported list of hardware. Please see vm-help.com [xiv] for the unofficial Hardware Third party lists and vmware.com/resources [xv] for the official VMware hardware support list.

Microsoft Hyper-V R2 Advantages

- **Familiar interface:** The dominance of the Microsoft suite of products provides reassurance to current users who prefer using products from Microsoft. Hyper-V virtualization provides a more user friendly transition from Windows server environments. The virtualization management engine that is part of System Center, adds features for customers in a simple layered approach, from the application to the OS, and as a result, to the virtualization engine. For organizations that have a large investment in other Microsoft System Center technologies, such as Operations Manager, System Center Virtual Machine Manager for Hyper-V may be a natural addition.
- **Broad hardware compatibility:** As HyperV R2 is part of Windows Server 2008 R2, it utilises the same driver support. VMware is expanding its product line and has added new pluggable storage architecture. While this helps VMware to add additional capability, HyperV R2’s Windows device support cannot be surpassed.
- **Integration with existing virtualization infrastructure:** Customers want to extract maximum value for their existing investments. Most organisations have some level of Microsoft Windows Server infrastructure investment, and adding HyperV R2 may provide additional capabilities that may be attractive in the medium to long term.

Microsoft Hyper-V R2 Disadvantages

- **Less third party vendor support:** When software developers offer virtualisation support, HyperV R2 is not a product that support is provided for. While virtualisation support is determined by a number of factors, Hyper-V isn't the most supported hypervisor for third-party applications.
- **Features gap:** Hyper-V virtualization provides further features that other hypervisors do not provide, such as alert management and monitoring within the guest virtual machine's OS with System Center Operations Manager and integration with Group Policy. VMware's Vsphere offers more virtualisation-specific features that are more importance to virtualisation infrastructure architects. **Hyper-V does not yet offer a fault tolerance virtual machine (VM) configuration that runs concurrently on two hosts**, and it has fewer virtualization-specific disaster recovery options than Vsphere.

Citrix XenServer 5.5 Advantages

- **Strongest free virtualization offering:** Citrix XenServer 5.5 offers the best free virtualization suite, which includes live migration, physical server to virtual machine (P2V) conversions and virtual-to-virtual (V2V) conversions, shared storage driver integration, centralized management, Active Directory integrated security, VM template functionality and infrastructure update management. Citrix Essentials provides extra features for customers and is a reasonably priced automation and management suite.
- **Enterprise ready:** Citrix XenServer (along with VMware's vSphere) meets the Burton Group's criteria for enterprise production virtualisation workloads [xvi]. The Xen hypervisor also has an active open source community for organisations that wish to produce their own virtualisation solutions.

Citrix XenServer 5.5 Disadvantages

- **Most limited application and vendor support:** VMware has broad virtualisation support in the application sphere; customers may face vendor support issues when moving critical systems to a Xen-based virtualisation platform.
- **Limited partner support:** Citrix Xen has the most limited software partner product support of the all the available platforms. VMware-based virtualisation has the largest level of partner support for applications in areas such as backup and recovery, capacity planning, lifecycle management and infrastructure management.

IBM PowerVM Advantages

- **Complete hardware & software all in a single package:** IBM build, integrate and test the hardware and software aspects of the PowerVM virtualisation offering. IBM has been offering virtualisation methods since the late 60's. This results in a very close integration of hardware and software to gain maximum advantage.
- **Largest number of VM's per CPU:** IBM's PowerVM can support up to 1000 [xvii] VMs per processor unlike VMware which supports 64 in version 5.1 [xviii].

IBM Power VM Disadvantages

- **Lock in to a particular platform:** As IBM build, integrate and test all the hardware and software aspects of the PowerVM virtualisation offering, moving away from this platform in the future will be a very costly exercise. By contrast movement between Xen, HyperV and Vsphere would be more cost effective as the other technologies can utilise the same hardware
- **Recognition of PowerVM as an alternative within the IT Industry:** PowerVM is not widely recognised as a popular virtualisation platform when compared to Vsphere Xen and HyperV. Data for researching PowerVM proved difficult to locate other than what was available from IBM.
- **Costs:** As IBM has developed the processors, hardware and software to enable PowerVM, the technology is locked to IBM hardware. PowerVM is a firmware extension to its hardware and cannot be ported to standard X86/X64 hardware like Vsphere or Xen can be moved between compatible hardware platforms.

