EETCO

Documentation

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EETCO

This tool models the total cost of ownership of a datacenter populated by computing resources. The tool in its current version, does not model in full detail non-computing resources.

Basic Operation

This tool takes as an input a datacenter configuration and computes the TCO of that configuration and the environmental impact of the datacenter. The computation starts with an estimation of the number Hot and Cold spares required to reach the number of server request during the server depreciation lifetime. This computation used the mttf of the server components and the performance vulnerability factor (PVF) of the chip. The tool, after performing this step, computes the server acquisition cost, the power cost (consumed by servers and cooling equipment), the maintenance cost and the cost of acquisition of the building (space) and cooling equipment infrastructure. After these steps, the resulting TCO and its different component are print as the environmental impact and some information about the data center.

The tool is defined to explore tradeoffs between different configurations. Some exploration experiments show how to define your own experiment based on the kernel tool (see Section Wrappers).

Download & Install

Requirements:
- perl, gawk, sed, gnuplot

Download the tool from http://www.cs.ucy.ac.cy/carch/xi/software/eetco.zip
The tool is written completely in Perl scripts. There is no need to install it.

Note:
- sed and gnuplot are used only by the exploration experiments (see Section Wrappers).

Use

Run the tool by writing:
./eetco.pl input_example/dc.params input_example/r.params
dc.params is a datacenter configuration file and *r.params* is a datacenter configuration file (see Section Input).

The output of the tool shows extensive information about costs and other estimations concerning the data center. For details about the output see Section Output.

Structure

The tool is written in perl scripts organized in 3 files:
+ eetco.pl
+ packages/dc.pm
+ packages/resource.pm

The **eetco.pl** script is the main tool script, which uses a datacenter analytical model to estimate and output the TCO and the environmental impact, along with other intermediate results (see Section Output). **dc.pm** and **resource.pm** are packages used by eetco.pl script to parse configuration files, to store the inputs information, to print the configuration, to estimate TCO and intermediate results.

In the main directory, there are three subdirectories:

+ doc	which contains this document
+ input_example	which contains configuration file examples See Section Input for more details.
+ wrappers	which contains different exploration experiments. See Section Wrappers for more details.

Input

EETCO takes as an input a datacenter configuration file and at least one resource configuration file where their structures are detailed bellow. In these files, character # is used for comments.

Datacenter Configuration file (dc.params)

```
#########################################################
# Basic datacenter parameters
#########################################################
#land, establishment
c_buildingpersqm 3000          Cost of land acquisition/building deployment ($/m^2)

#Cooling equipment area overhead
a_coolingarea 1.2              A simplified factor accounting for 20% more space for the
                               cooling equipment

#Data Center depreciation
dcdepr 15                      Depreciation of datacenter (years)
```

#Cost of cooling infrastructure

c_cooldeplperW 15 Cost of cooling infrastructure deployment ($/W)

#Electricity

c_electperKWH 0.07 Cost of electricity per KWh

#Power effectiveness

PUE 1.3 Power Usage Effectiveness

salary_perrackpermonth 200 Salary cost of datacenter staff per rack per month ($)

c_elecpeak 0 optional parameter: if the parameter is not present, default value=0
1 if the peak power consumption has to be considered for the power cost contribution to TCO
0 otherwise, if the actual power consumption has to be considered

report_resources 1 1 to report each resource details in the output
0 otherwise

##

Non srv modules requirements & params

##

n_othermodules 0 Number of non server modules (networking, storage)

p_othermodules 0 Total Power of non server modules (networking, storage)

p_othermodulesidle 0 Total Power of non server modules (networking, storage) when idle

n_othermodulesrepl 0 Number of replacements needed for non server modules throughout server depreciation time interval (servdepr)

c_nonsrvmodule 0 Average cost of a non server module ($)

depr_othermodules 3 depreciation of other modules (year)

u_othermodules 0.2 average utilization other modules

a_othermodules 0 total area used by other modules (m^2)

n_racks_othermodules 0 number of racks used by other modules

Resource Configuration file (r.params)

resource_name r name of the resource

##

Basic workload requirements

##

n_srvmodulesreq 50000 Total number of server required for the peak workload requirements

