

Matt Robbins CS25110 Assignment

Scenario Analysis Report for Mid Wales University

Release status: Draft

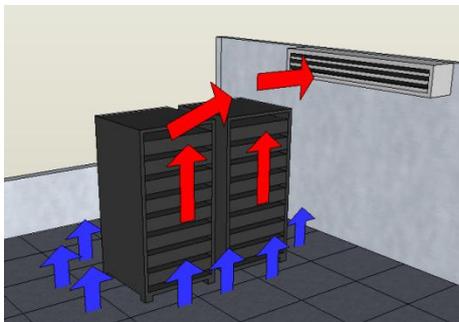
Date: 08/01/12

1. Introduction

This Scenario Analysis Report aims to outline my recommendations for the complete ICT re-fit for the Mid Wales University. This report will address eight issues: Server room design, project management, computer hardware, computer software, security, naming and directory services, business continuity and ongoing management. For each of these issues, this report will explore the best solutions to ensure optimum efficiency and cost effectiveness in the new ICT provisions. Due to Mid Wales University being a relatively small establishment, I assume its funding is limited and whatever money can be saved, will be appreciated and used elsewhere.

2. Custom Designed Server Room

The room that houses the servers for this university must be specially designed to keep the servers running safely, efficiently, and using the least power possible. The climate within the server room must be controlled effectively to reduce chances of failures, disasters and loss of equipment and data. Temperature and humidity are the two main environmental factors that must be controlled.

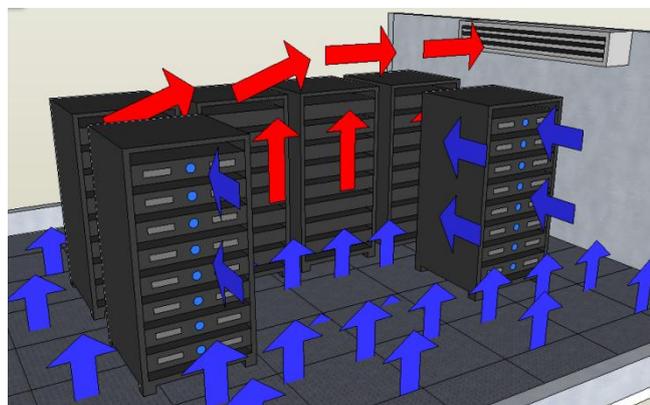


Heat is produced by constantly running servers and other equipment, and they can cause the ambient temperature to rise to dangerous levels if left unchecked. To keep the environment within acceptable limits, the climate must be managed.

Firstly, the floor of the server room should be raised, allowing cool air to circulate underneath the equipment, and be drawn up through the many small holes in the raised floor. This design also allows power cabling to be routed underneath the floor, so there are less trailing wires and cables going to the server. Hot air produced by the servers rises towards the ceiling, and towards the air conditioning intakes that are located on the ceiling (see image). This hot air can then be removed to the outside world, or can be recycled, for example by feeding it into another university building. To help reduce energy consumption, air from outside can be taken, which will usually be below the temperature of an average room.

This air conditioner will aim to keep the room between 16 and 24 °C (61–75 °F), temperatures recommended by ASHRAE's Thermal Guidelines for Data Processing Environments. These temperatures also fall well within the recommended operating limits provided by the hardware manufacturers.

The humidity also needs to be controlled – too low (< 35%) and static charge can build up and discharge, damaging the sensitive electronic equipment, too high (> 60%) and water may condense on internal components and begin to oxidise (rust) them. [ASHRAE, Thermal Guidelines for Data Processing Environments]. The humidity can also be monitored and controlled by the air



conditioning unit. The arrangement of the servers I recommend is a hot/cold aisle arrangement – where all of the servers expel their hot air into the same aisle – which transports the hot air to an air conditioning intake (see above image).

If the room was 10 x 5 metres and housed around 10 servers, Airconco estimates a 12.5kw ceiling mounted air conditioning unit should be sufficient to keep the room cool, costing around £4000 including fitting [Airconco]. However, two A/C units are needed to provide a resilient cooling solution, as is very easy for one to fail or become faulty (e.g “coil dry” button to kill bacteria getting stuck on, resulting in the A/C unit becoming a powerful heater). The 2 units should provide good redundancy as the other one should manage on its own if the other fails. Wetness sensors placed on the floor by each A/C unit would be good to detect leaks, and USB temperature and humidity monitors could be placed in different parts of the room to raise an alert by email/sound if certain conditions become true, then shut down the systems safely if conditions worsen [Openxtra, Xsensor lite USB temperature and humidity monitor].

