A Repeatable Framework for Best Fit Cloud Solution

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Keywords: AH – Authentication Header, CPU – Central Processing Unit, DNS – Domain Name Server, EPM – Evans Property Management, ESP – Encapsulation Security Payload, IaaS – Infrastructure as a Service, LAN – Local Area Network, NAS – Network Area Storage, PaaS – Platform as a Service, SaaS – Software as a Service, SME – Small Medium Enterprise, SMTP – Simple Mail Transfer Protocol, SSL – Secure Socket Layer, VPN – Virtual Private Network.

Abstract: To respond to business challenges with agility, modern businesses have to evolve quickly to stay competitive. Unfortunately, in many situations, proliferation of heterogeneous Information Technology shifts act as a barrier to innovations instead of as a driving force. Crucially, this is due to the confusions that they sometimes cause whilst Small Medium Enterprises (SMEs) are trying to elect the right technology solution appropriate for a given business challenge i.e. amidst various comparable options, claims, features and benefits from different technology vendors available in the market. To help small SMEs quickly make timely decision on what technology solutions are appropriate for a given business challenge i.e. given the vast array of solutions available in today's market, this paper proposes a guideline for an implementable solution for any SME with similar requirements to our chosen fictitious customer called EPM. The paper will cover main areas such as introducing a generic SME business case, analysing hardware solutions and methods typically employed in cloud networks to reduce costs. Then the paper will introduce the solutions as a repeatable framework to be critically analysed to find a suitable solution for the customer, this will then be looked into with any other cloud principals that could create a better fitting solution for the customer.

1 INTRODUCTION

In this paper, we will be analysing cloud and the factors behind its popularity driving more and more users towards its style of IT. One of the major barriers over cloud in this era is the user misunderstanding and confusion of what cloud is and what it can deliver.

In particular, we will relate this paper to a generic small to medium organisation, as this is the audience where potential growth can be easily obtained. This is due to SMEs having expendable income that can be invested in internal growth, and one of the major areas that growth can be achieved is through cloud services.

The rest of this paper is organised as follows: The background research and organisational structure of the chosen SME is covered in section 2. Section 3 describes the contributions of this paper. Section 4 illustrates the motivation, driving this paper. The risks involved with cloud computing and their impact is covered in section 4. Section 5 introduces the technology that will be analysed and implemented into the framework at the end of the paper. The method of the proposed framework is explained in section 6. Finally section 7 covers the conclusion of the paper.

2 BUSINESS CASE

In this paper we will relate our findings back to a specific business case for a SME. The reason behind this is to target our findings toward a specific set of requirements. Although the paper will cover a range of cloud converged services and infrastructures, the business scope will allow for some direction to be applied to these findings. The business background is described in the section that follows.

2.1 Business Background

The business that will be analysed is Evans Property Management Ltd (EPM). EPM has a large portfolio of properties which they are renting to customers.

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The business currently employs 100 staff spread over different departments. However the business is looking to grow the business so more staff could be expected in the future.

The business has been active since 2007 (9 years), much of the equipment that is used by the business currently is outdated and not meeting the requirements expected by EPM. Many of the servers currently used are failing due to high load balancing operations that have increased gradually over the 9 years of business. Another problem with current hardware installed in the business is that it does not allow for sufficient data storage, file servers installed within the business only allow for a maximum capacity of 1TB, this has now reached its maximum storage capacity and needs to be resolved with new solutions.

EPM already owns an area that is currently being as their data centre, there is no issue with size limitations as they guarantee the area is large enough to hold any solution.

The departments within the business [*Table 1*] all have a shared business plan and can share a solution if this keeps in line with their main business focus of reducing costs.

EPM current has gigabit Ethernet installed within the company, however current hardware used by the business cannot take full advantage of these transmission speeds. This is something they would like to resolve with new hardware. The main constraint that EPM has stressed is that of money, this is a highly important resource to EPM and SMEs in general. The budget that has been provided by EPM is £5,000.00.

Here the organisation structure of EPM is shown, this gives a clear understanding of who the main stakeholders in the business are and what their primary concerns are.

Table 1: EPM Organisation Structure.

Department	Title	Name
-	CEO	David Evans
Finance	CFO	Lesley Blake
Sales	VP	George Wright
IT	CIO	Dave Clark

Table 2: Number of Employees within EPM.

Department	**Employees**
Finance	20
Sales	65
IT	15

The stakeholders discussed above each want their problems to be considered in the final implemented solution. These problems are shown in Table 3, each department head wants problems addressed.

Table 3: Current Hardware in EPM.

