



# Lecture (03) Introduction To Virtualization, continue

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By:

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## 1. Defining A Virtualization Solution

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- Obviously, the first task at hand is to look at your current infrastructure and consider how you might apply virtualization to it.
- Should you consolidate a number of physical servers onto a smaller number of machines, each of which hosts a number of virtual machines?
- Do you need to construct a redundant infrastructure to allow guests to be migrated between machines to ensure high availability?
- Or do you need to virtualize your storage as well as consolidate servers?

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- Based on your assessment of the situation, you will identify what portion of the existing infrastructure is suitable for virtualization.
  - Once this assessment is completed, then you can identify the correct virtualization solution to implement.
  - Once this assessment is completed, you have the basis for performing a comparison between the pre-virtualization and post-virtualization configuration.
  - When this comparison is done, you can calculate the financial impact of going to virtualization as well as the operational benefits you should derive from the project.

## 2. Establishing Current Cost Structure

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- There are two broad categories of cost: hard costs and soft costs.
- **Hard costs** are any costs that require paying actual money to an entity. Hard costs are often associated with a specific product and service. For example, if your organization utilizes an outside company to run security scans on your servers, the fees you pay to that company are a hard cost.
- **Soft costs** are typically associated with internal personnel or internal services for which no explicit chargeback system is in place. Soft costs are what the organization spends on an ongoing basis doing its daily work.

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## **1. Hard costs first**

- A given organization might have many different types of hard costs. Typically these are easier to identify and track than soft costs.
- However, there are three hard costs that must be included in our analysis:
  1. Power
  2. Server maintenance
  3. Outside services
- We'll look at each of these three areas more closely.

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### **1.1 Power**

- Except for the rare organization that creates some or all of its own power, this a hard cost.
- Each machine in your current infrastructure should have documentation of how much power it draws.
- Use the power draw level associated with the most typical load factor for the machine.

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- If you are replacing old machines with newer machines, they will probably be more efficient in their power consumption and thereby save some on power costs.
  - Since the virtualization project will also, most likely, be reducing the number of physical machines, another power cost savings is realized.
  - A common ratio in the virtualization world is 5:1.
  - This means that you take five old servers and turn them into virtual machines running on one new physical server.
  - Your power savings would be amount of power to run four old servers plus the difference between the power draw of an old server and the power draw of the new server.

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## **1.2 Server Maintenance**

- The current machines in your data center are most likely under a service plan.
- Service plans come in many different forms; users can typically choose one of several different levels of response time guarantee.
- For example, reported problem might be considered in 2 hours, 4 hours, and so on.
- As you would expect, faster response times cost more money.
- Organizations often vary the level of service plan according to the importance of the machine.

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- Its not very cost effective to purchase a fast responsiveness for a machine used to generate low-priority reports.
  - On the other hand, if those reports are used to schedule the organization's work force, keeping the machine up might be vital.
  - Server maintenance costs should be a fairly easy hard cost to establish because the costs are directly associated with individual machines.
  - It might be the case that the organization has a blanket plan that covers a large number of machines, but it should still be a fairly easy task to identify how much maintenance costs per machine, and you'll need to use those numbers as the input to your assessment of baseline costs.

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### **1.3 Outside Services**

- It might be that the organization engages an outside organization to perform services within your data center.
- In the current world where "outsourcing" is so popular, it's often more cost effective, or just simpler, to use an outside vendor to perform work rather than rely on internal personnel.
- If your organization uses outside vendors for anything associated with keeping its infrastructure up and running (for example, someone to run backups on your machines), you have outside services hard costs that must be assigned to the baseline cost structure.

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## 2. soft cost analysis

- Things get a bit more tricky with soft costs.
- Some system administrators will tell you trying to assign soft costs to a specific server is very hard.
- However, with some diligent work, you can establish quite closely how much your organization spends on soft cost items for the machines in question.
- Soft costs come in various forms, so let's focus on two primary soft costs:
  1. Machine administration
  2. Backups

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### 2.1 Machine Administration

- Machine administration refers to the work done by internal personnel keeping the technology infrastructure life and functioning
- This term typically includes system administrators, network administrators, and database administrators.
- However, your analysis should focus on those personnel directly involved with the machines in question and discount the personnel whose work will be unaffected whether the machines are physical or virtual.