The server room must be located in a safe place, possibly in a sealed basement that is not susceptible to floods, or high up in a building, not facing the afternoon sun. The room must not have a sprinkler/water system due to the electronics, so a gas suppression system would be more suitable, with alarms (audio and visual for visually and hearing impaired people) and respirator/breathing masks if the room layout required them. There should be heat and smoke alarms and detectors appropriately placed in the room to detect fire or excessive heat. Ideally, another server that is mirroring the main server should be located in a different physical place for the highest redundancy, with a dedicated link to the main server.

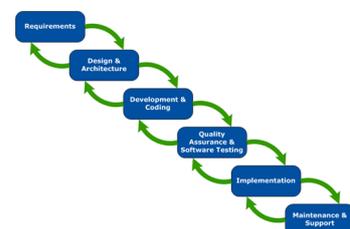
High speed network connections will be vital for the server room as the University network traffic will pass or go to the equipment in this room. I would recommend at least 2 connections to the network, as if there was just one and it failed, the whole network would stop working. The high speed internet connection must also enter here, especially if a web cache is in use to reduce data consumption.

3. Project Management

To develop a solution to this project, there are many steps that need to be considered, and these need to be followed in a structured way. After understanding the problem at hand, the requirements must be gathered to a potential solution, which can then be translated into a design. After this, the solution is built up and tested with modifications being made where appropriate. However, to develop an effective solution, we must gather *all* of the requirements to a proposed solution, and then do *all* of the design and so on, which is hard to keep track of – so a structure is needed to manage the project.

One structure to use is the Waterfall model, a sequential design process where one stage of the project follows the next. This would be quite suitable for this venture, as there should be sufficient time at the design stage to plan out exactly how the invested money will be used.

However, due to this being a large project – one phase may not completely finish until a time after the next one has started, and changing conditions from unexpected problems or changing requirements will mean going back to the design stage, modifying it and starting again. The Sashimi waterfall model provides overlapping phases, so feedback can be given back



“up” the waterfall to previous stages and issues can be discovered earlier in the development process, reducing the risk of wasting time and resources. [Waterfall-model.com, Sashimi waterfall model]. A Gantt chart would be essential to this structure, to organise each part of each step of the waterfall.

Another project management structure is iterative and incremental development. This would be a safe methodology to use, as it is largely based around the tracking and development of each assertion/iteration to ensure that the right problem is still being solved, the right resources are available, and that the end goal is realistic with the time and resources available.

This methodology also really helps to dramatically reduce risks by constantly challenging and evaluating each iteration, helping to keep all parts of the project on track and ensuring that they are all leading to the right goal in the most efficient way possible. This structure would be suitable for the Mid Wales University’s ICT refit, as the implementation needs to have a very good risk analysis due to the large amounts of money being invested in each part. [IBM, Iterative Development].

PRINCE2 is another structure that can help manage a project effectively. It is free, Government backed and has been developed using feedback from real projects. PRINCE2 vitally provides early warning of problems, which will be very useful in this situation to avoid wasting time and other resources. This is helped too by the fact that it has a *proactive* style of management rather than reactive. I believe using PRINCE2 would be the most appropriate management structure due to the fact it clearly defines a start, middle and end to the project, has flexible decision points, controls deviations from the original plan and has regular reviews against the primary business case. Deliverables are agreed upon and fixed to give terms of reference before the project starts, and good communication with the client leads to little time being wasted on unnecessary ventures. [John Gilbey, CS25110 Managing Standards 2]. Feature creep is also kept to a minimum as changes have to be sent back to the project board, who must agree to the change, bearing in mind how much it will cost them in time and money.

4. Computer Hardware

This section of the report aims to identify the best solutions to the need for physical computer hardware.

4.1 Personal Computers

Computers that are going to be used by staff will need to be quick, but they don’t need to be extremely powerful as they would be expensive to buy and use more power to run. Power users are going to need a higher specification PC, especially if they are performing resource intensive tasks such as video editing and music production.

i. Secretarial and Administrative staff.

Personal computers for these types of user will not need to be particularly powerful, but should be good enough so that they will not need upgrading in the near future.

The Dell Vostro 260 Slim would be a perfect fit for this role, with a new Intel i3 dual core (with 4 threads) processor, 2GB of DDR3 RAM, a 250GB hard drive and onboard graphics, all for a very reasonable £269. This price includes a standard Dell keyboard and mouse, a small 250W power supply, a DVD drive, a gigabit LAN port, a loop to padlock the case shut and a slim



build that takes up less space. The USB, headphone and multimedia ports on the front will be found useful by all users.

