you are the system administrator for an organization that is attempting to determine if virtualization of its server infrastructure would be beneficial to the organization from a financial perspective

* conducting the cost/benefit analysis

this requires that you be able to compare the way the organization is currently operating with the proposed changes to the operation

The first step in the analysis is to completely determine the costs associated with the current operational technique.

These servers are configured into four different groups:

– Group 1 consists of 15000 mission critical servers. Group 1 servers consume 3600W of power

each at full load (100% CPU utilization). The Group 1 servers average load is 17%.

– Group 2 consists of 4000 mission critical servers. Group 2 servers consume 4200W of power

each at full load (100% CPU utilization). The Group 2 servers average load is 14%.

– Group 3 consists of 100 non-mission critical in-house application and file servers, each of which

consumes 2800W of power at full load. The servers in this group run with an average load of 2% .

– Group 4 consists of a pool of 900 redundant servers utilized as backup servers. The Group 4

servers are split into two subgroups, call them Group 4A with 700 servers and Group 4B with

200 servers. Group 4A servers draw 3800W at full load and the Group 4B servers draw 3300W

at full load. The Group 4 servers are used as “hot” backups for, primarily, Groups 1 and 2, but

can be used by any group as needed. Group 4A and 4B servers run at average 1% load.

The power consumed by a server is measured in Watts. Power companies charge for

power based on kWH (kilowatt-Hours).

Group 1

The **Group 1** servers consume **3600W of power** at full load. However, they **only average a 17% load**, so what they consume, on average, is 3600W x 0.17 = 612W.

A device that consumes 1000W = 1kW for 1 hour will use 1kWH of power.

Thus, the **Group 1** servers are consuming 612W = 0.612kW, so in 1 hour they will use 0.612kWH of power.

Servers run 24/7 so in 1 day, one **Group 1** server will use 0.612kWH x 24hr = 14.688kWH of power.

There are 15000 servers in **Group 1**, so collectively they will consume 15000 x 14.688kWH = 220,320kWH of power in 1 day.

power company is charging 13 cents/kwH, so, running all **Group 1** servers **for 1 day** will cost: 220,320kWH x 0.13$/kWH = $28,641.60.

**For one year**, the cost to power **Group 1** servers will be $28,641.60 x 365 = $10,454,184.00.

Group 2

The **Group 2** servers consume **4200W of power** at full load. However, they **only average a 14% load**, so what they consume, on average, is 4200W x 0.14 = 588W.

Thus, the **Group 2** servers are consuming 588W = 0.588kW, so in 1 hour they will use 0.588kWH of power.

Servers run 24/7 so in 1 day, one **Group 2** server will use 0.588kWH x 24hr = 14.112kWH of power.

There are 4000 servers in **Group 2**, so collectively they will consume 4000 x 14.112kWH = 56,448kWH of power in 1 day.

power company is charging 13 cents/kwH, so, running all **Group 2** servers **for 1 day** will cost: 56,448kWH x 0.13$/kWH = $7,338.24/day.

**For one year**, the cost to power **Group 2** servers will be $7,338.24 x 365 = $2,678,457.60/year

Group 3

The **Group 3** servers consume **2800W of power** at full load. However, they **only average a 2% load**, so what they consume, on average, is 2800W x 0.02 = 56W.

Thus, the **Group 3** servers are consuming 56W = 0.056kW, so in 1 hour they will use 0.056kWH of power.

Servers run 24/7 so in 1 day, one **Group 3** server will use 0.056kWH x 24hr = 1.344kWH of power.

There are 100 servers in **Group 3**, so collectively they will consume 100 x 1.344kWH = 134.4 kWH of power in 1 day.

power company is **charging 13 cents/kwH**, so, running all **Group 3** servers **for 1 day** will cost: 134.4kWH x 0.13$/kWH = $17.472/day.

**For one year**, the cost to power **Group 3** servers will be $17.472 x 365 = $6,377.28/year

Group 4

Group 4A

The **Group 4A** servers consume **3800W of power** at full load. However, they **only average a 1% load**, so what they consume, on average, is 3800W x 0.01 = 38W.