Server	**Role**	**Department Owned by**	**Problems Experienced**
SALES-Fileserver	File Server	Sales	Insufficient Data Storage. Requires 1TB
FINANCE - Fileserver	File Server	Finance	Insufficient Data Storage. Requires 1TB
Network Server	Proxy Server DHCP Server	IT	Server Failure (Due to malfunctioning components that cannot be replaced)
CustMan-Server	Customer & Property Management	IT	Server Failure (Due to malfunctioning components that cannot be replaced)

2.2 Summary

The information provided by EPM above about, budgets, organisation structure and problems now taken into account, EPM would also like key concerns to be at the forefront of any implemented solutions. Their 2 main concerns are:

1. Scalability
2. Cost Saving

The objectives of the paper will be:

- Provide a solution for a budget of £5,000.00
- The solution must support:
  - Gigabit Ethernet
  - Storage Size (Over 1TB)
  - Also the solution must support functions such as a file server, proxy server, DHCP server and support the customer management application owned by EPM.

Only solutions that meet the objectives given above will be chosen for implementation into our proposed repeatable framework given later.

3 CONTRIBUTIONS

Although there are many papers that explore the most

befitting solution for a business. These are usually aimed at customers experienced in a cloud environment, overlooking customers entering a cloud consumer market. This paper looks to:

- Effectively creates a framework that looks at the cost benefit of a variety of different solutions on behalf of a customer.
  - It will ensure that the user is offered the most scalable solution, while minimising the costs associated with it such as upfront costs and running costs. This is shown in the method, across all of section 9.

The paper also contributes to how most SMEs look at cloud and what factors affect their decision on moving to the cloud. This is shown in sections 4 and 9.3.

4 MOTIVATION

This paper aims to obtain an understanding of how a framework can be implemented not only to the business case in question, but also the wider audience of SMEs in general. Below we have analysed the push and pull factors of SMEs in relation to cloud and will later implement these into a framework.

4.1 What Is the Attraction of Cloud?

Cloud has started to attract a lot of users from all different backgrounds. Different users have different requirements from cloud, in the business area that we are looking at we will analyse the attraction of cloud towards SMEs.

Figure 1 illustrates the main reasons behind UK SMEs adopting cloud into their business.

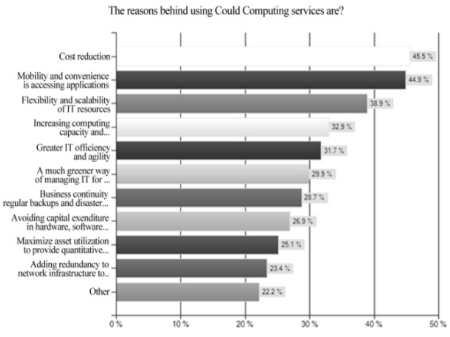


Figure 1: Showing the main attractions of cloud relating to SMEs (Sahandi et al., 2012).

The top three points taken away from this image are:

- Cost Reduction (45.5%)
- Mobility & convenience in accessing applications (44.9%)
- Flexibility & Scalability (38.9%)

These points made above have the most significance to SMEs as they feel this is how a competitive advantage will be gained. These are the main areas we will aim to provide in the framework for a general cloud infrastructure to be provided to customer at the end of the paper. EPM has particular attraction to the point made of cost reduction and how this can be achieved through an implemented solution.

4.2 What Factors Affect Cloud Take Up?

With the major attracting factors of cloud taken into consideration above, it's time to look at the main concerns that SMEs such as EPM have of moving to a cloud deployed environment.

(Sahandi et al., 2012), explained the biggest concern facing SMEs in cloud adoption in the paper 'SMEs perception of cloud computing'.

SMEs consider vender lock-in as a major concern for adopting cloud computing. Cloud computing users are concerned about losing control of their data that could be locked-in by a cloud provider.

In a paper published by information weekly (InformationWeek, 2015), looking at how cloud lock in can be avoided. Gunnar Hellekson, chief technology strategist for Red Hat's U.S. public sector business said that SMEs need to build a detail strategy for winding down a contract with a service provider. This can make it easier when migrating service to another provider if detail documents signed by cloud providers specifically state how information and data will be packed up in the case of provider migration.

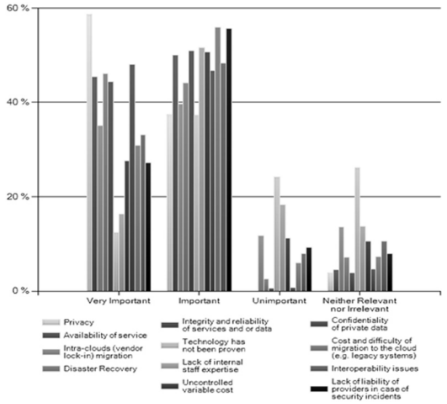


Figure 2: Factors affecting cloud take up in SMEs (Sahandi et al., 2012).

The biggest concerns facing UK SMEs on their transferal to cloud are shown in Figure 2. The top listed concern is:

- Security (VPN Security, 2008)

In the framework presented at the end of this paper, these two influencing factors will hope to be minimised to offer the most attraction of cloud services to customers.