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## 2.2 Backup

- Backup refers to creating a secure copy of the data on individual machines.
- This can be handled in a wide variety of methods.
- The data might be copied to a tape or by replicating the data across the network to another server, or even by sending the data outside the organization (a so-called “outside the firewall” backup) to a remote backup service.
- No matter what method is used to backup existing data, someone probably spends some time making sure it happens. It is the costs associated with this time that you need to track.

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- Although a number of vendors offer software designed to automate the backup process, many organizations still rely on manual work by employees.



# 3. Identifying Virtualization Costs

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- Once you've established the current cost structure for your as-is infrastructure, you need to identify the potential benefits and costs of moving to virtualization.
- This part of the analysis is in general more difficult and tricky than determining the current cost structure because it requires estimation rather than documentation.
- Nevertheless, to understand the complete implications of moving to virtualization, you need to know the financial impact of the virtualization scenario you intend to implement
- Note that you can't have it all despite all of the benefits of virtualization for free.
- The organization will incur a range of costs as you move to virtualization, and it is important to recognize them and estimate them in your overall cost/benefit analysis.

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- We'll focus on five primary areas of the virtualization project's potential costs:
    1. Selection of a virtualization deployment scenario.
    2. Identifying the new hardware requirements.
    3. Consideration of other physical equipment.
    4. Purchasing new software.
    5. Training employees.



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## **Step 1: Deployment Scenario**

- The first step in estimating your costs after virtualization by selecting the configuration you'll install.
- There are many different virtualization products and many different potential configurations.
- For example, will you have individual virtualized servers, or a virtualized pool of server, possibly including virtualized storage as well.
- The decision is not always easy.

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## **Step 1: New Hardware**

- Although virtualization is a very flexible technology and is capable of running on a very wide range of hardware, you might also want to employ the latest generation of virtualization-oriented hardware to host you virtualized servers.
- Some considerations such as use of Xen for paravirtualization (recall from the Introduction to Virtualization that this is lightweight virtualization that most likely requires guest OS modification to achieve high performance) will require hardware with the virtualization-enabled chips from Intel or AMD.

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- If you're going to implement a product such as VMware, that runs only on certain types of hardware, a hardware upgrade will again, probably be in order.
  - Sometimes in this sort of environment, it is useful to create two (or more) versions of the cost/benefit analysis: one with new hardware (various levels and hardware) and one without (assuming all existing hardware will be usable in the virtualized environment).
  - Note, that newer hardware is generally more energy efficient, so some cost savings will be gained from the new hardware that will help to offset its cost.

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- You'll need to estimate how many servers you will require.
    - For example, if you're planning to migrate 20 current physical servers and don't want to run more than 7 guests on each physical server, you'll need three physical servers.
  - Hardware is a hard cost, so the cost of the physical servers goes into the hard costs section of the cost/benefit analysis.

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### **Step 3: Other Physical Equipment**

- Depending on the proposed configuration you've designed for the virtualized infrastructure, you might also decide to include other physical equipment to handle virtualized storage, such as a Network-Attached Storage (NAS) or a Storage Area Network (SAN).
- Any additional physical equipment is, naturally a hard cost and should be included in that area of the cost/benefit analysis.

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### **Step 4: New Software**

- By the time you've reached this point in the virtualization project, you should have a pretty good idea how many of your current servers you'll be migrating to virtual machines.
- Depending on the load they place on the underlying physical hardware, you'll be able to estimate how many virtual machines you can support per physical machine.
- In turn, that estimate will tell you how many virtualization software licenses you'll require for the project. This too, is a hard cost.
- Even, if you select to use one of the free or open source products and thus incur no licenses costs, you may still purchase software maintenance, thereby incurring ongoing hard costs.

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## **Step 5: Training Employees**

- A learning curve is associated with beginning to use any new software product.
- Many organizations educate their employees through training classes to get them up to speed on the new software more quickly.
- If your organization is likely to take advantage of this type of training, the cost of the training should be included in the hard costs of the proposed virtualization project.

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## **4. Identifying The Virtualization Project Benefits**

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- After you have defined the configuration of your virtualization solution and identify the costs associated with it, you can estimate the financial benefits that will be gained by implementing the virtualization project.
- Because virtualization enables multiple systems to run on a single piece of hardware, most organizations find that they can reduce their current cost structure by using virtualization.
- There are two primary types of financial benefits that a properly implemented virtualization project can provide an organization:
  1. Cost savings achieved by not having to spend money that is currently being spent on existing infrastructure components.
  2. Cost savings achieved through more effective and efficient operations.