When comparing Hyper-V R2, PowerVM, Vsphere and XenServer 5.5 pros and cons, you'll find that there is no one-size-fits-all virtualization product or service. Each product can present customers with many advantages and disadvantages depending on their current environment and needs.

From the customers' perspective, virtualization must be an investment that fits with their overall IT goals and architecture. The aggregation of infrastructure components that virtualization brings to the table requires customers to choose wisely about which investments to make.

PowerVM on paper should be the market leader when it comes to virtualisation. It boasts the maximum number of VM per Cpu etc. So why are all the other virtualisation products more dominant in the marketplace?

Some of the concerns with PowerVM may reside in the fact that it is built into the hardware of IBM equipment. The upgrade of which may prove challenging to upkeep and maintain.

There is also the concern of being locked to a single vendor. A single vendor can at their own discretion alter pricing for equipment. Alternatively a comparison can be made to the pc printer industry where printers are sold at a loss and that the vendor hopes to make up the loss and make a profit on over-priced cartridges and support.

The market segment that IBM is targeting with PowerVM is the large corporate server market. IBM may not necessarily be interested in selling and supporting its hardware and software to SME's and CIT Radio.

Taking all of these points into consideration PowerVM was removed from the final comparison list. The comparison is based on the top three virtualisation solutions currently available in the market. This comparison based on a comparison from http://virtualization.findthebest.com [xix] and http://www.virtualizationmatrix.com [xx]

General Features		vmware	Microsoft	CITRIX
Version		vSphere 5.1	Hyper-V R2 SP1	XenServer 6
Edition		**Enterprise Plus**	**Enterprise**	**Platinum Edition**
Assessment	**Maturity**	5.1: Sep 2012 (ESX: 2001/2002, ESXi: Dec-2007)	Hyper-V Jun 08, Hyper-V Server: Oct 08	Xen - 2003, Citrix XenServer 2007, 5.6SP2 March 2011, v6: Sept 2011
	Market Position	Leader (Position 1)	Leader (P2/3)	Leader (P2/3)
Pricing	**Virtualization ($)**	5.1 Ent+: $3,495/socket + S&S 1Y: $734 (B) or $874 (Prod), vSphere Desktop: $65/active desktop	Enterprise: $3,999/server	$5000/server+$3000 (support)
	Management ($)	$4995(Std) + $1049(B) or $1249 (P), $1,495(Fnd) + $545(B) or $645(P)	SMSE: $1569/host) or SMSD: $1310 SMSD/CPU (2 CPU min)	Free (XenCenter)
	Guest OS Licensing	Not included	yes - 4 (Windows)	No
General	**Central Management**	Yes (vCenter Server + Web Client)	Yes (SCVMM/SMSE/SMSD)	Yes (XenCenter), SCVMM (new)
	Virtual and Physical	No	Yes	Limited
VM Mobility	**Live Migration of VMs**	Yes vMotion, Metro vMotion and 'shared nothing' vMotion	Yes Live Migration (1)	Yes XenMotion (1)
	Automated Live Migration	Yes (DRS) - CPU, Mem, Storage (now compatible with vCD - NEW)	Semi-Integr.(CPU,Mem,3rd party)	Yes (WB) - CPU, Mem, D, N
	Power Management	Yes (DPM)	Limited	Yes
	Storage Migration	Yes (Storage vMotion); up to 4 parallel operations (NEW)	Limited (Partially Live)	No (offline only)
HA/DR	**Integrated HA (Restart vm)**	Yes (VMware HA) - incl Storage heartbeat	Yes	Yes
	VM Lockstep Protection	Yes (Fault Tolerance)	No	No
Updates and Backup	**Hypervisor Upgrades**	Yes (Update Manager)	Yes	Limited (rolling upgrade wizard - new)
	Integrated Backup	Yes (Data Protection - New)	Yes (WSB&DPM)	Yes (VMPR)
Deployment	**Automated Host Deployments**	Yes - Auto Deploy (new: Stateless Caching & Stateful Installs)	No	No
Other	**Security**	Yes (ESXi Firewall, vShield Zones and vShield Endpoint - NEW), vCloud Networking and Security NEW (not included)	Yes	Yes
Host Config	**Max Consolidation Ratio**	512vm, 2048 vcpu	384 vm, 8/12 vCPU per core,	75 (up to 130 - see details)
	Max CPU - Host	160 (Logical)	8 (Sockets) 64(Logical)	64 (logical)
	Max Cores per CPU	unlimited	unlimited	unlimited
	Max Memory - Host	2TB	1TB	1TB
VM Config	**Max vCPU per VM**	64	4(Win) / 4(Linux)	16 (Win) / 32(Linux)
	Max RAM per VM	1TB	64GB	128GB
Storage	**Storage Integration (API)**	Yes (VASA, VAAI and VAMP)	Windows Ecosystem	Integrated StorageLink
	Storage QoS	Yes (SIOC) - incl. NFS - NEW	No	Basic
Networking	**Distributed Network Switch**	Yes (vDS), Various Operational and Scalability improvements - NEW	No	Yes (Fail-Save Mode - new)
	Network QOS	Yes (NetIOC)	No	Yes
Memory	**Dynamic / Over-Commit**	Yes (Memory Ballooning)	Yes (Dynamic Memory)	Yes
Interoperability	**Scripting / APIs**	CIM / SMASH API, SDKs for web services, Perl, Power CLI etc	Yes (PowerShell, WMI API)	Yes (SDK, API, PowerShell)
Cloud	**Cloud**	vCloud Suite, Promotional Upgrade (New)	TBA	TBA