5 CLOUD COMPONENTS

In this section we will talk about the aspects of a cloud network and how each is beneficial to its deployment. We will also analyse three providers of these components, one low range, one medium range and one high range to gain an understanding of what quality can be delivered to the customers and for what price.

5.1 Tower, Rack and Blade Servers

In the current era most data centres incorporate the user of rack servers, moving on from previous generations that typically incorporated tower servers. However blade servers are gaining popularity with customers. These components all work in similar ways however they have key differences between them.

5.1.1 Tower Servers

These servers care becoming outdated and are not typically employed by customers anymore. Reasons behind this are that they are large and take up a lot of space and are typically hard to manage as they cannot be mounted on top of each other. Also tower servers require individual monitors, keyboards and mice to allow them to be managed. All this increases the price of the solution dramatically, something that all SMEs look to avoid and ECM in particular.

However all of this being said, tower servers are a lower cost for customer to initially purchase. Expansion with tower servers is very achievable however this increases prices dramatically also, due to management costs and data centre space issues.

However even though tower servers are becoming outdated they could fit to customer requirements. For example: A tower server could serve as a backup system for a SME as a failover in case the main system was to fail.

5.1.2 Rack Servers

These are the most common servers implemented by customers. Unlike tower servers discussed above, rack servers do not contain critical equipment such as backup batteries, switches and storage arrays. These are contained in rack units, in which rack servers are installed.

Rack servers offer a lot more flexibility and scalability than tower servers. Rack servers offer expandability through implementable disks, processors and RAM which can be added to the chassis themselves. Also as multiple servers can be added to racks (installed in bays), this means that all components can be found together. This will then make the network easier to manage. Many applications or functions can be installed in a chassis across the servers such as:

- Email
- Storage
- Specific business applications

However unlike tower servers, rack servers will need to purchase chassis for the servers to be deployable, this adds to business expenses driving up costs.

5.1.3 Blade Servers

Here we will be looking at the final server type which is blade servers. Blade servers are like self-contained servers, which fit into enclosures with other blades. The enclosure provides power, cooling and connectivity for each blade in the enclosure. Contained in a single blade are components such as hard drives, I/O cards, memory and storage. One of the main selling points behind blade servers is hot plugging, blades can be added to enclosures easily just by pushing in the blade when demand calls for it. This can also improve management of servers, benefiting the business.

Blade servers are best suited to workloads such as:

- Virilisation
  - Server
  - Desktop
- Cloud infrastructure
- Big Data Applications

Blade servers have the computing power to be able to handle high intensity processes. Furthermore blade servers take up a small area in regards to data centres, this could cut the cost that needs to be spent on chassis to house the servers. Blade servers offer flexibility to customers as they can be added to chassis depending on the business needs and can be easily scaled up if needed.

However blade servers are expensive to purchase upfront, and may be out of reach of many businesses. The blade chassis are often made to house 14, 16 blades, this needs to be utilised for customers to really get the most out of blade.

6 METHOD

In this section of the paper we will be talking through the generic framework that has been developed to implement a chosen solution for EPM. In this framework we will break the solutions down into criteria important to EPM relating to business goals and business constraints.

6.1 Mathematical Optimisation

The best solution for EPM will refer to achieving the best computing power from specified servers under specified constraints which in EPM case is cost. Finding the best solution often refers to achieving best performance under specified constraints (Model Based Test Case Optimization, 2014).

In the specified case from EPM the performance criteria that needs to be explored is:

1. Maximisation of computing power (CPU, RAM etc.)
2. Minimisation of resources (cost)

Achieving these two areas will therefore maximise the outcome.

These two factors contribute to cloud system as, maximising computing power will mean customer have access to a larger resource pool (RAM, CPU, Hard disk space), access to services when they need them (On demand self service). The cost saving side of the analysis will ensure those customers reduce the amount of resources needed to achieve this. This is particularly important in SMEs where cost saving is needed for company growth and survival.

Maximisation of Computing Power.

There are three main aspects consistent over all solutions that are being analysed in this paper and they are:

1. CPUs
2. RAM
3. Hard-drive space

We will be looking at maximising all three of these areas in regards to the cost of each component.

CPU.

To measure the computing power we will be referring to a publication made at CPU benchmarks (PassMark CPU Value Chart, 2015). This analysis looks at the computing power achieved in regards to the cost of the component and ranks them, rating each component of the power achieved / price of the component.

$$\text{Processor Value for Money} = \frac{CPU\ Mark}{Price\ (£)} \quad (1)$$

Each processor to be analysed is included in this paper and will be implemented into this project.

RAM.

In the analysis of RAM we will be looking at the GB provided by the component and calculating the cost per GB. We will be referring to a statistical study taken, that analyses the cost per GB gained in hardware (Average Historic Prince of RAM, 2015). The analysis states that the cost per GB is £3.73per GB ($5.50). Analysis of this component will look something like:

Table 4: Showing conversion of RAM GB to total cost (£) (Average Historic Prince of RAM, 2015).