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## 4.1 Hard Cost Reductions

- As you migrate operating systems and applications from physical to virtual servers, you have the opportunity to run fewer physical machines.
- For every machine you retire, you save on hardware maintenance and power costs.

(1) reduced hardware maintenance,

(2) reduced software licenses, and

(3) reduced power costs.

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### 4.1.1 Reduced Hardware Maintenance

- Even modest virtualization servers can support four or more simultaneous virtualized servers, you might be able to retire a number of machines from your present infrastructure.
- Part of calculating the current costs is identifying the ongoing maintenance costs for every machine; for every machine that can be retired, you can identify the maintenance fees that will no longer be necessary and add them to the cost savings.

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### **4.1.2 Reduced Software Licenses**

- By moving to a virtualized environment, you may be able to realize a savings on the software licenses .
- If your analysis indicates that this will be possible, you should include these savings in the potential benefits the project will provide.
- Be careful with this analysis however as many software vendors are still grappling with the implications of virtualization, so in the end you might not be able to show any savings at all, and in fact may even pay more!

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- For example, if you migrate to more powerful systems, even if you aren't currently using all of the processing power for the migrated system, you may pay more for your software.
  - The reason for this is that some software manufacturers charge by how many processors the underlying hardware has; if you're running your virtualized server on a four-way machine but using only one processor's power, with these software vendors you may be charged a license fee for a four-processor box.
  - Don't be surprised if your software license and software maintenance costs don't show any savings due to virtualization.

### 4.1.3 Reduced Power Costs

- When it comes to identifying the potential power saving, the process is straightforward.
- The documentation should provide several power measurements associated with various loads.
- Use the power draw level associated with the most typical load factor for the machines in your infrastructure.
- The next couple of pages illustrates this for a Sun Server X2-8.



Configure your Sun Server X2-8 and calculate your system's total power consumption.

Item	Quantity	Notes
Processor	E8830, 2.13GHz, 105W	Select Processor Type
Number of CPUs	4 CPUs	Select Number of CPUs
Memory (32 GB DIMM)	None	Select number of DIMMS per CMOD
Memory (16 GB DIMM)	None	Select number of DIMMS per CMOD
Memory (8 GB DIMM)	None	Select number of DIMMS per CMOD
Hard Disk Drives	1 HDD	Select number of Hard Drives (Min 1, Max 8 Total per System)
PCIe Express Modules	None	Select number of PCIe Express Modules (Min 0, Max 8)
NEM (Network EM) 8508A 2x10GbE, 2x SAS 2.0, 2x 1GbE passthru NEM	2 NEMs	Select number of NEM (Min 2, Max 2)
FEM X4871A-Z Niantic	None	Select number of FEM (Min 0, Max 4)
Indicate Workload (%):	100	Select Workload range (1% - 100%)

Calculate Reset

Item	Active Idle Power	Sample Power
Total Power of System (Watts)	<input type="text"/> (estimated)	<input type="text"/> (estimated)
Total Power of System (BTU/HR)	<input type="text"/> (estimated)	<input type="text"/> (estimated)

**Notices and Disclaimers**

You MUST allow electrical and cooling headroom for unforeseen circumstances, component upgrades, and increased computational loads. Please allow for worst-case power conditions. Actual power consumption will vary from the sample workload used in the power calculator. These include, but are not limited to, the factors below. Each of these factors may cause significant differences in power consumption:

Item	Quantity	Notes
Processor	X8870, 2.40GHz, 130W	Select Processor Type
Number of CPUs	8 CPUs	Select Number of CPUs
Memory (32 GB DIMM)	32 DIMMs	Select number of DIMMS per CMOD
Memory (16 GB DIMM)	None	Select number of DIMMS per CMOD
Memory (8 GB DIMM)	None	Select number of DIMMS per CMOD
Hard Disk Drives	8 HDDs	Select number of Hard Drives (Min 1, Max 8 Total per System)
PCIe Express Modules	8 PCIe Express Modules	Select number of PCIe Express Modules (Min 0, Max 8)
NEM (Network EM) 8508A 2x10GbE, 2x SAS 2.0, 2x 1GbE passthru NEM	2 NEMs	Select number of NEM (Min 2, Max 2)
FEM X4871A-Z Niantic	2 FEMs	Select number of FEM (Min 0, Max 4)
Indicate Workload (%):	85	Select Workload range (1% - 100%)