FIGURE 8-2 PRODUCT COMPARISON VCENTER, HYPERV, XENSERVER

The difficulty in selecting a virtualisation platform is that there is no clear outright winner. Consideration needs to be given to who is going to be installing the system but more importantly who will be maintaining the system in the medium to long term.

If an organisation is starting from a clean slate in terms of product selection then Citrix Xen may be the best suited product, as it provides high availability for the cheapest price. This assumes that the intended organisation's goals can be achieved using this platform.

Microsoft HyperV may be attractive to existing Microsoft users who wish to gain maximum return on investment on their existing equipment. However as outlined in the comparison table, HyperV provides very limited high availability support.

The selection of VMware Vsphere may be the most attractive in terms of features and support. CIT has some familiarity with Vsphere as it is used across the Institute. The selection of any different virtualisation platform may leave the radio station vulnerable if an unexpected issue arises that cannot be resolved by station staff.

However the costs of licencing all the features needed to implement high availability and fault tolerance may prevent SMEs from gaining maximum advantage of the technology. However if the costs of downtime of a high availability service exceeds the cost of implementing and supporting the service, then it is very easy to justify the expenditure.

8.5 RECOMMENDATIONS

The selection of a virtualisation solution is a key factor in the overall success of the project. The selection of the wrong product could put the project at great risk and as a result other considerations need to be taken into account.

The timeframe for successful completion of the project is challenging considering the available human resources available to the project. These resources have had previous exposure to one of these products and this needs to be considered in the final selection of a solution.

It goes without saying that the least cost option would be selected; Citrix Xen. However VMware Vsphere is the market leader, has more third party support and can be licenced through the VMware academic alliance web store and, if necessary, the use of a fully loaded 60 day free trial version with all the features viz high availability, fault tolerance, to ensure the successful completion of the project.

9 HARDWARE DISCUSSION

9.1 INTRODUCTION

The physical hardware that allows this project to operate is just as important as selecting the virtualisation platform, the backup & replication platform and the storage platform.

The current situation with CIT radio is; if the streaming distribution server crashes, or the ESXI host crashes, the station cannot operate. It is vital to station operations that the distribution server is kept up and running.

The implementation of the stream distribution server on a VM is by design. The long term plan for station operation is to move the distribution server to a high availability configuration.

To ensure high availability, independent storage from the hypervisor host for the VM needs to be implemented. Using a Network Attached Storage device (Freenas server), allows the radio station to provide a central repository for logging server data, archiving broadcasts and music and program storage.

An important point that needs to be addressed when designing any high availability system is the elimination of “single points of failure”. The idea being the provision of redundancy, as far as is practically possible, for all key sections of the system.