RAM (GB)	Value for money (£)
8GB	29.84

This shows that a hardware product with 8GB of RAM is equivalent to £29.84. Taking this into consideration when analysing all systems, this number will look to be maximised to show customers are achieving value for money.

Hard-drive Capacity.

In the analysis of Hard-drive space much like that of RAM above, the cost per GB will be analysed. Hard-drive cost per GB is relatively cheaper than that of Ram, according to studies taken, the analysis states that the cost per GB of hard-drive size is £0.02 per GB ($0.03) (Average Cost of Hard Drive Storage, 2015).

Analysis of this component will look something like this:

Table 5: Showing Hard-drive conversion GB to value (£) (Average Cost of Hard Drive Storage, 2015).

Hard-drive capacity (GB)	Value for money (£)
500GB	10.00

This analysis shows us that a hardware product containing 500GB storage space is equivalent to £10.00. This value will look to be maximised in the analysis of servers later on in the paper.

Minimisation of Resources.
There are a few areas to take into account here apart from the main concern which is total cost of the solution itself. The aspects to be analysed are:

1. Total cost of the solution
2. Running costs
3. Cooling costs

The latter aspects are often overlooked by customer when purchasing hardware. However they can make up a substantial maintenance cost when implemented in a business. If this was overlooked by a customer it could mean that the cost benefit of the product was not accurately reflected at purchase time and could not provide the requirements that they were expecting.

Total Cost of Solution.
The total cost of a solution will just look at the total price of the solution. It will provide a justification mark for performance aspects of the system. Example, a solution costing £500 should deliver less computing power than a solution costing £1000. However the gap between cost and performance will be analysed to provide the best solution to a customer.

Running Cost.
Running costs will take into account the electricity required to run a server over as given timescale and the cost of this power consumption.

A formula has been taken of how to convert the electricity consumption of a hardware solution (Weijdema, 2011):

$$\frac{(\text{Operating Hours} * \text{Watt Usage Per Hour})}{1000} = Kwh * Electricty\ Costs \quad (2)$$

The wattage of a solution can be taken using the formulae:

$$W = \text{Amps} * \text{Volts} \quad (3)$$

Analysis of the power usage of solutions will look to find the solution with the lowest power consumption.

Although energy prices will vary from location to location, for the simplicity of the framework to be applied a constant value of 0.09 (£) per kWh will be used across all solutions analysed in this paper. This price has been taken from a quote on UK power, from the supplier extra energy, (Gas and Electricity Tariffs, 2015).

Cooling Costs.
Cooling costs is also another aspect of solution running that needs to be taken into account. A formula can also be implemented to calculate cooling costs (Weijdema, 2011).

$$\frac{((\text{Operating Hours} * \text{BTU per hour}) * 0.293)}{1000} = Kwh * Electrictiy\ costs\ per\ Kwh \quad (4)$$

Cooling, another aspect that will look to be minimised across all the solutions.

Summary.
In summary, the analysis of hardware components that was performed earlier in the paper will now be implemented into the proposed framework explained above. Weighing up the initial cost of the propose system against the provided computing power will indicate a cost benefit to the customer. This will provide collated analysis information that will propose the best solution for EPM.

6.2 Implementing the Business Scenario

In this section we will be implementing the framework explained above into the different solutions that were analysed earlier in the paper. We will first shown each solution compared in its group, e.g. Blade, Rack & Tower. We will then go on to compare each solution group against each other.

Tower Server Comparison.
We will first be looking at the tower server solution for EPM.

Table 6: Lenovo ThinkServer, Tower Server.

Solution:	Lenovo ThinkServer TS140	
	Data and Formulas	
Computing Power	Ram	32
	CPU	43.84
	Hardrive	16
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	450
	Electricity Costs	£ 0.09
	Total	**£ 354.78**
Cooling Costs	Operating Hours	8760
	BTU per Hour	1535.4
	Electricity Costs	£ 0.09
	Total	**£ 354.68**

Component Values (£)		
Ram	£	119.36
CPU	£	43.84
Hardrive	£	320.00
Total Component Price:	£	483.20

Overall Pricing		
Unit Price	£	289.23
Running Costs	£	354.78
Cooling Costs	£	354.68
Total Price	**£**	**998.69**

Analysis of this allow us to see the other costs of a server that are sometimes not taken into consideration along with the computing output of this solution.

The numbers highlighted in red shown the dynamic figures of the solution, they will vary from solution to solution and indicate the computing value provided to the customer. These values are displayed in the component values section.