Calculate Reset

Item	Active Idle Power	Sample Power
Total Power of System (Watts)	1560 (estimated)	2530 (estimated)
Total Power of System (BTU/HR)	5323 (estimated)	8633 (estimated)

**Notices and Disclaimers**

You MUST allow electrical and cooling headroom for unforeseen circumstances, component upgrades, and increased computational loads. Please allow for worst-case power conditions. Actual power consumption will vary from the sample workload used in the power calculator. These include, but are not limited to, the factors below. Each of these factors may cause significant differences in power consumption:

- Actual workload and its fluctuations

FEM X4871A-Z Niantic	2 FEMs ▼
Indicate Workload (%):	85
<input type="button" value="Calculate"/>	

For the previous configuration, the estimated power consumption for the server is shown after you click the Calculate button.

Sample Results		
Item	Active Idle Power	Sample Power
Total Power of System (Watts)	1560 (estimated)	2530 (estimated)
Total Power of System (BTU/HR)	5323 (estimated)	8633 (estimated)

**Notices and Disclaimers**

You MUST allow electrical and cooling headroom for unforeseen circumstances, component upgrades, and increased computational loads. Please allow for worst-case power conditions. Actual power consumption will vary from the sample workload used in the power calculator. These include, but are not limited to, the factors below. Each of these factors may cause significant differences in power consumption:

- If you've played around a bit with the power calculator for the Sun Server X2-8 server as demonstrated on the previous few pages, you probably noticed a fairly big difference in the idle power and the typical power when the server is loaded.
- This means that to get an accurate estimate of the power your existing physical machines consume, you need a fairly accurate picture of their average loading. (Notice that even an idle server still draws a significant amount of power.)

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- In the end, power costs can be reduced in two significant ways:
  - (1) by retiring some physical machines and
  - (2) replacing older less efficient machines with newer more efficient machines to serve as the virtualization platforms.
  - If you use the 5:1 ratio (old system was 20 servers), the total power savings are the amount of power required to run four old servers plus the difference between the power draw of a single old server and the power draw of the new server.

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- **Reduced Power Costs – Example Scenario**
  - Suppose you currently have 15 servers operating in your infrastructure.
  - You decide to migrate all of them to new virtualization servers. Using the 5:1 ratio, you conclude you will need 3 new servers to replace the 15 old servers.
  - You'll completely retire 12 machines, so you can add the power consumption of each of those machines to the power savings.
  - In addition, you'll replace 3 of the old machines, with new, lower-power-draw machines.

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- The power you save for these three machines will be three times the difference between the power requirements of the old machines versus the new machines, so you can add this number to the total power savings.

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## 4.2 Soft Cost Reductions

### 4.2.1 System Administration Work Is Reduced

- Keeping a physical server up and running takes a lot of work.
- It needs to be monitored, have its hardware upgraded occasionally, and have backups run.
- In general, the effort needed to keep a virtualized server up and running is reduced when compared with a physical server. Some estimates show a reduction of effort in the 30-50% range.
- This is due primarily to the fact that hardware issues are reduced as you only have the host hardware to deal with.

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- Of course, the ability to migrate the virtualized servers requires additional hardware or existing hardware that can handle the additional load, so you don't typically want to have all your physical hosts running at capacity (nor your virtual servers either for that matter).

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## 5. Creating The Spreadsheet

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- The culmination of your work in the first four parts of the project analysis takes the shape of a detailed spreadsheet that will clearly illustrate the costs and benefits of your proposed project.
- We'll look at the details of this final step of the cost/benefit analysis in the following slides.

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- You should include the following aspects on three spreadsheets:
    1. Current Cost Structure spreadsheet
    2. Virtualized Cost Structure spreadsheet
    3. A summary project cost spreadsheet

## Example 1

- A company currently has an infrastructure of 20 physical servers.
- Server consumes power of 1000\$/year and maintenance contract with vendor of 300\$/year
- IT dept staff spends 1 hours/week for server administration tasks and 15 min/day for backup tasks.
- A project of virtualization at ratio of 1:7 is proposed, the price of new servers are 21k\$ each.
- New server consumed power in average is 600\$/year. maintenance contract with vendor of 300\$/year
- Vmware license is 4000\$/server, free maintenance for first year then 20% of license price for each year after.
- Employee training costs 1500\$, and you will train 2 employees in the first year, then employee for next 4 years
- assume that there will be a 2% increase in the cost to power each server in year 3 as well as a 3% increase in the server maintenance contract in year 4.
- Assume sys admin monthly salary = 5000\$/month
- Build a cost summary spreadsheet to calculate the reduced expenses