For monitors, I would recommend a Dell E-series E1912H 18.5" LED monitor, due to the big, energy efficient, long lasting LED display, and it is only £71 per unit.



ii. Visitors

The above type of computer would be appropriate for visitors too, but cleanly wiped existing single core computers would be enough for users only needing them for a short period.

iii. Power Users

(I assume that a power user is a user that regularly uses large and resource intensive software.)

A power user, such as a film and media student or system admin, is going to care more about having a powerful, capable system than about it being cheap and efficient. They are likely to need a better processor such as an Intel i5 or i7, more storage space, more RAM and probably a graphics card. The Dell XPS 8300 will be more handle almost any program with ease, and will continue to do so for the near future. It contains an Intel i7, 6GB of RAM, an NVIDIA GT 530 graphics card whilst being just £524.



4.2 Server Hardware

Most of the servers are going to be run in virtual environments due to the large savings in space, hardware and power, gained from running many virtual machines on one physical system.

Due to the virtualisation, less physical server racks and cabinets will be needed, meaning our server room has more room for expansion and scalability in the future.

I recommend using the Dell PowerEdge R710 server, because it is:

- Built for virtualisation performance with more, power efficient, low voltage DDR3 memory and embedded hypervisors.
- Powerful Intel Xeon quad or hex core (hyper threaded to 2 threads per core)
- Very upgradeable (can add another CPU and up to 288GB of RAM)
- Redundant power supply – 2 PSUs.
- Price starts from £1200

It is likely that at 3-4 of these machines will be needed, to provide all the required services and also backup machines to provide redundancy. I would also heavily recommend a UPS (Uninterruptable Power Supply - ~£100 upwards)

to allow the servers to shut down safely in the event of long external power disruption. Hard drive, switch and network interface racks as well as server cabinets will also be needed in the server room.



Throughout the university, especially in the teaching labs, offices and coffee shops, wireless routers, access points and switches would be required to provide wireless internet.

5. Computer Software

5.1 Domain Controller

Servers running Active Directory are called domain controllers. Active Directory is needed to authenticate user accounts logging onto a domain, and to control their privileges and access to resources. [Wikipedia, Active Directory]. As it is so vital, I recommend that another physical domain controller be implemented so that it replicates its virtual counterpart. This would mean the network would carry on working, even if the virtual environment died or there was a fault on the machine hosting it.

5.2 DNS Server

As the network is going to have hundreds of computers connected to it, a DNS server will be needed to manage host names and information in one central area, and can also cache DNS information for the internally connected clients. [Redhat.com, How to set up a home DNS server].

5.3 Mail Server

There are many options for different web based email software, including some open source and free software alternatives to Microsoft Exchange like SquirrelMail, Postfix and Exim. I recommend a webmail like SquirrelMail, as then users can access all of their emails from any computer, as it is all online, and can be centrally backed up.

5.4 File Server

An Apache file server will be needed to be responsible for the central storage and management of data, making it easier to back up and giving the possibility of access via HTTP with a public_html directory. The University website could also be hosted here.

5.5 Virtualisation

The Dell PowerEdge R710 supports 3 of the best virtualization solution manufacturers (hypervisors): VMware, Citrix and Windows Server. I would recommend using VMware vSphere due to its simple, yet effective resource management and security. It is also recommended by many leading hardware manufacturers such as HP and Cisco.



5.6 Antivirus

I would recommend using Sophos antivirus due to Sophos being the best make for volume licenses.

5.7 Operating Systems

As most students will be accustomed to using Microsoft Windows, and most of their course software is built to run on Windows, Windows 7 will be used. The only downside is the cost, but

due to the fact that the PCs specified earlier already have a Windows 7 license each, Dell may sell them cheaper in bulk, and without the license.

One uncertainty I have come across is that I do not know the current number of staff and computers in computer rooms; therefore I am going to assume there will be around 200 staff, and 300 other computers in computer rooms and labs that will need Windows 7 and Microsoft Office licenses.

After a look at the Microsoft Website and a chat with a Microsoft member of staff, 500 Windows 7 professional licenses could be got for around £24 each for 3 years = £12,000.

5.8 Microsoft Office

On the Microsoft Office Volume Licensing site, 500 Microsoft Office Professional Plus licenses look to be around £35 each for 3 years, for 500 computers would be around £17,500 for 3 years.

Currently, this totals £29,500 for Windows 7 and Microsoft Office for 500 computers for 3 years. I am sure, however, that this price could be beaten either by phoning Microsoft and getting an actual quote, or by contacting an Academic license reseller. Another option, the Microsoft assistant advised me, is to leave the Windows 7 that Dell installs on the machines. I would recommend using the volume license if possible, as the installation of operating system, settings and programs can be done easily by installing off one Windows image stored on the server.

