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

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LOCOS Seminar @ Glasgow (online)

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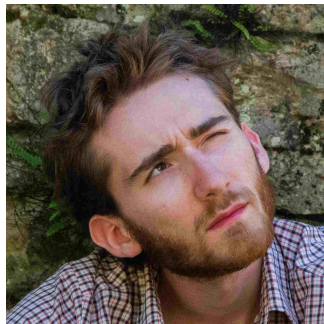# Introduction

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)

www.pexels.com

Efficiency techniques

Before

After

Energy

Data center

Less energy

Data center

Rebound effect?

Before

After

Energy

Data center

Data center = 1
Energy = 2

Data center = 3
Energy = 3

Sufficiency
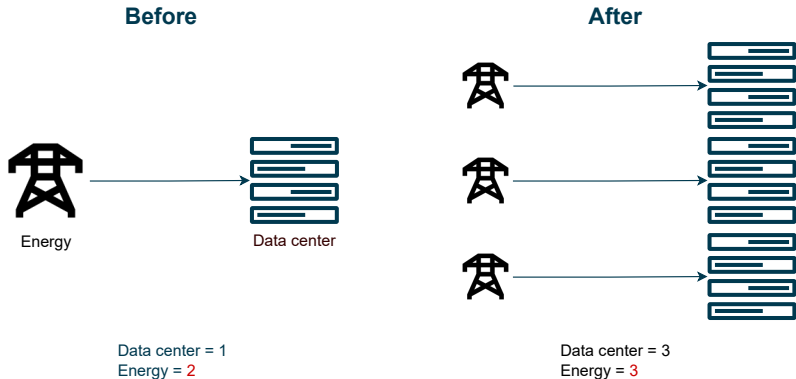
- Efficiency is not enough: **sufficiency**

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.

Contents

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
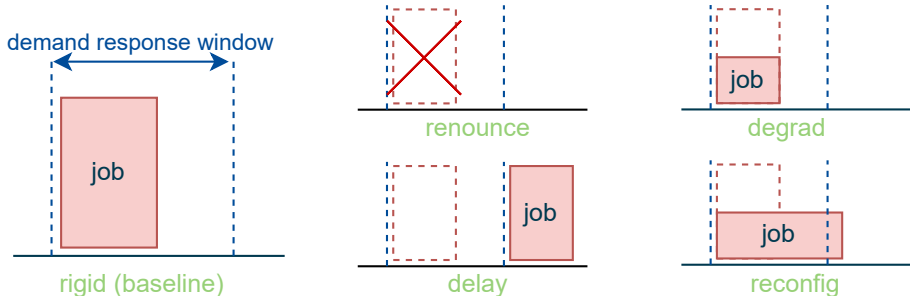2. **case study:** digital sufficiency in flexible work

Data center simulation

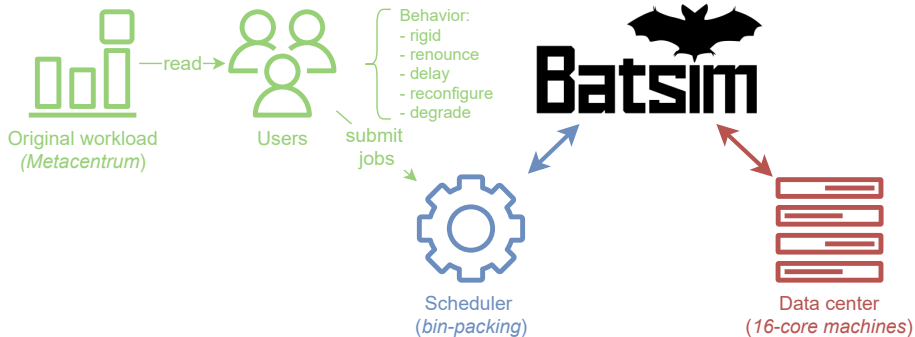## Understand how the user submission behavior affects the load in the data center