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## Current situation

### 1. Hard costs:

power = 1000\$/year/server

maintenance = 300\$/year/server

### 2. Soft costs:

administration = 1h/week/server

= 1 \* 52 = 52 h/server/year

assume that working hours = 8 h/day

administration = 52/8 = 7 days/server/year

as sysadmin salary = 5000\$/month = 5000/24 = 210 \$/day

administration = 7 \* 210 = 1470 \$/year  $\equiv$  1500 \$ / year

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backup = 15 min/day/server

= .25\*5\*52 = 65 hours/server/year = 65/8 =

= 9 days/year/server

= 9\* 210 = 1890\$ = 1900\$ server/year

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Current Yearly Costs						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Costs</b>						
Power						x Servers X \$x/year
Server Maintenance						x Servers X \$x/year
Outside Service						all operations handled by staff
Total Yearly Hard Costs	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
Total Five Year Hard Costs =	\$0.00					
<b>Soft Costs</b>						
Machine Administration						x Servers X \$x/year
Backup						x Servers X \$x/year
Total Yearly Soft Costs	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
Total Five Year Soft Costs =	\$0.00					
Total Yearly Current Costs =	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	

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Current Yearly Costs						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Costs</b>						
Power	20,000	20,000	20,400	20,400	20,400	20 Servers X \$1000/year
Server Maintenance	6,000	6,000	6,000	6,240	6,240	20 Servers X \$300/year
Outside Service	0	0	0	0	0	all operations handled by staff
Total Yearly Hard Costs	26,000	26,000	26,400	26,640	26,640	
Total Five Year Hard Costs =	131,680					
<b>Soft Costs</b>						
Machine Administration	30,000	30,000	30,000	30,000	30,000	assume 1h/ week/server
Backup	38,000	38,000	38,000	38,000	38,000	assume 15 min/day/server
Total Yearly Soft Costs	68,000	68,000	68,000	68,000	68,000	
Total Five Year Soft Costs =	340,000					
Total Yearly Current Costs =	94,000	94,000	94,400	94,640	94,640	
Total Five Years Costs =	\$471,680					

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## Virtualization

- Number of machines =  $20/7 = 3$

- **Hard cost**

machines purchase =  $21000 * 3$

machines maintenance =  $300 * 3$  (3% increase 4<sup>th</sup> year)

software =  $4000 * 3$

software maintenance =  $0.2 * 4000 * 3$  (except 1st year)

power =  $600 * 3$  (2% increase 3<sup>rd</sup> year)

- **Soft cost** (same as current situation)

Virtualized Infrastructure Yearly Costs						
Category	Cost					Notes
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Cost</b>						
Machine Purchases						x Servers X \$x/year
Software Purchases						x Servers X \$x/year
Software Maintenance						x Servers X \$x/year
Power						x Servers X \$x/year
Server Maintenance						x Servers X \$x/year
Training						
Outside Services						all operations handled by staff
Total Yearly Hard Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Years Hard Cos	\$0					
<b>Soft Cost</b>						
Machine Administration						x Servers X \$x/year
Backup						x Servers X \$x/year
Total Yearly Soft Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Years Soft Cost	\$0					
Total Yearly Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Years Costs =	\$0					

### Virtualized Infrastructure Yearly Costs

Category	Cost					Notes
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Cost</b>						
Machine Purchases	\$63,000					3 Servers x \$21K/Server
Software Purchases	\$12,000					VMWare/Server
Software Maintenance	\$0	\$2,400	\$2,400	\$2,400	\$2,400	3 Vmware at 20% maintenace
Power	\$1,800	\$1,800	\$1,836	\$1,836	\$1,836	3 servers x \$600/Year
Server Maintenance	\$900	\$900	\$900	\$927	\$927	3 Servers x \$300/Year
Training	\$3,000	\$1,500	\$1,500	\$1,500	\$1,500	2/y1 then 1/y2,3,4
Outside Services	\$0	\$0	\$0	\$0	\$0	all operations handled by staff
<b>Total Yearly Hard Costs</b>	<b>\$80,700</b>	<b>\$6,600</b>	<b>\$6,636</b>	<b>\$6,663</b>	<b>\$6,663</b>	
<b>Total Five Years Hard Cost =</b>	<b>\$107,262</b>					
<b>Soft Cost</b>						
Machine Administration	\$4,500	\$4,500	\$4,500	\$4,500	\$4,500	assume 1h/ week/server
Backup	\$5,700	\$5,700	\$5,700	\$5,700	\$5,700	assume 15 min/day/server
<b>Total Yearly Soft Costs</b>	<b>\$10,200</b>	<b>\$10,200</b>	<b>\$10,200</b>	<b>\$10,200</b>	<b>\$10,200</b>	
<b>Total Five Years Soft Costs =</b>	<b>\$51,000</b>					
<b>Total Yearly Costs</b>	<b>\$90,900</b>	<b>\$16,800</b>	<b>\$16,836</b>	<b>\$16,863</b>	<b>\$16,863</b>	
<b>Total Five Years Costs =</b>	<b>\$158,262</b>					