9.2 STORAGE SERVER HARDWARE

For storage, the Freenas hardware would normally be a pc with a hard drive. However the server hardware being proposed would be a two disk RAID 1 array controller to provide redundancy against data loss on a single disk.

The other key components of the server are dual hot swappable power supplies fed from independent power sources and dual independent gigabit Ethernet connections. These connections would then be connected to separate redundant network switches.

Each Freenas server would be configured identically. Each server would be connected to the same redundant network switches and replicated using the Veeam replication solution. Additionally, the Veeam replication solution will back up the contents of the NAS over a WAN connection to either a cloud provider or another NAS device.

9.3 VIRTUALISATION SERVER HARDWARE

The ESXI servers that provide the platform for the VM to operate on do not need to utilise the on-server storage provided by the server hardware. Each server could be configured to boot over the network from the Freenas storage server using PXE boot. For further information please see virtualblog.org [xxi] for further information.

The other key components of the ESXI servers are dual hot swappable power supplies fed from independent power sources and dual independent gigabit Ethernet connections.

These connections would then be connected to the same redundant network switches that the Freenas servers are connected to.

It would also be recommended to separate each ESXI, Freenas server, and network switch cluster into separate physical rooms and use Uninterruptable Power Supplies for each cluster.

This is not a fully considered elimination of single points of failure. However it is hoped that where possible as many of the single points of failure have been addressed and hence, can be removed.

9.4 NETWORKING HARDWARE

In order to manage the large volumes of data exchanged between each ESXI host and Freenas server, some form of Quality of Service (QoS) networking needs to be implemented.

There is also a QoS consideration when using managed switches and routers. It is recommended to segment the network using VLANS, to prevent broadcast storms and to separate Vmotion traffic from other network traffic. Please see post #2 from the VMware forum [xxii] where a recommendation is made for Vlans on a shared physical network.

1. Management - this will be used by the administrator & virtual center to connect to ESX Servers.
2. Production - This is the network that your virtual machines will connect to.
3. vMotion - it is only the ESXI server that will have access to this network
4. IP Based Storage (iSCSI / NAS) - this should be on its own isolated network for security and performance.

If it is found that there is not enough physical bandwidth linking the ESXI servers to the Freenas servers, NIC teaming or link aggregation can also be utilised. NIC teaming can also be configured to automatically reroute network traffic to a VM in the event of an adapter failure.

It is also recommended to isolate the high availability system from the existing network or the Internet using a managed router. This would need to be able to manage the outbound WAN connection, the VLAN configuration & manage the configuration of VLANS and QoS across the system.

According to vmadmin.co.uk [xxiii] and the VMware install configure and manage manual [xxiv], the recommended Ethernet physical connection should be Gigabit and where possible provide redundancy and NIC teaming, multiple physical Gigabit interfaces should be implemented into the physical design where possible.

9.5 RECOMMENDATIONS

The key to operating a stable high availability system is the selection of appropriate hardware at the outset. Eliminating as many single points of failure in the design will minimise the likelihood of an outage or the loss of data. Careful consideration should also be given to deploying hardware that at least matches, if not exceeds, the recommended specifications. This will result in speed and redundancy advantages immediately, as well as extending the long term life of the underlying hardware into the future.

10 PROJECT RISKS

10.1 INTRODUCTION

According to businessdictionary.com [xxv], Risk is a probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive action.

There are 3 areas of risk that are identifiable in this report. These are

1. Human factor risks.
2. Financial risks.
3. Technical risks.

10.2 HUMAN FACTOR RISKS

Human factor risks emanate from the dependence on key individuals, to achieve the goals of the project. External factors that affect these key individuals will ultimately determine the success or failure of the project. To reduce the threat of human factors on the project the following measures should be considered.

1. Assign additional human resources to ensure that no single individual can delay the project.
2. Ensure that human resources commit the outcomes of tasks in a written form.
3. Encourage project team members to raise concerns if project deadlines are seen to slip.

10.3 FINANCIAL RISKS

Financial risks emanate from the dependence on adequate finance being made available to complete the project within the time allocated to the project. As the project is heavily based on physical hardware and commercial software, significant delays can occur if the necessary funding is not put in place to ensure a successful project outcome. To reduce the threat of financial risk to the project the following measures should be considered.

