Towards sufficient use of data centers: simulation work and qualitative research

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Introduction
About me

- Maël Madon, 2nd year PhD student
- SEPIA team at IRIT (Toulouse)
- Supervisors: Georges Da Costa and Jean-Marc Pierson
Traditional techniques for footprint reduction in data centers

- **Energy efficiency**
  (virtualization, workload consolidation, DVFS...)

- **Use of renewable energies**
  (workload adaptation to power envelope, geographic load shifting, ...)

- **Data center environment**
  (cooling management, waste heat utilization, use of batteries)
Efficiency techniques

Before

Energy → Data center

After

Less energy → Data center
Introduction

Rebound effect?

Before

Data center = 1
Energy = 2

After

Data center = 3
Energy = 3
Efficiency is not enough: sufficiency

Sufficiency policies (IPCC, 2022)
A set of measures and daily practices that avoid demand for energy, materials, land and water while delivering human well-being for all within planetary boundaries.
What would "sufficiency" mean for data centers?
=> auto-regulate ourselves: raise awareness, empower and involve the user

1 simulation work: understand how the user submission behavior affects the load in the data center
2 case study: digital sufficiency in flexible work
Data center simulation
Understand how the user submission behavior affects the load in the data center
Behaviors

- **Context:** demand response
- **Five behaviors studied:**

  - rigid (baseline)
  - demand response window
  - renounce
  - delay
  - degrad
  - reconfig
Data center simulation

Understand how the user submission behavior affects the load in the data center

The simulated system

Original workload
(Metacentrum)

Users

submit jobs

Behavior:
- rigid
- renounce
- delay
- reconfigure
- degrade

Scheduler
(bin-packing)

Data center
(16-core machines)
Understanding how the user submission behavior affects the load in the data center

Behavior during demand response window: **rigid**

Output

![Graph and Chart]

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Output

- Behavior during demand response window: **renounce**

```
./out/demand_response/DMRenonce_may1_2_3
```

```
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```
Behavior during demand response window: delay
Data center simulation

Understand how the user submission behavior affects the load in the data center

Output

Behavior during demand response window: degrad

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Data center simulation
Understand how the user submission behavior affects the load in the data center

Output

Behavior during demand response window: reconfig

../out/demand_response/DMReconfig_may1_2_3

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Data center simulation
Results
Fluid and residual mass

- Residual mass
- Fluid mass
- Max cores (1664)
- Demand response window

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## Results

### Pros and cons of each behavior:

<table>
<thead>
<tr>
<th>behavior</th>
<th>energy in</th>
<th>energy overall</th>
<th>sched. metrics</th>
<th>&quot;acceptability&quot;</th>
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<td>1st</td>
<td>1st*</td>
<td>4th</td>
</tr>
<tr>
<td>delay</td>
<td>1st</td>
<td>4th</td>
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<td>2nd</td>
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<td>2nd</td>
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<td>reconfig</td>
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<td>3rd</td>
<td>3rd</td>
<td>1st</td>
</tr>
</tbody>
</table>

### All the details in the article

Pilot study
Digital Sufficiency in Flexible Work
Study goal: Re-design the use of cloud services for flexible working towards sufficiency

How much digital interventions are necessary and how much is superfluous?

Method: Focus groups within companies
Conclusion and research directions
Conclusion

- Going beyond *efficiency*, investigating *sufficiency* for data centers
  - through *simulation* and *qualitative research* methods
- the link between the two works is quite distant
  - simulation: user HPC, direct actor
  - qualitative study: user SaaS, does she have the *agency*?
Future works

- Simulation work:
  - Synergies with renewable energies
  - More realistic user submission patterns in simulations

- Pilot study:
  - quantify the impact of the tactics towards sufficiency

- Please, do not hesitate to contact me :-)  
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