The Lenovo ThinkServer TS140 allows for up to 32GB of RAM to be installed along with 16TB of Hard-disk space. These values do not come installed

in the solution however they offer room for expansion which will be required in EBS in coming time. These components will have to be purchased separately, however this is the same with every solution that will be displayed in this paper. The CPU value displayed in this figure, shows that the bench mark performance of the CPU was relatively good compared to the performance of similar Intel Xeon processors with similar GHz. However the low cost of this CPU allows a much greater value for money to be achieved.

The running cost shown in this figure illustrates the amount of electricity required to run this solution. The running time has been specified by EPM as 24/7 (8760 hours). This is often an overlooked cost by customers and real costs of a solution are not explored. This paired with the cooling cost of the solution, which is calculated in a similar manner allows us to see the overall costs of a system over a 1 year period.

Table 7: Dell Power Edge, Tower Server.

Solution:	Dell Power Edge T320	
Data and Formulas		
Computing Power	Ram	192
	CPU	24.29
	Hardrive	32
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	495
	Electricity Costs	£ 0.09
	Total	£ 390.26
Cooling Costs	Operating Hours	8760
	BTU per Hour	1688.94
	Electricity Costs	£ 0.09
	Total	£ 390.15

Component Values (£)		
Ram	£	716.16
CPU	£	24.29
Hardrive	£	640.00
Total Component Price:	£	1,380.45

Overall Pricing		
Unit Price	£	879.00
Running Costs	£	390.26
Cooling Costs	£	390.15
Total Price	£	1,659.41

Table 8: HP ProLiant, Tower Server.

Solution:	HP ProLiant ML350 G6 Base	
Data and Formulas		
Computing Power	Ram	192
	CPU	18.1
	Hardrive	24
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	750
	Electricity Costs	£ 0.09
	Total	£ 591.30
Cooling Costs	Operating Hours	8760
	BTU per Hour	2559
	Electricity Costs	£ 0.09
	Total	£ 591.13

Component Values (£)		
Ram	£	716.16
CPU	£	18.10
Hardrive	£	480.00
Total Component Price:	£	1,214.26

Overall Pricing		
Unit Price	£	1,260.00
Running Costs	£	591.30
Cooling Costs	£	591.13
Total Price	£	2,442.43

All of the information from the three tower solutions taken into consideration, a graph can be produced to show the best value for money solution. This is calculated by subtracting the component costs from the total cost of the solution.

This illustrates that the dell power edge system is the best value for money as it delivers the most amount of potential computing power for the smallest cost to the customer.

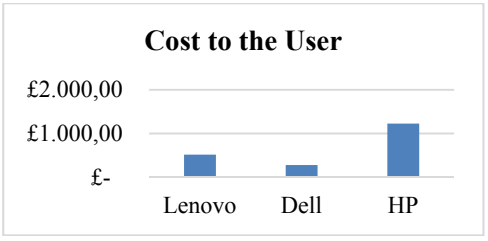


Figure 3: Best Value Solution, Tower Server.

The values shown are negative as each system does not actually deliver more potential computing power than is paid for, however the graph indicates that the closer a solution value is to 0 means that it provides the same potential computing power as the overall costs of the solution, providing a better return on investment.

Rack Servers.

Now we will look at the next solutions recommended in the analysis. The rack servers will be compared to each other in the same method that was applied above, comparing the value of money achieved from each solution.

The first rack server that will be looked at is the Asus RS100-X7, this is the entry level rack server for EPM.

Table 9: Asus, Rack Server.

	Data and Formulas	
Computing Power	Ram	8
	CPU	29.2
	Hardrive	16
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	250
	Electricity Costs	£ 0.09
	Total	£ 197.10
Cooling Costs	Operating Hours	8760
	BTU per Hour	853
	Electricity Costs	£ 0.09
	Total	£ 197.04

Component Values (£)		
Ram	£	29.84
CPU	£	29.20
Hardrive	£	320.00
Total Component Price:	£	379.04

Overall Pricing		
Unit Price	£	235.00
Running Costs	£	197.10
Cooling Costs	£	197.04
Total Price	£	629.14

The medium range server from IBM was the next solution to be analysed.

Table 10: IBM, Rack Server.

Solution:	Cisco X220 M3	
Data and Formulas		
Computing Power	Ram	128
	CPU	29.2
	Hardrive	84
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	750
	Electricity Costs	£ 0.09
	Total	£ 591.30
Cooling Costs	Operating Hours	8760
	BTU per Hour	2559
	Electricity Costs	£ 0.09
	Total	£ 591.13

Component Values (£)		
Ram	£	477.44
CPU	£	29.20
Hardrive	£	1,680.00
Total Component Price:	£	2,186.64

Overall Pricing		
Unit Price		1,157.00
Running Costs	£	591.30
Cooling Costs	£	591.13
Total Price	£	2,339.43

Table 11: Cisco, Rack Server.