1. Assess the costs of implementing the project using all the equipment desired and present a budget.
2. Assess the costs of implementing the project using the minimum equipment necessary to deliver project goals.
3. Seek out alternatives to necessary equipment or consider purchasing second user equipment.
4. Scrutinise the spending of financial resources on hardware and software.

10.4 TECHNICAL RISKS

Technical risks emanate from new IT projects or when attempting unknown tasks. As these tasks are technical and complex in nature, any changes to a configuration must be documented, in order to permit a reversal caused by unexpected results or consequences to the project. To reduce the threat of technical risks delaying the project the following measures should be considered.

1. Assess the skills in the project team and assign tasks that are best suited to each member's skill level.
2. Implement change management within the project from the outset to manage the rollout of new services.
3. Encourage project team members to share issues in an open manner to arrive at solutions that deliver on the goals of the project.

10.5 RECOMMENDATIONS

With all projects it is not possible to eliminate the element of risk. However managing risk in a controlled and proactive fashion reduces the threat of a single or multiple risks delaying the project.

11 GOALS AND OBJECTIVES ..... KEY MILESTONES

The overall objective of the project is to deliver a best value, easy to maintain High Availability solution for CIT On-Line Radio.

To ensure that this overall goal is met the following key objectives have been identified.

1. The selection of suitable hardware and software to deliver the high availability system.
2. The purchase of the selected storage, networking and virtualisation hardware.
3. The installation, configuration and test of the appropriate NAS application to enable the hardware on the primary NAS storage device.
4. The installation, configuration and test of the appropriate NAS application to enable the hardware on the secondary NAS storage device.
5. The installation, configuration and test of networking hardware.
6. The installation, configuration and test of the hypervisor hosts.
7. The installation, configuration and test of hypervisor management system.
8. The transfer of the Stream distribution server VM to the high availability system.
9. The installation, configuration and test of the backup and replication system within the network.
10. The configuration and test of the backup and replication system to an external storage service (cloud or remote NAS).
11. The testing of the manual and automatic failover capabilities of the system.
12. The completion of a maintenance and training document to train suitable candidates in the correct use of the equipment and applications.

12 SOLUTION PROCEDURE

The solution to deliver a successful outcome to the project is outlined in Table 1 as follows.

TABLE 1 TASKS DURATIONS AND IMMEDIATE PREDECESSORS

Task Id	Task	Duration in days	Immediate Predecessor
1	The selection of appropriate hardware	3	None
2	The selection of appropriate software	3	None
3	Purchase of selected storage hardware and software	1	1,2
4	Purchase of selected networking hardware and software	1	1,2
5	Purchase of selected virtualisation hardware and software	4	1,2
6	The installation, configuration and test of the primary storage server	3	3
7	The installation, configuration and test of the secondary storage server	3	3
8	The installation, configuration and test of networking hardware	2	4
9	The installation, configuration and test of the primary hypervisor host	6	5
10	The installation, configuration and test of the secondary hypervisor host	4	5
11	The installation, configuration and test of hypervisor management system	3	8,9,10
12	The transfer of the Stream distribution server VM to the high availability system	1	11
13	The installation, configuration and test of the backup and replication system within the network	4	6,7,8
14	The configuration and test of the backup and replication system to external network storage	2	13
15	Final system testing of the project	4	6,7,11,12,13,14
16	Completion of a maintenance and training document	5	15
17	Formal handover of solution to CIT radio	1	16

The critical path tasks for the project are:

1) Task 1, Selection of appropriate hardware.
2) Task 2, Selection of appropriate software.
3) Task 5, Purchase of selected virtualisation hardware and software.
4) Task 9, Installation, configuration and test of the primary hypervisor host.
5) Task 11, Installation, configuration and test of hypervisor management system.
6) Task 12, Transfer of the Stream distribution server VM to the high availability system.
7) Task 15, Final system testing of the project.
8) Task 16, Completion of a maintenance and training document.
9) Task 17, Formal handover of solution to CIT radio.

13 EXPECTED DELIVERABLES

The expected deliverables for this project are outlined below

1) Primary and secondary NAS storage server utilising RAID 1 storage protection.
2) Primary and secondary hypervisor host servers to run the streaming distribution server.
3) A high speed, segmented and redundant network to link the equipment.
4) An automated replication and backup solution to manage data.
5) A demonstration of the high availability and fault tolerance of the system.
6) A training manual on the correct operation and configuration of all the servers and personal computers, used in the project.
7) The provision of a training course based on the training manual.