u 0.2 Average server utilization (0<=u<=1)

```
coef_maintenance 1          coefficient to reduce the cold spares' cost
                            e.g.: 1 no reduction ; 0.5 half the price
#########################################################
# Rack cabinet params
#########################################################
k_bladesperrack 6           Number of blades per rack
k_modulesperblade 14        Number of (server) modules per blade
height 1.78                 Rack height (m). 42RU->1.78m - not used
width 0.6                   Rack width (m)
depth 1.2                   Rack depth (m)
minimumdistance 0.92        Minimum distance between two racks (m) - not used
useddistance 1.2            Distance between two rack lanes in our datacenter (m)
#########################################################
# Server module configuration & characteristics
#########################################################
srvdepr 3                   Depreciation of server equipment (years)
mttr 4                      Mean time to repair a faulty server module (hours)

mttf_coef 1                 optional parameter: if the parameter is not present, default
                            value=0
                            to adjust the mttf of all component in case the ambient
                            temperature increases

time_step 30                step used in spares estimation (days)

SPUE 1.3                    Server Power effectiveness.
                            IT power/SPUE= power to pure electronic
                                           components (no fans etc)

k_chipspersrvmodule 1       Number of server chips per server module

#System
c_system 50                 System cost ($)
p_system 1                  System power (W)
p_system_idle 0.5           System power idle (W)

# DRAM information
n_dram 2                    Number of DRAM element per server module
c_dram 15                   DRAM cost (1 element) ($)
p_dram 1                    DRAM power (1 element) (W)
p_dram_idle 0.25            DRAM power idle (1 element) (W)
mttf_dram 200               DRAM MTTF (1 element) (year)

# Disk information
```

n_disk 1	Number of disk element per server module
c_disk 50	Disk cost (1 element) ($)
p_disk 2	Disk power (1 element) (W)
p_disk_idle 1.3	Disk power idle (1 element) (W)
mttf_disk 100	Disk MTTF (1 element) (year)

#Switchport information

n_switchport 1	Number of switchport element per server module
c_switchport 15	Switchport cost (1 element) ($)
p_switchport 2.5	Switchport power (1 element) (W)
p_switchport_idle 2.5	Switchport power idle (1 element) (W)
mttf_switchport 200	Switchport MTTF (1 element) (year)

#other server component if required

c_other 0	Cost other component ($)
p_other 0	Power other component (W)
p_other_idle 0	Power idle other component (W)

```
#########################################################
# Chip configuration & characteristics
#########################################################
```

c_chip 100	Chip cost ($)
pvf 0	Performance vulnerability factor (0<=pvf<=1)
p_chip 5	Chip Power (W)
p_chip_idle 0.5	Chip Power idle (W)
chip_mttf 100	Chip Mean Time To Failure (years).

Output

The main output consists of an extensive costs report followed by data center information, like the one bellow:

```
-----------------------
DC parameters
-----------------------
…
-----------------------
Resources parameters
-----------------------
…
-----------------------
DC results
-----------------------
tco: 608777.58 $/month
        c_acquisition:  84873.13 $/month
        c_server:       340277.78 $/month
        c_power:        28704.31 $/month
        c_maintenance:  154922.36 $/month

n_racks:        596
a_dc:           1029.888 m^2
p_total_avg:    337000 W
p_total_peak:   625000 W
```

```
co2peryr:       2720147.72 kg
pinetreesperyr: 1007462.12

-----------------------
Resources results
-----------------------
Resource: r

tco: 608777.58 $/month
        c_acquisition:  84873.13 $/month
        c_server:       340277.78 $/month
        c_power:        28704.31 $/month
        c_maintenance:  154922.36 $/month

n_racks:        596
a_perrack:      1.44 m^2
p_peakperrack:  1365 W
a_dc:           1029.89 m^2
n_srvmodules:   50000
n_coldsp:       5249
c_srvmodule:    245 $
availability:   0.99998402130898

p_total_avg:    337000 W
p_total_peak:   625000 W
```