# Project Cost Summary Spreadsheet

- The final step in our virtualization project cost/benefit analysis is to create a summary spreadsheet that will, hopefully, illustrate the cost benefit of the proposed virtualization project.
- This part is probably the simplest step, in that we only need to gather the summary numbers from the current cost structure and the virtualized cost structure spreadsheets.
- For ease of reference, I included the total yearly and five year lifetime hard and soft costs for both the current and the proposed project in the summary sheet.
- The main numbers of concern in the summary are the net five year hard, soft and overall cost savings predicted to be gained through implementation of the proposed project.

- The next page illustrates the summary spreadsheet for our hypothetical organization and virtualization project.
- Notice, as we had hoped, the proposed project should provide a significant return to the company over its projected five year life time.
- The net overall cost savings based on our scenario is just over dollars 1,300,000\$, or about per 260,000\$year.

Virtualization Project Cost Summary						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Current Infrastructure Costs</b>						
Total Yearly Hard Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Years Hard Costs	\$0					
Total Yearly Soft Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Year Soft Costs	\$0					
<b>Virtualized Infrastructure Costs</b>						
Total Yearly Hard Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Years Hard Costs	\$0					
Total Yearly Soft Costs	\$0	\$0	\$0	\$0	\$0	
Total Five Year Soft Costs	\$0					
Net Five Years Hard Cost Savings	\$0					
Net Five Years Soft Cost Savings	\$0					
Net Five Years Overall Savings	\$0					

Virtualization Project Cost Summary						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Current Infrastructure Costs</b>						
Total Yearly Hard Costs	\$26,000	\$26,000	\$26,400	\$26,640	\$26,640	
Total Five Years Hard Costs	\$131,680					
Total Yearly Soft Costs	\$68,000	\$68,000	\$68,000	\$68,000	\$68,000	
Total Five Year Soft Costs	\$340,000					
<b>Virtualized Infrastructure Costs</b>						
Total Yearly Hard Costs	\$80,700	\$6,600	\$6,636	\$6,663	\$6,663	
Total Five Years Hard Costs	\$107,262					
Total Yearly Soft Costs	\$10,200	\$10,200	\$10,200	\$10,200	\$10,200	
Total Five Year Soft Costs	\$51,000					
Net Five Years Hard Cost Savings	\$24,418					
Net Five Years Soft Cost Savings	\$289,000					
Net Five Years Overall Savings	\$313,418					

Virtualization Project Cost Summary						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Current Infrastructure Costs</b>						
Total Yearly Hard Costs	\$0	\$0	\$0	\$0	\$0	
Total Yearly Soft Costs	\$0	\$0	\$0	\$0	\$0	
Total Yearly Costs	\$0	\$0	\$0	\$0	\$0	
Cumulative Yearly Costs	\$0	\$0	\$0	\$0	\$0	
<b>Virtualized Infrastructure Costs</b>						
Total Yearly Hard Costs	\$0	\$0	\$0	\$0	\$0	
Total Yearly Soft Costs	\$0	\$0	\$0	\$0	\$0	
Total Yearly Costs	\$0	\$0	\$0	\$0	\$0	
Cumulative Yearly Costs	\$0	\$0	\$0	\$0	\$0	
Cumulative Yearly Savings	\$0	\$0	\$0	\$0	\$0	
Total Savings	\$0					

