Making IT Green
Awareness-Driven Service Design and Management

Monica VITALI
monica.vitali@polimi.it

October 13, 2022
WHO AM I?

Assistant Professor at Politecnico di Milano in Italy and Visiting Researcher at Umeå University in Sweden

I research new strategies to improve the efficiency of data centers and clouds by applying techniques derived from the Artificial Intelligence and Machine Learning fields.

I am very interested in adaptation and self-adaptation to discover how a complex system can heal itself when some problems occur.
MY TOPICS

GREEN IS

IS MONITORING
Enable monitorability of applications. Discover hidden relations between monitoring data. Build prediction models. Apply techniques to reduce the volume of monitoring data.

DaaS IN FOG
Move computation and/or data nearer to the users to improve Data Utility (QoS and Data Quality). Support the selection of the most suitable data source and manage data and computation movement for SLA satisfaction.

BIG DATA QUALITY

PROCESSES IN IoT
Discover the relation between business process execution and data generated by IoT sensors. Improve the cooperation between business processes.

SERVERLESS IN FOG
Improving energy efficiency and quality of service of serverless applications and FaaS scenarios in heterogeneous fog environments.
Data centers are energy-intensive enterprises, estimated to account for around 1% of worldwide electricity use [and] have clear implications for global energy demand. By 2018, global data center workloads and compute instances had increased more than sixfold [compared to 2010]. The next doubling of global data center compute instances may occur within the next 3 to 4 years.

CLOUD

FOG

EDGE NETWORK

EDGE DEVICES

MANAGED BY:
- Cloud provider
- Telecom operator
- On-premise

Number of elements:
- 10s globally
- 10s per city
- 100s per city
- 1000s per city

MANAGED BY:
- Cloud provider
- Telecom operator
- On-premise
GOAL engage application designers in the path towards IT and IS sustainability
GOAL engage application designers in the path towards IT and IS sustainability

- Increasing sustainability-awareness
- Suggesting best practices
- Providing tools for sustainable-driven (re)design
CLOUD NATIVE APPLICATIONS

1. Flight Search
2. Weather Information
3. Flight Booking
4. Rental Car Booking
5. Payment
CLOUD NATIVE APPLICATIONS

Each component has different requirements

Not time sensitive

Time sensitive

Security sensitive
"All services are equal, but some services are more equal than others"
Alternative implementations of the same functionality can be provided.
Microservices are black boxes for the infrastructure provider. All these features are hidden and don’t adapt with the context of execution.
SADP - Sustainable Application Design Process

1. **SUSTAINABILITY AWARENESS**
   Microservice annotation with computational requirements, QoS constraints, and power consumption metadata

2. **MICROSERVICE CLASSIFICATION**
   Application components are annotated with their relevance for the overall process

3. **MICROSERVICE ENRICHMENT**
   Designers provide different execution modalities for the microservices composing the application
SADP 1 - Sustainability Awareness
SADP 2 - Microservice Classification

Flight Search

Rental Car Booking

Flight Booking Orchestrator

Weather Information

Flight Booking

Payment

VM Type: medium
RT: <10 ms
Throughput: >100
Power: 6 kWh

VM Type: small
RT: <1000 ms
Throughput: >100
Power: 2 kWh

VM Type: small
RT: <1000 ms
Throughput: >100
Power: 2 kWh
SADP 3 - Microservice Enrichment
SADP - Increasing sustainability awareness

Flight Booking Service Dashboard

CO2 emissions per component over time

Energy usage per component over time

SADP Score

Sustainability Awareness 90%
Microservice Classification 70%
Microservice Enrichment 30%

HINTS
1. Provide alternative implementations for microservice “Flight Booking”
2. Provide alternative implementations for microservice “Payment”
3. ...

...
SADP - Sustainable Workflow Design

Exploiting the SADP features at execution time

Different execution modalities:

- **NORMAL** - typical execution
- **BASIC** - skips optional components
- **HIGH PERFORMANCE** - executes the performance enhanced version of a component if available
- **LOW POWER** - executes the low power version of a component if available
SADP - Sustainable Workflow Design

Different execution policies:

- **ALL IN** - same execution modality for all the components
- **OPTIMISED SELECTION** - best combination at the component level
SADP - Sustainable Workflow Design

Enriching the process with Business Rules based on DMN
PRELIMINARY RESULTS

CPU/Memory Utilization 100 Users
- CPU (vCPUs)
- RAM (GB)

- 20% energy
HOW CAN WE CHANGE IT?

SERVICE PROVIDER

Enriches application design with sustainable features

SERVICE PROVIDER

Makes energy mix composition information available to service providers

SERVICE PROVIDER

Empowered sustainability awareness through indicators and certifications

SERVICE CONSUMER

SUSTAINABILITY

Gets insights on application sustainability and sets sustainability targets

INFRASTRUCTURE PROVIDER

QUALITY of SERVICE

Manages application components exploiting the application enriched design
HOW CAN WE CHANGE IT?

SERVICE PROVIDER

- Gets insights on application sustainability and sets sustainability targets
- Enriches application design with sustainable features

INFRASTRUCTURE PROVIDER

- Makes energy mix composition information available to service providers
- Manages application components exploiting the application enriched design

SERVICE CONSUMER

- Empowered sustainability awareness through indicators and certifications

SUSTAINABILITY

QUALITY OF SERVICE
CONCLUSIONS

IS sustainability requires the involvement of all the stakeholders.

A sustainability-aware design enables a **greener application management**

Preliminary results shown feasibility and energy reduction.

The tradeoff between sustainability and QoE/revenue need to be explored.

THANK YOU FOR YOUR ATTENTION
Making IT Green
Awareness-Driven Service Design and Management

Monica VITALI
monica.vitali@polimi.it

October 13, 2022