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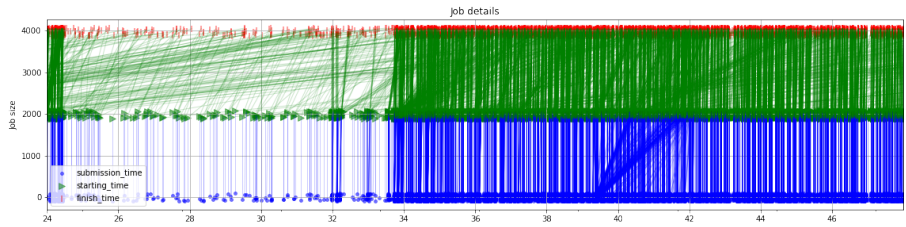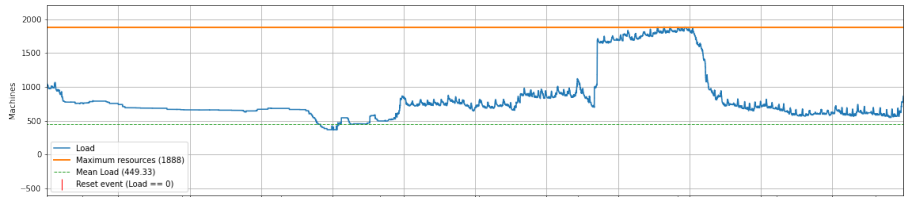
- Context: **demand response**
- Five behaviors studied:

demand response window

job

rigid (baseline)

renounce

delay

job

degrad

job

job

reconfig

The simulated system

Output

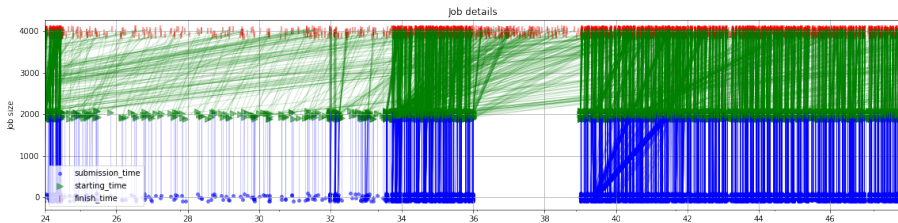- **Behavior during demand response window: rigid**
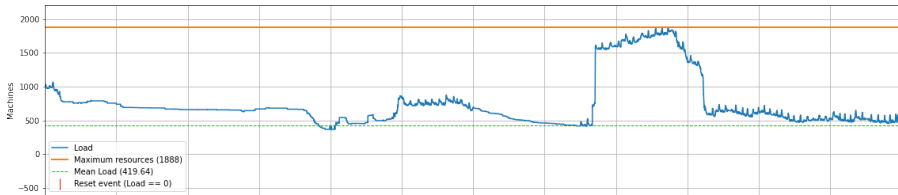

../out/demand_response/ReplayRigid_may1_2_3

Output

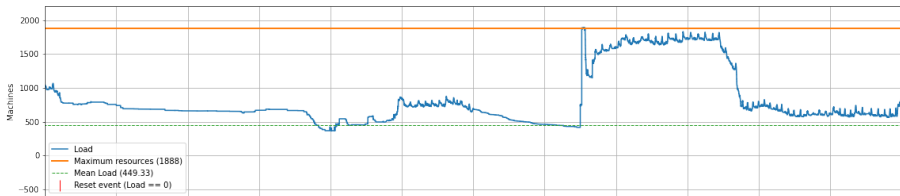- Behavior during demand response window: **renounce**

../out/demand_response/DMRenonce_may1_2_3

Output

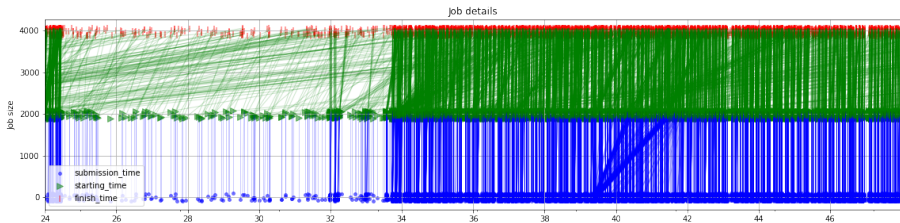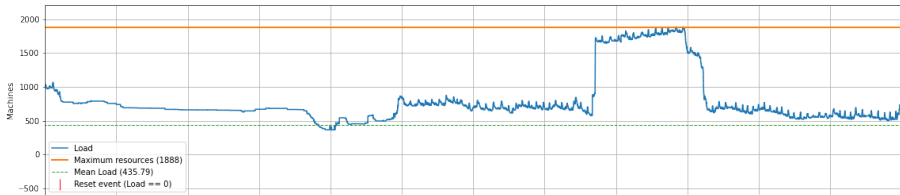- Behavior during demand response window: **delay**