Other software such as Macromedia Studio could be discussed with staff student committees to see if there was a demand for it, but alternatives like Picasa can be used until then. I would heavily recommend installing Google Chrome for users that do not wish to use Internet Explorer.

6. Security

The issue of security covers not only the computers and equipment the university owns, but also more importantly covers the data and information owned by the university and its staff and students. Measures must be put in place to ensure that data is kept safe, so it is not lost easily and only those authorised to access it, can see it.

My high level security goals for the university are:

- Prevent loss/theft of data, especially private and sensitive data
- Prevent loss and damage of hardware such as workstations
- Protect university network from unauthorised users and damage

6.1 Hardware Aspects

To stop the loss of hardware due to actions like theft, I recommend investing in Kensington locks for the desktop computers and monitors to attach them to desks/table legs.

Kensington locks are standard across most modern computing items, and the Dell computers selected have padlock-able cases, which would stop the theft of hard drives and other components.

Swipe cards for students (could use pre-existing ones if available) could be used to gain entry to computer rooms or other university buildings at any time of the day or night. It would also deter unauthorised personnel from entering. Cards with elevated clearance levels would be needed to access more secure rooms such as the server room and staff rooms.

6.2 Software aspects

As well as physical security such as CCTV, swipe locks and key codes, I would recommend configuring the workstation computers to be more secure, as they will be in constant use.

- They should all have an anti-virus program (such as Sophos – cost effective for many user licenses) installed and their personal firewall active, to help stop malicious software running and infecting computers.
- They should be set to log off after 15 minutes of inactivity, after giving a warning after 10 minutes – in case the user is still there but not actively using the computer. This should help prevent insecurities from users forgetting to log off.
- User access to certain parts of the system should be restricted, such as the windows installation and program files
- Some privileges should be restricted – such as the execution of any unknown .exe file, as it may be malicious software
- Restriction of removable media may be needed to stop data portability insecurities in some office situations

To protect the university network from unauthorised devices, 2 approaches can be considered:

- Have one university wide password for the wireless
- MAC address control for both wired and wireless devices

I recommend using the MAC address control approach due to it being many times more secure than using a WEP or WPA password for the wireless that could easily be found out by unauthorised users by either cracking the password or by an authorised user telling them. Making the users register MAC addresses to their own account ensures that responsibility is given to the users to only register their own devices for use on the network. Also using MAC address control enables the possibility of joining the “eduroam” scheme to allow visiting students from participating universities to access the internet (Radius server needed).

User passwords must be encouraged to be secure by setting guidelines to force the user to use a mixture of upper and lower case, as well as numbers. Passwords can also be set to expire after a certain period, to force the user to create a new one.

7. Naming and Directory Services

7.1 One option for a naming/directory service would be to use NIS. NIS stores a lot of useful information in “maps” such as usernames, passwords, groups and memberships and services. In the university, each academic department could have its own group, with its own private resources and dedicated services like printers etc. One large problem though is that if slave/secondary servers are installed to add redundancy, and the master goes down – all secondary servers will hang as they can’t see the master.

7.2 Another directory service is LDAP which is more like a phone book, as it is able to look up phone numbers and email addresses using names. OpenLDAP, a free open source implementation of LDAP, can locate things such as people, resources and services and uses a directory tree structure which can be organised into groups and sub groups in a hierarchy. LDAP can also have SSL security, which NIS and DNS do not have.

7.3 DNS would be the best naming and name translation system to use, as this is what DNS is designed to do. This would allow the use of meaningful names for computers, email addresses and other resources, without having to know their numeric addresses.

The best solution is to use not just one of these services, but in fact to use a few together and capitalise on each one's strengths. DNS is the most prominent type of name server, and is essential for name to number and back translations. A DHCP can be used to assign IP addresses to the client computers, and the database of all the addresses is stored on that server. LDAP, NIS or NIS+ could be used as system to centrally store information about parts of the network, and I would recommend OpenLDAP due to its better security, master/replica server configuration, hierarchically organised data, and its ability to be work on UNIX or Windows systems.

8. Business Continuity

Important measures must be taken to ensure the highest safety of data and consistent continuity of service, especially in this university situation where the data is extremely valuable to the students, and significant measures should be taken to reduce the probability of data loss to as low as it can be. Also the services provided such as the webmail, personal file store and internet link must be kept to as near 100% uptime as possible, as these services may be essential to staff and students alike.