## Virtualization Project Cost Summary

Category	Cost				
	Year 1	Year 2	Year 3	Year 4	Year 5
<b>Current Infrastructure Costs</b>					
Total Yearly Hard Costs	\$26,000	\$26,000	\$26,400	\$26,640	\$26,640
Total Yearly Soft Costs	\$68,000	\$68,000	\$68,000	\$68,000	\$68,000
Total Yearly Costs	\$94,000	\$94,000	\$94,400	\$94,640	\$94,640
Cumulative Yearly Costs	\$94,000	\$188,000	\$282,400	\$377,040	\$471,680
<b>Virtualized Infrastructure Costs</b>					
Total Yearly Hard Costs	\$80,700	\$6,600	\$6,636	\$6,663	\$6,663
Total Yearly Soft Costs	\$10,200	\$10,200	\$10,200	\$10,200	\$10,200
Total Yearly Costs	\$90,900	\$16,800	\$16,836	\$16,863	\$16,863
Cumulative Yearly Costs	\$90,900	\$107,700	\$124,536	\$141,399	\$158,262
<b>Cumulative Yearly Savings</b>					
Cumulative Yearly Savings	\$3,100	\$80,300	\$157,864	\$235,641	\$313,418
Total Savings	\$313,418				

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## Example 2

- A company currently has an infrastructure of 15 physical servers.
- Servers consumes power of 1200\$/year and maintenance contract with vendor of 400\$/year
- IT dept stuff spends 2 hours/week for server administration tasks and 30 min/day for backup tasks.
- A project of virtualization at ratio of 1:5 is proposed, the price of new servers are 7k\$ each.
- New server consumed power in average is 1000\$/year.
- Vmware license is 5000\$/server, free maintenance for first year then 15% of license price for each year after.
- Employee training costs 1500\$, and you will train 5 employee in the first year
- assume that there will be a 2% increase in the cost to power each server in year 3 as well as a 3% increase in the server maintenance contract in year 4.
- Assume sys admin monthly salary = 4000\$/month
- Build a cost summary speared sheet to calculate the reduced expenses

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## Current situation

### 1. Hard costs:

power = 1200\$/year/server

maintenance = 400\$/year/server

### 2. Soft costs:

administration = 2h/week/server

= 2 \* 52 = 104 h/server/year

assume that working hours = 8 h/day

administration = 104/8 = 13 days/server/year

as sysadmin salary = 4000\$/month = 4000/24 = 170 \$/day

administration = 13 \* 170 = 2210 \$/year

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backup = 30 min/day/server

= .5\*5\*52 = 130 hours/server/year

= 130/8 = 17 d/server/year

= 17\* 170= 2,890\$ = 2900\$ server/year

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Current Yearly Costs						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Costs</b>						
Power	\$18,000.00	\$18,000.00	\$18,000.00	\$18,000.00	\$18,000.00	15 Servers X \$1200/year
Server Maintenance	\$6,000.00	\$6,000.00	\$6,000.00	\$6,000.00	\$6,000.00	15 Servers X \$400/year
Outside Service	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	all operations handled by staff
<b>Total Yearly Hard Costs</b>	<b>\$24,000.00</b>	<b>\$24,000.00</b>	<b>\$24,000.00</b>	<b>\$24,000.00</b>	<b>\$24,000.00</b>	
<b>Total Five Year Hard Costs =</b>	<b>\$120,000.00</b>					
<b>Soft Costs</b>						
Machine Administration	\$33,150.00	\$33,150.00	\$33,150.00	\$33,150.00	\$33,150.00	15 Servers X \$2210/year
Backup	\$43,500.00	\$43,500.00	\$43,500.00	\$43,500.00	\$43,500.00	15 Servers X \$22100/year
<b>Total Yearly Soft Costs</b>	<b>\$76,650.00</b>	<b>\$76,650.00</b>	<b>\$76,650.00</b>	<b>\$76,650.00</b>	<b>\$76,650.00</b>	
<b>Total Five Year Soft Costs =</b>	<b>\$383,250.00</b>					
<b>Total Yearly Current Costs =</b>	<b>\$100,650.00</b>	<b>\$100,650.00</b>	<b>\$100,650.00</b>	<b>\$100,650.00</b>	<b>\$100,650.00</b>	