Below there is an explanation of each figure for the Datacenter and the contribution of each resource:

```
-----------------------
DC parameters
-----------------------
…
-----------------------
Resources parameters
-----------------------
…
-----------------------
DC results
-----------------------
```

`tco: 608777.58 $/month`	Total Cost of Ownership per month
`c_acquisition: 84873.13 $/month`	Cost of acquisition per month of the datacenter infrastructure (building, land, cooling equipment).
`c_server: 340277.78 $/month`	Cost of server acquisition per month
`c_power: 28704.31 $/month`	Cost of power per month
`c_maintenance: 154922.36 $/month`	Cost of maintenance per month. It includes staff salaries and replacements of server modules.
`n_racks: 596`	Number of racks required for the peak workloads
`a_dc: 1029.888 m^2`	Total Datacenter Area
`p_total_avg: 337000 W`	Average power dissipated
`p_total_peak: 625000 W`	Peak power dissipated
`co2peryr: 2720147.72 kg`	Enviromental impact of the datacenter in kg CO2 (per year)
`pinetreesperyr: 1007462.12`	Enviromental impact of the datacenter in pinetrees required to compensate for the CO2 emission

(per year)

Resources results		

Resource: r		Resource name
tco: 608777.58 $/month		Total Cost of Ownership per month
c_acquisition:	84873.13 $/month	Cost of acquisition per month of the datacenter infrastructure (building,land, cooling equipment).
c_server:	340277.78 $/month	Cost of server acquisition per month
c_power:	28704.31 $/month	Cost of power per month
c_maintenance:	154922.36 $/month	Cost of maintenance per month. It includes staff salaries and replacements of server modules.
n_racks:	596	Number of racks required for the peak workloads
a_perrack:	1.44 m^2	Area required for one rack (taking into account the distances between each other)
p_peakperrack:	1365 W	Peak power dissipated per rack
a_dc:	1029.888 m^2	Total Datacenter Area
n_srvmodules:	50000	Number of server modules required for the peak workloads: n_srvmodulesreq (+hotspares if pvf>0)
n_coldsp:	5249	Number of replacements required throughout srvdepr (year)
c_srvmodule:	245 $	Cost of a server module
availability:	0. 99998402130898	Availability of computing resources (doesn't include networking and storage availability - see service level availability section in Technical Report)
p_total_avg:	337000 W	Average power dissipated
p_total_peak:	625000 W	Peak power dissipated

Wrappers

So far, this document has focused on how to run the tool with a given configuration. This tool can also be used to explore tradeoffs between different configurations by defining wrapper scripts. Different experiments are defined in the subdirectory wrappers, for instance:

- performance vs. chip price
- pvf vs. chip price
- epc performance (comparison of different server performance)
- ambient_temperature impact

We focuses on the performance vs. chip price experiment (subdirectory: wrappers/perf_vs_price) in that document to explain how this experiment is defined (the other are closed to that case study) and to show how a given analysis can be defined.

Requirements: sed, gnuplot*

*if you do not have gnuplot, you can see the results in an output text file.

Run the script by writing:

./experiment_ perf_vs_price.pl

The directory perf_vs_price is organized as follow:

+ perf_vs_price.pl	which is the perl script to run this experiment (detailed hereafter)
+ output directory	empty directory used to store the output files generated during the execution of the script
+ template	
-> dc_template.params	template of dc.params file.
-> r_template.params	template of r.params file. The values to change during the exploration experiment are set to XXNAME (i.e. XXSERVERS, XXPRICE)
-> gnuplot_template.plot	template for gnuplot to generate a 3D graph of the experiment
+ perf_vs_price.txt	output file which contains the results of each experiment. This file is then used as an input of gnuplot.
+ perf_vs_price.eps	The resulting 3D graph of the experiment

experiment_perf_vs_price.pl

This script explore different normalized server performance and normalized chip price according to given reference values and produce for each configuration a normalized TCO in file perf_vs_price.txt.

The script is organized as follows:
+ $basedir variable
+ Basic parameters of the exploration, this part has to be change to define your own experiment
+ initialisation phase
+ main loop exploration
+ gnuplot call
+ clean phase

All this steps are commented in the script to help the generation of new experiments.