Thus, the **Group 4A** servers are consuming 38W = 0.038kW, so in 1 hour they will use 0.038kWH of power.

Servers run 24/7 so in 1 day, one **Group 4A** server will use 0.038kWH x 24hr = 0.912kWH of power.

There are 700 servers in **Group 4A**, so collectively they will consume 700 x 0.912kWH = 638.4kWH of power in 1 day.

power company is charging 13 cents/kwH, so, running all **Group 4A** servers **for 1 day** will cost: 638.4kWH x 0.13$/kWH = $82.992/day.

**For one year**, the cost to power **Group 4A** servers will be $82.992 x 365 = $30,292.08/year

Group 4B

The **Group 4B** servers consume **3300W of power** at full load. However, they **only average a 1% load**, so what they consume, on average, is **3300**W x 0.01 = 33W.

Thus, the **Group 4B** servers are consuming 33W = 0.033kW, so in 1 hour they will use 0.033kWH of power.

Servers run 24/7 so in 1 day, one **Group 4B** server will use 0.033kWH x 24hr = 0.792kWH of power.

There are 200 servers in **Group 4B**, so collectively they will consume 200 x 0.792kWH = 158.4kWH of power in 1 day.

power company is charging 13 cents/kwH, so, running all **Group 4B** servers **for 1 day** will cost: 158.4kWH x 0.13$/kWH = $20.592/day.

**For one year**, the cost to power **Group 4B** servers will be $20.592 x 365 = $7,516.08/year

Together, Group 4 servers will be $7,516.08 + $30,292.08 = $37,808.08

**The maintenance contracts on the current physical servers are as**

**follows**

Group 1 servers: $1100.00/100 servers/year (150 cost units)

– Group 2 servers: $1450.00/100 servers/year (40 cost units)

– Group 3 servers: $500.00/group/year (1 cost unit)

– Group 4A servers: $110.00/100 servers/year (7 cost units)

– Group 4B servers: $100.00/100 servers/year (2 cost units)

* Assume that **server maintenance costs will increase 3%/year** over the

duration **of the study** for all server maintenance agreements

Server administration efforts also vary across the server groups as follows:

– Group 1 (3500W) servers: **4 administrative weeks**/server/year

– Group 2 (4500W) servers: 6 administrative weeks/server/year

– Group 3 (2800W) servers: 1 administrative week/server/year

– Group 4A (3800W) servers: 1 administrative weeks/server/year

– Group 4B (3300W) servers: 0.5 administrative week/server/year

• Administrative costs are currently $90/administrative hour.

Assume that **administrative costs will increase** at the rate of **2%/year** over the duration **of the study**(5 years).

• An administrative day is 10 hours long. An administrative week is 7 days long. A server day is 24 hours long.

Server backup efforts also vary across the server groups as

follows:

– Group 1 servers: these servers are backed-up nightly and require 45 minutes

per **100 servers** (**150 cost units**).

– Group 2 servers: these servers are backed-up nightly and require 75 minutes

per 100 servers (40 cost units).

– Group 3 servers: these servers are backed-up weekly and require 2 hours and

15 minutes for the entire group (1 cost unit).

– Group 4A servers: these servers are backed-up every other week and require

90 minutes per 100 servers (7 cost units).

– Group 4B servers: these servers are backed-up every other week and require

150 minutes per 100 servers (2 cost units).

• Servers that are backed-up weekly require only 52 backups/year. Similarly,

those which are backed-up every other week will require only 26 backups/year

Group 1

Group 1 servers are backed-up nightly requiring 45 minutes/100 servers. **Since there are 150 subgroups of 100 servers/subgroup in Group 1**, **each of these subgroups** requires 365 x 0.75 hours/year of administrative time for backups.

Since you are given the time requirement in minutes and administrative time is based on hours, convert backup effort into hours.

So 45 minutes = 0.75 hours(45 minutes/ 60 minutes = 0.75 hours). Thus, one subgroup in Group 1 requires a total of **273.75 hours of backup time in 1 year**.

