Resource allocation in a Cloud partially powered by renewable energy sources

Supervisor:
Anne-Cécile Orgerie (CNRS)
Jean-Marc Menaud (EMN)

Myriads - IRISA - Rennes

Yunbo LI - March 17, 2015
Project EPOC: Energy Proportional and Opportunistic Computing system.

- 4 Phd students
- 5 partners
- 6 teams

→ It aim at optimizing energy consumption at the level of hardware, software, network and the trade-off between energy costs and performance.
My subject: Resource allocation in a Cloud partially powered by renewable energy sources.

→ At the infrastructure level, by designing an energy-aware distributed system in charge of optimizing the energy consumed by the infrastructure running the jobs.
Analysis the energy consumption in datacenters

How can we reduce the energy consumption in datacenters?

Figure: Energy consumption in datacenters

How can we reduce the energy consumption in datacenters?

Ref: Eugen Feller Phd thesis
Problem

Actual

Survey from Google: 5000 servers, average CPU utilization [10%, 50%] [1]. An idle server consumes between 50% and 80% of its peak power [2].

How can we reduce the energy consumption in datacenters?
→ Increase the CPU/RAM utilization for each Physical Machine (PM) and switch-off the unnecessary powered-on PMs.

Advantage:

- More green by using the solar/wind power
- Reduce $CO_2$ emission footprint
- Reduce brown energy consumption and save money

In a mono-site [50 servers]. PMs hardware can be either homogeneous or heterogeneous.

Three kinds of modes to provide power (Green energy, brown energy, hybrid)

No batteries to store electricity
Job scheduling

- **When**
  
  *Time is divided into slot.*

  **Job classification:**
  1. web-job - Non-Interruptible
  2. batch-job - Interruptible within deadline

  *Schedule/Reschedule jobs at the beginning of each slot:*
  
  - Schedule web-job first (Algo-webjob)
  - Then schedule the batch-job (Algo-batchjob)
  - If there is not enough green energy (Algo-consolidation if necessary)

- **Where** (e.g. #node/#server) The chose serve should satisfy job’s demand
  
  - Constraints of servers:
    1. CPU resource (e.g. number of cores)
    2. Memory resource
The system model

Figure: The system model
Switch ON servers

Receive the green energy and Compute the #servers to switch on

Figure: Switch ON servers
Job placement algorithm

**Figure**: Job placement algorithm
Job placement algorithm

Figure: Job placement algorithm
Job placement algorithm

Figure: Job placement algorithm
Job placement algorithm

Figure: Job placement algorithm
Job placement algorithm

New Arrival

Place the first batch-job:

Reject:

Figure: Job placement algorithm
Job placement algorithm

**Figure**: Job placement algorithm
Job placement algorithm

![Algorithm Diagram]

**Figure**: Job placement algorithm
Switch OFF servers

We want to switch off this server if possible.

New Arrival:

......

Reject:

Figure: Switch OFF servers
Figure: Switch OFF servers
Switch OFF servers

Figure: Switch OFF servers
Switch OFF servers

Figure: Switch OFF servers
Switch OFF servers

**Figure:** Switch OFF servers
Switch OFF servers

Figure: Switch OFF servers
Switch OFF servers

We want to switch off this server if possible

New Arrival:

Move all the batch ran on current server:

Temporary rejection:

Reject:

Figure : Switch OFF servers
Switch OFF servers

- Switch OFF servers

**Figure**: Switch OFF servers

- New Arrival:
  - web
  - batch

- Move all the batch ran on current server:

- Reject:
  - 4
  - 4
  - 3
  - 2

- Temporary rejection:
  - 3
  - 2
  - 4
  - 4

- We want to switch off this server if possible
Switch OFF servers

**Figure**: Switch OFF servers
History from the 1 Jan 2005 to 31 Dec 2012

Figure: 4 sites’ coordinate in France
Solar power (2) - Real trace

![Solar Power Chart]

**Figure**: 2009 solar radiation, site North near Calais

Database provided by **EasyVirt**.
End of development a simple simulator to valid our algorithm.
Code source : Java
After valid this prototype, we will experimenter it on Grid’5000.
**Topic**: Resource allocation in a Cloud partially powered by renewable energy sources

General problem to solve:

- Resource allocation
- Maximize on using the renewable energy instead of the Brown energy.

For VM consolidation, our research is focus on the three following points.

- **VM placement**: The server manager rank the PM and VM by combining different weighting factors.
- **Reduce the number of powered-on physical machines by increasing the VM consolidation ratio**
The End
Merci:)}