Solution:	Cisco	
Data and Formulas		
Computing Power	Ram	128
	CPU	29.2
	Hardrive	84
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	750
	Electricity Costs	£ 0.09
	Total	£ 591.30
Cooling Costs	Operating Hours	8760
	BTU per Hour	2559
	Electricity Costs	£ 0.09
	Total	£ 591.13

Component Values (£)		
Ram	£	477.44
CPU	£	29.20
Hardrive	£	1,680.00
Total Component Price:	£	2,186.64

Overall Pricing		
Unit Price	£	2,420.75
Running Costs	£	591.30
Cooling Costs	£	591.13
Total Price	£	3,603.18

Now that all of the solution values have been taken into consideration. The figure below illustrates the value for money of each solution. Looking at the overall running costs of the solution subtracting the potential computing power available.

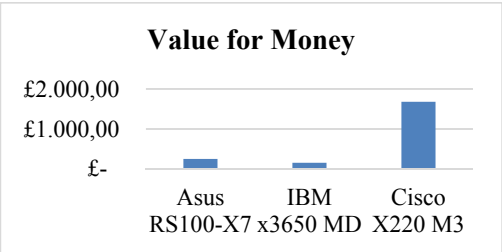


Figure 4: Best Value Solution, Rack Server.

From the analysis of cost shown in the figure above, the IBM x3650 rack server showed to be the best investment for EPM. The x3650 returned £1713.00 worth of potential computing power to the solution from the £2, 339.43 upfront cost and running costs. The other two servers (Asus & Cisco) didn't return as much potential computing power as the IBM rack server. The Cisco solution that was analysed has a very large upfront cost and the large power consumption of the solution means that the potential computing power provided cannot overcome the large costs, extracting valuable resources from EPM which would be hard for them to invest in a system like this.

Blade Servers.

The next solution group that will be looked at is the blade servers. These were analysed earlier in the paper and appeared to have very large upfront costs and high power supply's required. In the analysis below it will reveal if blade servers can justify the high prices of various suppliers products.

The firs solution that will be analysed is the Cisco UCS B230 M2.

Table 12: Cisco, Blade Server.

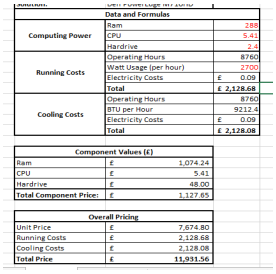
Solution:	Cisco UCS B230 M2	
Data and Formulas		
Computing Power	Ram	512
	CPU	2.15
	Hardrive	2.4
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	2500
	Electricity Costs	£ 0.09
	Total	£ 1,971.00
Cooling Costs	Operating Hours	8760
	BTU per Hour	8530
	Electricity Costs	£ 0.09
	Total	£ 1,970.44

Component Values (£)		
Ram	£	1,909.76
CPU	£	2.15
Hardrive	£	48.00
Total Component Price:	£	1,959.91

Overall Pricing		
Unit Price	£	5,838.00
Running Costs	£	1,971.00
Cooling Costs	£	1,970.44
Total Price	£	9,779.44

The values expressed in the above figure also takes into account the cost of the blade rack to support the individual modules.

Table 13: Cisco, Blade Server.



Data and Formulas		
Computing Power	Ram	288
	CPU	5.41
	Hardrive	2.4
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	2700
	Electricity Costs	£ 0.09
	Total	£ 2,128.68
Cooling Costs	Operating Hours	8760
	BTU per Hour	9212.4
	Electricity Costs	£ 0.09
	Total	£ 2,128.08

Component Values (£)		
Ram	£	1,074.24
CPU	£	5.41
Hardrive	£	48.00
Total Component Price:	£	1,127.65

Overall Pricing		
Unit Price	£	7,674.80
Running Costs	£	2,128.68
Cooling Costs	£	2,128.08
Total Price	£	11,931.56

The Dell Power Edge adopts the same method used in the last blade analysis, the cost of the blade enclosure has been included in the unit price of the solution.

Table 14: HP ProLiant, Blade Server.

Solution:	HP ProLiant BL680c	
Data and Formulas		
Computing Power	Ram	2000
	CPU	5
	Hardrive	4.8
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	2400
	Electricity Costs	£ 0.09
	Total	£ 1,892.16
Cooling Costs	Operating Hours	8760
	BTU per Hour	8188.8
	Electricity Costs	£ 0.09
	Total	£ 1,891.62

Component Values (£)		
Ram	£	7,460.00
CPU	£	5.00
Hardrive	£	96.00
Total Component Price:	£	7,561.00

Overall Pricing		
Unit Price	£	7,622.00
Running Costs	£	1,892.16
Cooling Costs	£	1,891.62
Total Price	£	11,405.78

Now that the values of all of the blade solutions have been taken into consideration, they can be analysed together to illustrate which solution provides the best value for money to EPM.