There are 150 subgroups (cost units) in **Group 1 so the total time required for backups is 150 x 273.75 = 41,062.5 hours.**

Administrators are paid at the rate of $90.00/hour, so the cost of backing up all the **Group 1 servers for year 1 of the study is,41,062.5 hrs x $90.00/hr = $3,695,625.00/year**

Group 2

Group 2 servers are backed-up nightly requiring 75 minutes/100 servers. **Since there are 40 subgroups of 100 servers/subgroup in Group 2**, **each of these subgroups** requires 365 x 1.25 hours/year of administrative time for backups.

Since you are given the time requirement in minutes and administrative time is based on hours, convert backup effort into hours.

So 75 minutes = 1.25 hours(75 minutes/ 60 minutes = 1.25 hours). Thus, one subgroup in Group 2 requires a total of **456.25 hours of backup time in 1 year**.

There are 40 subgroups (cost units) in **Group 2 so the total time required for backups is 40 x 456.25 = 18,250 hours.**

Administrators are paid at the rate of $90.00/hour, so the cost of backing up all the **Group 2 servers for year 1 of the study is,18,250 hrs x $90.00/hr = $1,642,500.00/year**

Group 3

Group 3 servers are backed-up weekly requiring 135 minutes/all servers. **Since there is 1 group in Group 3**, **this group** requires 52 x 2.25 hours/year of administrative time for backups.

Since you are given the time requirement in minutes and administrative time is based on hours, convert backup effort into hours.

So, 2 hours and 15 minutes = 2.25 hours. Thus, one subgroup in Group 3 requires a total of **117 hours of backup time in 1 year**.

There is 1 group (cost units) in **Group 3 so the total time required for backups is 1 x 117 = 117 hours.**

Administrators are paid at the rate of $90.00/hour, so the cost of backing up all the **Group 3 servers for year 1 of the study is,117 hrs x $90.00/hr = $10,530.00/year**

Group 4A

Group 4A servers are backed-up every other week requiring 90 minutes/100 servers. **Since there are 7 subgroups of 100 servers/subgroup in Group 4A**, **each of these subgroups** requires 26 x 1.50 hours/year of administrative time for backups.

Since you are given the time requirement in minutes and administrative time is based on hours, convert backup effort into hours.

So, 90 minutes = 1.50 hours. Thus, one subgroup in Group 4A requires a total of **39 hours of backup time in 1 year**.

There are 7 subgroups (cost units) in **Group 4A, so the total time required for backups is 7 x 39 = 273 hours.**

Administrators are paid at the rate of $90.00/hour, so the cost of backing up all the **Group 4A servers for year 1 of the study is, 273 hrs. x $90.00/hr. = $24,570/year**

Group 4B

Group 4B servers are backed-up every other week requiring 150 minutes/100 servers. **Since there are 2 subgroups of 100 servers/subgroup in Group 4B**, **each of these subgroups** requires 26 x 2.50 hours/year of administrative time for backups.

Since you are given the time requirement in minutes and administrative time is based on hours, convert backup effort into hours.

So, 150 minutes = 2.50 hours. Thus, one subgroup in Group 4B requires a total of **65 hours of backup time in 1 year**.

There are 2 subgroups (cost units) in **Group 4B so the total time required for backups is 2 x 65 = 130 hours.**

Administrators are paid at the rate of $90.00/hour, so the cost of backing up all the **Group 4B servers for year 1 of the study is, 130 hrs. x $90.00/hr. = $11,700.00/year**

Groups 1, 2, and 3 will require a backup effort assumed to be 60 min/physical server/day.

So 60 minutes = 1 hour(s) (60 minutes/ 60 minutes = 1 hour(s)

Group 4 servers will require 90 min/physical server/week

Percentage decrease = [($13,545,297.04 - $2,654,438.70) / $13,545,297.04] \* 100%

Percentage decrease = [($10,890,858.34) / $13,545,297.04] \* 100%

Percentage decrease ≈ (0.8037) \* 100%

Percentage decrease ≈ 80.37%

Percentage decrease=( 2,934,399,066.061

1,177,178,519.421)×100%

Percentage decrease≈(0.4013)×100%

Percentage decrease≈40.13%