../out/demand_response/DMDelay_may1_2_3

Output

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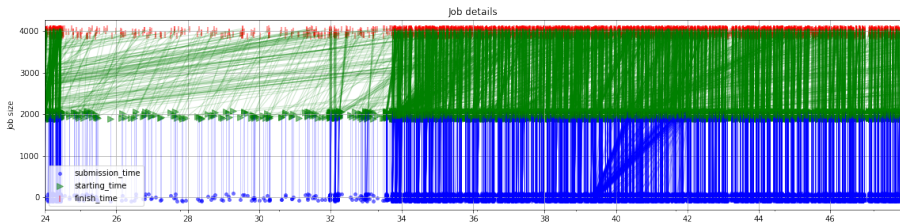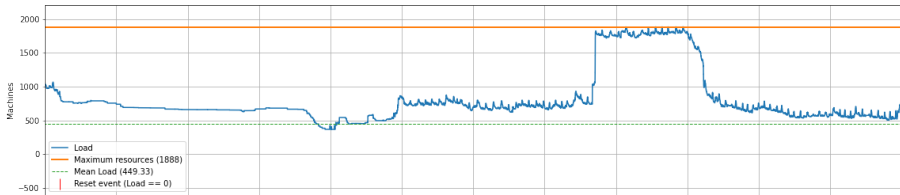

../out/demand_response/DMDegrad_may1_2_3

Output

- ■ Behavior during demand response window: **reconfig**
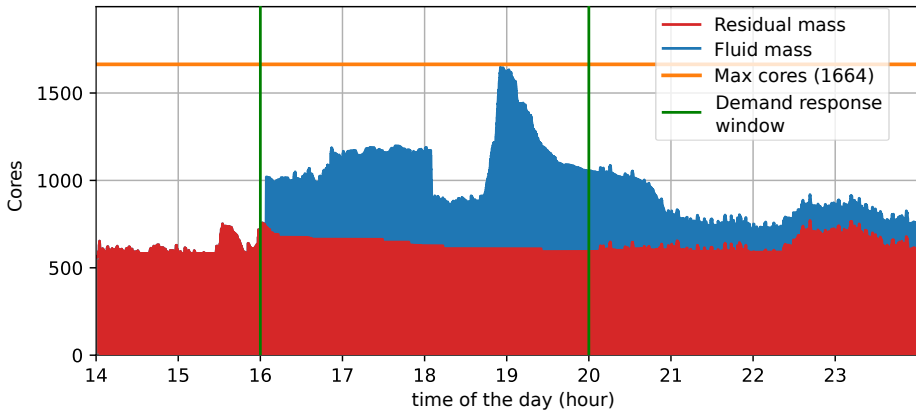

../out/demand_response/DMReconfig_may1_2_3

Data center simulation
Results

Fluid and residual mass

Results

- Pros and cons of each behavior:

behavior	energy in	energy overall	sched. metrics	"acceptability"
renounce	1st	1st	1st*	4th
delay	1st	4th	4th	2nd
degrad	3rd	2nd	2nd	3rd
reconfig	4th	3rd	3rd	1st

- All the details in the article[1]
- Open-source software and reproducible experiments:
  gitlab.irit.fr/sepia-pub/open-science/demand-response-user

[1] M. Madon, G. Da Costa, and J.-M. Pierson, "*Characterization of Different User Behaviors for Demand Response in Data Centers*," in Euro-Par 2022, doi: 10.1007/978-3-031-12597-3_4

Pilot study

Digital Sufficiency in Flexible Work

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

What is "flexible work" for you?
Describe the organisation of your working week

work-life balance

working hours

work locations

____

For each cloud-based daily task
Could you do without?

- If yes, how?
- If no, why?

____

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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