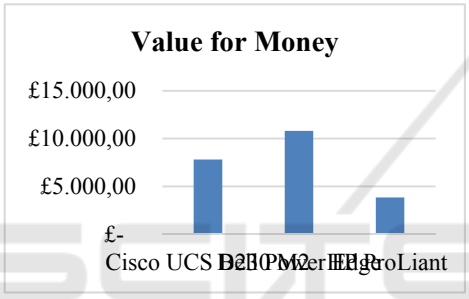


Figure 5: Best Value Solution, Blade Server.

The graph illustrates that the HP ProLiant was the best value for money, as it delivered high RAM and Hard drive capacity unmatched by the other two solutions. However the CPU power provided is not the best for the money paid for the solution. All of this taken into consideration the HP ProLiant Blade server is the best blade solution for EPM.

What this analysis does not take into consideration is the amount of blades required by EPM. As EPM is a small business with fairly simple computing requirements, the blade solutions are a bit too high tech for the intended business and therefore would provide the needs of the business with one server blade. The values shown above indicate that it is relatively worse value for money than the other solutions. However the total price of the solution incorporates the one off payment of an enclosure to support up to 8 blades, so sharing this value over 8 blades would decrease the overall upfront enclosure value. Also as the power is supplier through the enclosure to blades the running costs would be shared over the 8 servers, also lowering the total price of the solution and providing a better value for money result.

However for true value for money to be recognised on this solution the customer would have to purchase 4 or 5 server blades, this is out of scope for the customer and does not represent a real solution to the customer's needs.

Other Solutions.

File Servers. Another server that was considered in the analysis at the beginning of this paper was the file server. As EPM require two file servers to be implemented into the business the below analysis will look at identifying if a suitable solution lies within file servers.

Table 15: NetGear ReadyNAS 102, File server component values and running costs.

Solution:	NetGear ReadyNas 102	
Data and Formulas		
Computing Power	Ram	512
	CPU	27.5
	Hardrive	8
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	31
	Electricity Costs	£ 0.09
	Total	£24.44
Cooling Costs	Operating Hours	8760
	BTU per Hour	105.772
	Electricity Costs	£ 0.09
	Total	£24.43

Component Values (£)		
Ram	£	1.91
CPU	£	27.50
Hardrive	£	160.00
Total Component Pr	£	189.41

Overall Pricing		
Unit Price	£	100.00
Running Costs	£	24.44
Cooling Costs	£	24.43
Total Price	£	148.87

Table 16: Asustor, File Server.

Solution:	Asustor AS-604T NAS	
Data and Formulas		
Computing Power	Ram	3
	CPU	6.6
	Hardrive	16
Running Costs	Operating Hours	8760
	Watt Usage (per hour)	33.2
	Electricity Costs	£ 0.09
	Total	£ 26.17
Cooling Costs	Operating Hours	8760
	BTU per Hour	113.2784
	Electricity Costs	£ 0.09
	Total	£ 26.17

Component Values (£)		
Ram	£	11.19
CPU	£	6.60
Hardrive	£	320.00
Total Component Price:	£	337.79

Overall Pricing		
Unit Price	£	373.90
Running Costs	£	26.17
Cooling Costs	£	26.17
Total Price	£	426.24

The next file server analysed here has slightly higher specifications than the previous server, however some areas have not been delivered at a high value/cost rate.

The two standalone file server products have been analysed using data about their computational power and total cost of ownership. The graph below illustrates the products in comparison.

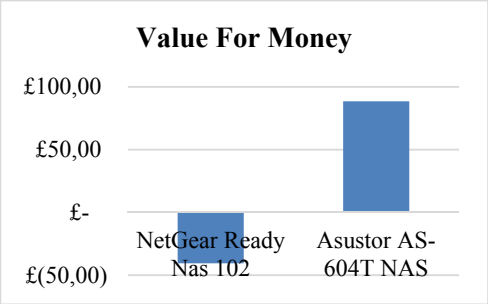


Figure 6: Best Value Solution, File Server.

The two servers taken into consideration do both deliver great value for money, more so in the case of the NetGear ReadyNas. The total cost of the product including running and cooling costs is worth less value compared to the potential computing power offered by the solution. The Asustor AS-604T also offer good value for money.

Analysing these products has shown that they would be great value for money in a home scenario where a lot of data storage is required, however they would not be suitable for SME and commercial use. Both the products do not offer any additional services besides file storage.

EPM could implement a standalone file server to the business and this product would be suitable for the data requirements needed. However additional products would have to be purchased to support a proxy and DHCP server. This would involve implementing other servers also, adding to the total cost of the infrastructure for EPM. Also the standalone file servers would not allow for room with scalability if the data storage requirements of EPM became larger. For these reasons file servers will not be considered for final implementation in EPM.

6.3 Results and Reasoning

As we have now analysed three different areas of servers, and analysed the key features that relate to EPM. We will now produce the findings of the analysis and my recommendation of the solution to be implemented.