8.1 Risk Analysis

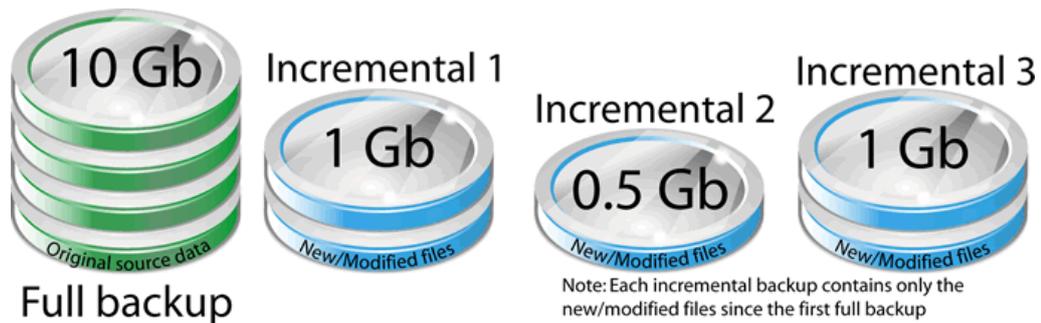
Due to the large amount of money being invested, coupled with the scale and objective of this project, makes a risk analysis vital to help stop wasted resources and ensure success of the project. Although funding should be secure, identifying other threats such as late deliveries or unavailability of products is important to stop the re-fit going over time and budget. Therefore, planning must be done to ensure resources arrive early, so small delays will not affect work. Many other things must be factored into the risk analysis too, from natural and environmental factors such as weather and disasters, to human and technical aspects like illness, accidents and equipment failure, all of which may threaten a successful outcome. [Mindtools, Risk Analysis]

Many meetings will have to take place to analyse the risk analysis, as even the location of the server room must be decided on so that it is as safe from theft, natural disasters, the sun etc as it can be, whilst also being accessible enough to be able to move server cabinets into it.

This risk analysis must be on-going through the planning, implementation and when complete, as when the new systems are up and running, all precautions must be taken to ensure services such as Blackboard are kept online.

8.2 Backups (Long term)

To help keep user's data secure, incremental backing up should be implemented to help prevent data loss due to user error and hardware faults, whilst not producing too much data as only the changed files since the last full, incremental or differential backup are copied and stored. A procedure would be needed to daily move all backups to a different physical location, to help decrease the chances of all copies getting destroyed simultaneously. Backups also must be tested to ensure they work. I obtained the image and following information from Backup4all.com, the image effectively shows how an incremental backup works:



Full backup

Backing up this way is quicker than backing up the entirety data every time, as only small amounts of data need to be copied and stored. This strategy will still be effective if the university grew with more students and more data. [Backup4all, Incremental Backup]

8.3 RAID

For hard drives holding valuable real-time data, such as the Active Directory servers, RAID can be used to increase redundancy if one drive is to fail, at the expense of buying extra disks. For file servers holding users data, a RAIDZ2 configuration (if server is running on ZFS) can be used to provide effective resilience against drive failure. This system also uses “copy-on-write” to preserve old copies of data, and “doubles the parity structure” and can “sustain up to two drive failures without losing data”[Wikipedia, RAID].

8.4 Future Risks

- 8.4.1 A Disaster recovery plan will be essential to help minimize disruption in the event of future disasters such as equipment, software or security failures. Regular tests of this plan should be practised to ensure it works, and backup options work, when they are needed.
- 8.4.2 Future proofing is one risk that must be considered heavily to ensure more money is invested now, to save frequent replacement of equipment
- 8.4.3 Upgrades will certainly be needed in the future, and if data logging is started now, it may be useful in the future to see where bottlenecks lie, and services nearing capacity.
- 8.4.4 With rising energy prices almost assured for the future, an initial expenditure on solar panels would be recouped quickly and then start generating free electricity.
- 8.4.5 Vulnerability management – Always assessing vulnerabilities, prioritising and fixing the most threatening, and continuously monitoring.

9. Ongoing Management

The university is not a static entity, and will continue to develop and grow as time passes, and this can put strain on the ICT systems unless they are continuously managed.

- 9.1 Regular performance monitoring and evaluation against high-level goals is needed to assess usage and performance to discover weaknesses in the ICT provisions, such as points in the network that are frequently used and nearing designed capacity. If the number of students at the university increased, there would be more load on the network and on the servers servicing requests. With more people logged on at the same time, it may eventually be necessary to invest in another domain controller to ease

the load on the existing one. Due to the extra users all storing files, more storage would be needed, and it may be more viable to increase the frequency of backups.