14 SUMMARY

The purpose of this project is to devise and implement a low cost, highly availability solution for the Cork Institute of Technology radio society. When the initial radio station project was completed the distribution server VM was operating on a single ESXI host. If that VM or ESXI host crashed, the radio station would not be able to broadcast.

In this instance the high availability system built upon the ESXI server, starts another copy of the “streaming distribution server” on a separate ESXI server. This is done without interruption to the listeners.

In order for this to happen, the VM needs to be stored independently of either ESXI server.

Storage for the VM is achieved using a Freenas storage server equipped with RAID 1 configured hard drives.

In order to protect against possible data loss, the Freenas storage server will replicate itself to an identical secondary Freenas storage server automatically. The application used to replicate storage data is Veeam Essentials. This will replicate stored data on the primary storage server to the secondary server and manage off-site backup to a cloud service provider or external NAS server.

The network infrastructure for a high availability system needs to have redundancy designed into it from the beginning. The redundant network needs to operate at Gigabit speeds, utilise link aggregation and requires that VLANs and QoS be implemented to obtain the maximum performance from the overall system.

The selection of Vsphere as the virtualisation platform was based on the features available, the fact that the previous project used Vsphere, the team doing the project has previous experience with Vsphere and finally, when handed over to CIT radio, other members of staff will be able to assist in the upkeep of the system.

High availability systems are not cheap to implement. However, this project tries to minimise the cost of implementing a high availability system while delivering the performance that listeners demand.

15 BIBLIOGRAPHY

References.

[i] BSc Session 1 – Storage.pdf
[ii] BSc Session 2 - Fibre Channel Storage.pdf

[iii] BSc Session 3 - iSCSI Storage.pdf

[iv] http://storagemojo.com/2007/01/22/whipping-out-the-checkbook-for-isilon/

[v] http://www.backupacademy.com/basic-principles-backup-policies.html?ad=hp

[vi] veeam pricing.docx

[vii] http://forums.veeam.com/viewtopic.php?f=21&t=9329&start=0#p39898

[viii] ITM4 project proposal 2012-2013.doc

[ix] VMware Vsphere 4.1 Install Configure & Manage module 12 page 533
[x] http://www.virtualizationadmin.com/articles-tutorials/general-virtualization-articles/vmwares-paravirtual-scsi-adapter-benefits-watch-outs-usage.html

[xi] http://searchsystemschannel.techtarget.com/tip/Comparing-Hyper-V-R2-vSphere-and-XenServer-55-pros-and-cons

[xii] value proposition for IBM Power systems.pdf

[xiii] power vm vs vmware.pdf

[xiv] http://vm-help.com/esx40i/esx40_whitebox_HCL.php
[xv] http://www.vmware.com/resources/compatibility/wizard/request.php

[xvi] http://dcsblog.burtongroup.com/data_center_strategies/2009/07/citrix-meets-100-of-burton-groups-virtualization-hypervisor-requirements-for-production-workloads.html

[xvii] http://www-03.ibm.com/systems/power/software/virtualization/editions.html

[xviii] http://www.vmware.com/pdf/vsphere5/r51/vsphere-51-configuration-maximums.pdf

[xix] http://virtualization.findthebest.com/compare/2-3-11-27-40/Citrix-XenServer-Platinum-Edition-vs-Microsoft-Hyper-V-Server-2008-R2-SP1-DataCenter-vs-VMware-vSphere-Enterprise-Plus-Acceleration-Kit-vs-IBM-PowerVM-Enterprise-Edition-vs-VMware-vSphere-Enterprise-Edition

[xx] http://www.virtualizationmatrix.com

[xxi] http://virtual-blog.com/2011/06/howto-configure-pxe-manager-for-stateless-esxi-deployments/?doing_wp_cron=1343246548

[xxii] http://communities.vmware.com/thread/193161

[xxiii] http://www.vmadmin.co.uk/vmware/36-virtualcenter/275-vcenter5install

[xxiv] VMware Vsphere 4.1 Install Configure & Manage module 4 page 74

[xxv] http://www.businessdictionary.com/definition/risk.html