The below figure has been produced to illustrate all of the server solutions analysed.

The best value solution area for EPM is rack servers. These provide the highest amount of potential computing power (RAM Capacity, Hard-drive capacity & CPU value for money) while minimising the total cost of the solution.

The importance of the potential computing power is to ensure that EPM can grow the server (swapping resources such as RAM, hard-disk space and CPUs

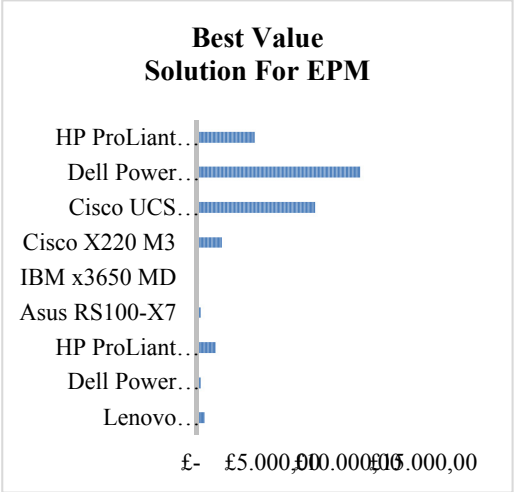


Figure 7: Overall best value solution, looking at blade, rack and tower servers.

when needed) as the business grows. The initial costs of the solution is greater than the tower server solution however this is made up for with the computational power provided.

IBM x3650 MD has shown to be the most cost efficient solution to the customer's problem so we will suggest that this is implemented as it takes into account EPM requirements as well as the cost aspect.

Blade servers have not provided a viable solution for EPM as they offer minimal computing power (when only one is implemented) for a very large cost, straining EPMs cost resources. This solution may be viable in a very large business that requires a lot of computing power and has the available resources to purchase the blades and enclosures as well as run them. However in EPMs case the solution is not an option that would be available to them.

When choosing the solution for EPM, other areas must be considered that may not be specific to them but will be specific to SMEs in general. If these factors are not considered it could affect the take up and implementation of the chosen solution and EPM could simply reject it.

Other factors that need to be considered in the chosen solution are points that we have made previously in the paper and been supported by statistical data (Sahandi et al., 2012; YouTube Virtual Computing, 2015; Virtualisation Best Practices for SMEs, 2015; IBM Data Center Operational Efficiency, 2015), section 4.

- How can the solution reduce cost and meet scalability aspects?
- How does the solution offer security?

The solution to be implemented has met scalability

aspects by providing swappable drive bays for disk space and RAM. This means that EPM can add hardware components when needed to support their network.

The cost reducing aspect could also be implemented from the solution. We have already talked about how the best value product has been chosen for EPM as this is one of their main priorities, but how can costs be reduced further?

The IBM rack server chosen as EPMs implementable solution will support the installation of virtual managers so many users can be supported from one server. This would reduce the costs as only one server would need to be purchased even if multiple Operating systems wanted to be run from it. Section IX also refers to how EPM could adapt their server room to operate more efficiently. This could also ensure that EPM are getting the most potential out of their servers for the money they paid.

The security aspect has also been considered in the choice of solution. The IMB rack server comes with administrative user's controls as standard, such as password protection and trusted platform module (TPM). Furthermore the solution supports security protocols such as SSL and PPTP. These are the two fundamental protocols used in VPN connectivity. This means EPM could implement a VPN network to the business to secure their connections and reduce the risk of security breaches. The organisation structure of EPM would allow for a VPN connection to be implemented, as the sales and finance departments may want to keep their files separate from each other. VPN would allow for the security of these departments to be maintained while still operating from the same server.

7 CONCLUSIONS

In this section we will talk through how a network solution has been applied to EPM and how it meets their unique requirements. We will then go on to explain how other measures could be implemented which have been talked about in areas of this paper.

If we relate back to the business background introduced at the beginning of this paper.

1. EPM required a network solution for under £5,000.00
2. The solution must support functions such as File server, Proxy server, DHCP server and support the customer management application owned by EPM.
3. Maximise potential scalability, which may be needed by EPM in the coming years.

The solution that we have chosen for implementation (IBM X3650 MD) meets all of the criteria stated by EPM.

The framework that was created to analyse each potential solution for EPM, found that products more focused towards a home use audience generally provided more value for money and a lower TCO. However the solutions focused towards a SME audience delivered a lower value for money in terms RAM, CPU and Hard-Drive, and a higher TCO. This is to be expected in a higher grade solution as the extra costs are justifiable by the extra computing power provided and the extra functionality that the solutions can provide.

In this paper we feel that all of EPMs unique requirements have been implemented with the chosen solution. However we also feel a more general approach has been taken relating to all SMEs, as the views and concerns of various SMEs have been taken into consideration to provide a solution that creates an all-round fit for the customer.

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