As Sustainable Tourism Online says: "You can't manage what you don't measure."
[Sustainable Tourism Online, Ongoing Management].

- 9.2 Monitoring the needs of both users and management is important too, and they will both be quite different. Users will know what they want from the computing service, like equipment such as printers, scanners and wireless, as well as a reliable service with good support. The management's needs will be more corporate, and although they want reliability and security, they also want it to be cheap and low risk.
- 9.3 The ICT provisions for any company or business must be upgradeable, as technology is continually advancing and getting cheaper. The recommendations I have made have future-proofed the university well, the Intel i3 desktop computers for the staff and computer rooms are more than powerful enough for today's everyday tasks, and will be good computers for at least the next 6 years, but probably much longer, and they were less than £270 each.
- 9.4 Training may be needed for both new and existing staff, especially when making large changes such as upgrading from Windows XP to Windows 7, and from Office 2003 to 2007 or 2010.
- 9.5 Continual planning, implementing and reviewing will be needed to aid the on-going improvements and expansions to the services provided, resulting in money saved due to options being constantly considered, and taken when they are cost-effective and useful to the university.

10. Overall Summary

This report has detailed the key aspects that must be considered to completely re-fit the entire ICT provision for the university. I have outlined the recommendations that I would make to ensure the maximum efficiency and cost effectiveness of the new systems, and look forward to discussing these suggestions further with the management to confirm that our long term goals for the ICT refit conform.

Below is a breakdown of the combined estimate costs, ordered by report section:

2. Custom Server room
 - 2.1 Flooring (assuming it is not there already) - £600
 - 2.2 Resilient air conditioning for up to 10 servers - £7000
3. Project management – none other than wages for employees, PRINCE2 is free.
4. Hardware
 - 4.1 Personal computers
 - 4.1.1 Secretarial and Admin staff (assuming around 200 permanent staff in offices) 200 x £269 Dell Vostro 260 Slim = £53,800

Computer room and lecture room computers – same Dell Vostro 260 Slim (assuming around 300 needed likely to be less) = £80,700 [before discounts for buying 500 computers for a University]
 - 4.1.2 Visitors – (assuming they just need them for a short time, they can use existing machines that have been cleanly wiped, Windows 7 installed, possibly upgraded RAM. £200 max

- 4.1.3 Power Users – such as film and media department computers (assume less than 10 extremely powerful computers needed) and system administrators (3-4 needed max), 14 x £524 = £7,336

Monitors – About 500 at £71 = £35,500, plus a few HD screens for the film and media's i7 computers = 10 x £100 = £1000.

4.2 Server Hardware

- 4 Dell PowerEdge R710 Servers (start from £1200) = from £4,800
- 4 Uninterruptable Power Supplies, (£400 for a good one for each physical server) = £1,600
- Switches – Switches will be needed to link together the entire network infrastructure. Due to the current provision of around 500 computers, plus maybe 50 access points and 20 networked printers, I estimate around 15 x 48 port switches (large department / computer room size) and about 10 x 24 port switches (small department / small office sets) should be sufficient to connect all computers and have some spares.
10 x 24 port switches = £3,050 (Dell PowerConnect 2824 @ £305 each)
15 x 48 port switches = £8,925 (Dell PowerConnect 2848 @ £595 each)
- Extra USB temperature and humidity monitors (2 for the server room at about £80 each) = £160
- Routers and about 50 wireless Access Points will be needed to emit the wireless network, and it is best to spend a little extra to buy reliable ones from a trusted company like Cisco. 50 x Cisco Small Business WAP4410N Wireless-N PoE Access Points at £120 each (As pictured to the right – picture from ebuyer.com) = £6000. These access points can be installed anywhere – as long as they have a data cable going to them, as they can receive power over Ethernet.
- I assume there is a pre-existing LAN infrastructure, but if not, CAT5 cabling and Ethernet heads for Ethernet cables would be needed, along with Ethernet sockets, crimping tools and line testers. (Picture from amazon.co.uk)
- 2 Server cabinets (from £1000 up from Dell) = £2000
- Storage – It is probable that a few Dell PowerVault MD1200 Direct Attached Storage racks will be needed to handle the file stores, and each rack supports up to 12 3.5" disks. 3-4 of these may be needed, at £2,079 each = £8,316
- Hard Drives – Normal consumer 1TB hard drives used to be £40 for 1TB, but prices are currently (January 2012) still high due to the floods in Thailand impacting hard drive manufacturers. To start with, I estimate at least 20TB of (server grade) hard drive space will be needed, and a Western digital 1TB Enterprise drive can be obtained from ebuyer for £105.30, giving a total of £2106 for 20TB.