Virtualized Infrastructure Yearly Costs						
Category	Cost					Notes
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Hard Cost</b>						
Machine Purchases	\$63,000	\$0	\$0	\$0	\$0	3 Servers x \$21K/Server
Software Purchases	\$15,000	\$0	\$0	\$0	\$0	VMWare/Server
Software Maintenance	\$0	\$2,250	\$2,250	\$2,250	\$2,250	3 Vmware at 15% maintenace
Power	\$3,000	\$3,000	\$3,060	\$3,060	\$3,060	3 servers x \$1000/Year
Server Maintenance	\$1,200	\$1,200	\$1,200	\$1,236	\$1,236	3 Servers x \$400/Year
Training	\$7,500	\$0	\$0	\$0	\$0	5 Employee 1st
Outside Services	\$0	\$0	\$0	\$0	\$0	all operations handeled by staff
<b>Total Yearly Hard Costs</b>	<b>\$89,700</b>	<b>\$6,450</b>	<b>\$6,510</b>	<b>\$6,546</b>	<b>\$6,546</b>	
<b>Total Five Years Hard Cos</b>	<b>\$115,752</b>					
<b>Soft Cost</b>						
Machine Administration	\$6,630	\$6,630	\$6,630	\$6,630	\$6,630	3 Servers X \$2210/year
Backup	\$43,500.00	\$43,500.00	\$43,500.00	\$43,500.00	\$43,500.00	3 Servers X \$22100/year
<b>Total Yearly Soft Costs</b>	<b>\$50,130</b>	<b>\$50,130</b>	<b>\$50,130</b>	<b>\$50,130</b>	<b>\$50,130</b>	
<b>Total Five Years Soft Cost</b>	<b>\$250,650</b>					
<b>Total Yearly Costs</b>	<b>\$139,830</b>	<b>\$56,580</b>	<b>\$56,640</b>	<b>\$56,676</b>	<b>\$56,676</b>	
<b>Total Five Years Costs =</b>	<b>\$366,402</b>					

## Virtualization

- Number of machines =  $15/5 = 3$
- **Hard cost**  
 machines purchase =  $21000 * 3$   
 machines maintenance =  $400 * 3$  (3% increase 4<sup>th</sup> year)  
 software =  $5000 * 3$   
 software maintenance =  $0.25 * 5000 * 3$  (except 1st year)  
 power =  $1000 * 3$  (2% increase 3<sup>rd</sup> year)
- **Soft cost** (same as current situation)

Virtualization Project Cost Summary						
Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Current Infrastructure Costs</b>						
Total Yearly Hard Costs	\$24,000	\$24,000	\$24,000	\$24,000	\$24,000	
Total Five Years Hard Costs	\$120,000					
Total Yearly Soft Costs	\$76,650	\$76,650	\$76,650	\$76,650	\$76,650	
Total Five Year Soft Costs	\$383,250					
<b>Virtualized Infrastructure Costs</b>						
Total Yearly Hard Costs	\$89,700	\$6,450	\$6,510	\$6,546	\$6,546	
Total Five Years Hard Costs	\$115,752					
Total Yearly Soft Costs	\$50,130	\$50,130	\$50,130	\$50,130	\$50,130	
Total Five Year Soft Costs	\$250,650					
<b>Net Five Years Hard Cost Savings</b>	<b>\$4,248</b>					
<b>Net Five Years Soft Cost Savings</b>	<b>\$132,600</b>					
<b>Net Five Years Overall Savings</b>	<b>\$136,848</b>					

## Virtualization Project Cost Summary

Category	Cost					
	Year 1	Year 2	Year 3	Year 4	Year 5	
<b>Current Infrastructure Costs</b>						
Total Yearly Hard Costs	\$24,000	\$24,000	\$24,000	\$24,000	\$24,000	
Total Yearly Soft Costs	\$76,650	\$76,650	\$76,650	\$76,650	\$76,650	
Total Yearly Costs	\$100,650	\$100,650	\$100,650	\$100,650	\$100,650	
Cumulative Yearly Costs	\$100,650	\$201,300	\$301,950	\$402,600	\$503,250	
<b>Virtualized Infrastructure Costs</b>						
Total Yearly Hard Costs	\$89,700	\$6,450	\$6,510	\$6,546	\$6,546	
Total Yearly Soft Costs	\$50,130	\$50,130	\$50,130	\$50,130	\$50,130	
Total Yearly Costs	\$139,830	\$56,580	\$56,640	\$56,676	\$56,676	
Cumulative Yearly Costs	\$139,830	\$196,410	\$253,050	\$309,726	\$366,402	
<b>Cumulative Yearly Savings</b>						
Cumulative Yearly Savings	-\$39,180	\$4,890	\$48,900	\$92,874	\$136,848	
<b>Total Savings</b>						
Total Savings	\$136,848					

**Thanks,..  
See you next week (ISA),...**