5. Software

- Operating systems (Assuming the University doesn't have a pre-existing Microsoft contract). All of the Dell workstations each have a Windows 7 license, and it may be cheaper to leave these on. Another option is to ask Dell for just the hardware, and see if they can drop the price by £24+ per unit, then a volume license from Microsoft could be obtained (around £12,000 for Windows 7 for 500 PCs for 3 years).
- Microsoft Office – Microsoft was willing to sell Office Pro Plus licenses for £35 for 3 years when I asked them and that would come out at £17,500 for 3 years.
- Google Chrome, Sketchup and Picasa are free. As is Notepad++ and OpenOffice.
- Anti-Virus for around 514 computers – price unknown – about £4,000

6. Security

- Around 514 Master Lock padlocks for the Dell computers - £1713 at most (6 for £20 on Amazon, picture from Amazon.co.uk)
- Around 600 Kensington Locks for computers, switches, printers etc (£2.15 from Amazon, picture from Amazon.co.uk) = maximum £1290



This gives a total of £247,596 (Dell hardware prices exclude VAT). This price will likely be reduced assuming VAT can be claimed back, and also the University might be able to get more specialised campus volume licenses from Microsoft. Dell should also drop some prices due to the fact we are purchasing over 500 computers, monitors, some servers, switches and cabinets from them.

Additional costs not mentioned due to systems probably already being place or unknown costs:

- Fire suppression systems
- Internet connection to JANET
- Wages
- CCTV
- Swipe card system

Bibliography

Includes all sources I may have consulted, ordered by the sections corresponding to the report. Date published and Author included where possible. All sources are online unless stated otherwise (e.g [PowerPoint Slideshow]).

Custom Server Room section

Pictures of server cooling – made by myself on Google Sketchup 8

ASHRAE 2008, Thermal Guidelines for Data Processing Environments, Available at:

http://tc99.ashraetcs.org/documents/ASHRAE_Extended_Environmental_Envelope_Final_Aug_1_2008.pdf, [Accessed 08/01/12].

Airconco, Air conditioning estimate , available at:

<http://www.airconco.com/coolculator-home/index.php?calctype=fixed>, [Accessed 08/01/12].

Openxtra, Xsensor Lite USB Temperature and Humidity Monitor , Available at:

<http://www.openxtra.co.uk/p/xsensor-lite-usb-temperature-and-humidity-monitor>, [Accessed 02/01/12].

Project Management

IBM, What is iterative development – Ian Spence and Kurt Bittner, 15 March 2005, Available at:

<http://www.ibm.com/developerworks/rational/library/mar05/bittner/index.html>, [Accessed 03/01/12].

Waterfall-model.com, Waterfall Model, Available at:

<http://www.waterfall-model.com/>, [Accessed 03/01/12].

Waterfall-model.com, Sashimi Waterfall Model, Available at:

<http://www.waterfall-model.com/sashimi-waterfall-model/>, [Accessed 03/01/12].

Wikipedia, Waterfall Model, Available at:

http://en.wikipedia.org/wiki/Waterfall_model, [Accessed 03/01/12].

Managed Mayhem, Sashimi Waterfall Image – Jim Rising May 2009, Available at:

<http://www.managedmayhem.com/2009/05/06/sashimi-waterfall-software-development-process/>, [Accessed 08/01/12].

John Gilbey, CS25110 – Managing Standards 2 [PowerPoint Slideshow],

CS251_Managing_Standards_2010_for_web.ppt, [Accessed from Blackboard 04/01/2012]

Computer Hardware

Dell, Dell.co.uk / Dell.com, product information and pictures as listed below, [Accessed on 30/12/2011].

Dell E-series E1912H 18.5" LED monitor

<http://search.dell.co.uk/1/2/141629-dell-e-series-e1912h-18-5-47cm-led-monitor-vga-only-1366x768-black-uk.html>

Dell Vostro 260s Slim Tower Desktop

<http://www.dell.com/uk/business/p/vostro-260s/pd>

Dell MS111 Mouse Picture

<http://accessories.us.dell.com/sna/productdetail.aspx?c=us&l=en&s=corp&sku=330-9456>

Dell KB212-B Keyboard Picture

<http://accessories.dell.com/sna/productdetail.aspx?c=us&l=en&s=gen&sku=331-2249>

Dell XPS 8300

http://www.dell.com/uk/business/p/xps-8300/pd?oc=d00x8328&model_id=xps-8300

[Picture of Dell desktops, monitor, keyboard and mouse obtained from above sites' product pages.]

Dell PowerEdge R710 Servers being used by The Planet

<http://en.community.dell.com/dell-blogs/enterprise/b/inside-enterprise-it/archive/2009/04/20/the-planet-deploys-first-powerededge-r710-servers.aspx>

Dell PowerEdge R170 Server Info and picture

<http://www.dell.com/uk/business/p/poweredge-r710/pd>

Computer Software

Wikipedia, Active Directory, Available at:

http://en.wikipedia.org/wiki/Active_Directory, [Accessed 02/01/12].

Wikipedia, Domain Controller, Available at:

http://en.wikipedia.org/wiki/Domain_controller, [Accessed 02/01/12].

Redhat.com, Shannon Hughes, November 16, 2006, How to set up a home DNS server, Available at:

<http://www.redhat.com/magazine/025nov06/features/dns/>, [Accessed 02/01/12].

Cisco.com, Cisco Server Virtualization with VMware, Available at:

<http://www.cisco.com/en/US/netsol/ns1148/index.html>, [Accessed 02/01/12].

Dell, Dell PowerEdge R710 picture, Available at:

<http://www.dell.com/uk/business/p/poweredge-r710/pd>, [Accessed 02/01/12].

Microsoft, Volume Licensing quotes, Available at:

<http://www.microsoft.com/licensing/mla/quickquote.aspx>, [Accessed 02/01/12].

Microsoft Employee and myself, Text from Microsoft chat, Transcript available at:

<http://users.aber.ac.uk/mcr1/cs25110/microsoftchat.pdf>, [Accessed 02/01/12].

Security

Eduroam, Information, Available at:

<http://www.eduroam.org/>, [Accessed 04/01/12].

Naming and Directory Services

OpenLDAP, LDAP Information, Available at:

<http://www.openldap.org/>, [Accessed 04/01/12].

Wikipedia, DNS, Available at:

http://en.wikipedia.org/wiki/Domain_Name_System, [Accessed 04/01/12].

Dave Price, CS25110 – Naming and Directory Services continued [PowerPoint Slideshow], naming_2.ppt, [Accessed from Blackboard 02/01/2012].

Samba, DNS and DHCP Configuration Guide, Available at:

<http://www.samba.org/samba/docs/man/Samba-HOWTO-Collection/DNSDHCP.html>, [Accessed 04/01/12].

DHCPserver, DHCP Server for Windows, Available at:

<http://www.dhcpserver.de/dhcpsrv.htm>, [Accessed 04/01/12].

Oracle, System Administration Guide: Naming and Directory Services, Available at:

<http://docs.oracle.com/cd/E19253-01/816-4556/intro-1/index.html>, [Accessed 04/01/12].

Well House Consultants, What are NIS, LDAP, DNS and BIND, Available at:

<http://www.wellho.net/solutions/general-what-are-nis-ldap-dns-and-bind.html>, [Accessed 04/01/12].

Wikipedia, Lightweight Directory Access Protocol, Available at:

http://en.wikipedia.org/wiki/Lightweight_Directory_Access_Protocol, [Accessed 04/01/12].

Business Continuity

Mindtools.com, Risk Analysis , available at:

http://www.mindtools.com/pages/article/newTMC_07.htm, [Accessed 08/01/12].

[b4a] Backup4all.com, Differential Backup (Information and images), available at:

<http://www.backup4all.com/kb/incremental-backup-118.html>, [Accessed 06/01/12].

[wikraid] Wikipedia, Non Standard RAID levels from Wikipedia, available at:

http://en.wikipedia.org/wiki/Non-standard_RAID_levels, [Accessed 08/01/12].

Ongoing Management

Sustainable Tourism Online, Ongoing Management (information and quote), available at: <http://www.sustainabletourisonline.com/destinations-and-communities/implementation/ongoing-management>, [Accessed 08/01/12].

Overall Summary

Prices and images for products obtained on the following websites, Accessed 08/01/12:

Ebuyer – Cisco Access Point

<http://www.ebuyer.com/164592-cisco-small-business-wap4410n-wireless-n-poe-access-point-wap4410n-g5>

Amazon – Network Tester

<http://www.amazon.co.uk/ETHERNET-TESTER-NETWORK-CABLE-RJ45/dp/B002SUCY9K>

Dell - PowerVault

<http://www.dell.com/uk/business/p/powervault-md1200/pd>

Ebuyer – WD SATA Hard Drive

http://www.ebuyer.com/226057-wd-wd1003fbyx-re4-1tb-sataii-7-2k-64mb-enterprise-hard-drive-wd1003fbyx?utm_source=google&utm_medium=products