UNIVERSITATEA TEHNICA DIN CLUJ-NAPOCA

Faculty of Automation and Computer Science

DSRL Distributed Systems Research Laboratory

Data Centers heat reuse in nearby neighborhoods: from air to liquid cooling

Catalyst

CoolDC

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HORIZON 2020

UEFISCDI

PRO INVENT, Cluj-Napoca, ROMANIA,
19 November 2020

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Presentation Outline

- Context and Motivation
- Heat Reuse Scenario
- DC Thermal Model
- DC Flexibility Management and Optimization
- H2020 Catalyst Project
- PD 2019 CoolDC Project

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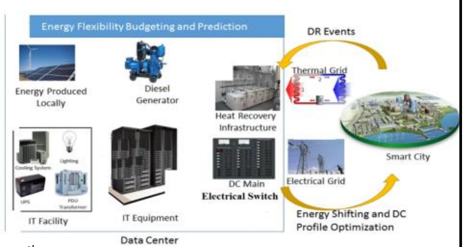
Context and Motivation

- DCs are large producers of waste heat
  - High potential of becoming thermal energy sources
  - Effectively used either internally for Space Heating and/or Domestic or District Heating network operators



- Smart thermal and energy grids integration
  - Achieve cost-effectiveness
  - Participation in demand response programs

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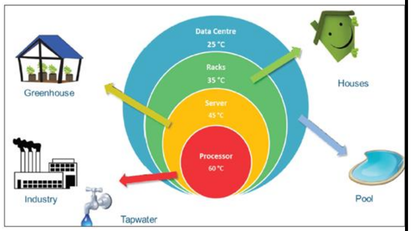
Heat Reuse Scenario

- Optimize DC operations to **deliver heat** to the local heat grid.
- Recover, redistribute and reuse DC residual heat for building space heating (residential and non-residential such hospitals, hotels, greenhouses and pools), service hot water and industrial processes.
- DC participates to the local Heat Marketplace trading heat and as such creating a new revenue source over longer period for the DC.
- In doing so, the DC achieves significant energy & cost savings, reduces its CO2 emissions, contributes to reducing the system-level environmental footprint and supports smart city urbanization.



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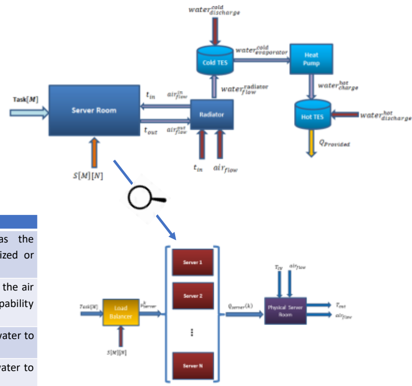
DC Thermal Model

- Develop **a Digital Twin** of the Internal processes of the DC to allow proactive control and planning
- Use a System-of-Systems recursive modeling methodology



Equipment	Energy Flexibility Capabilities
Server Room	Schedule the tasks on servers such as the temperature in the server room is minimized or maximized
Fan and Radiator	Modify the air flow in the server room and the air temperature to maximize the heat reuse capability of the DC
Cold TES	Use the cold-water tank as a buffer of cold water to vary the heat sent to the heat pump
Hot TES	Use the hot water tank as a buffer of hot water to vary the heat sent to neighbourhood

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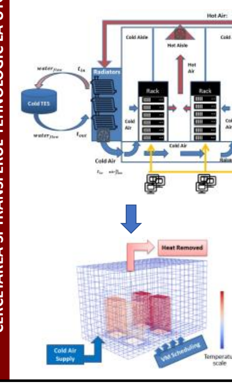
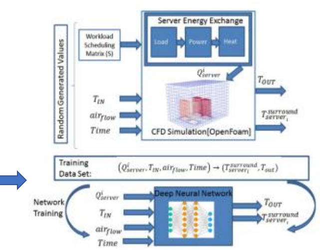
DC Thermal Model



The most complex techniques for estimating the thermal flexibility of the server room is based on Computational Fluid Dynamics (CFD) used to simulate the thermodynamics processes due to workload allocation on servers.



Estimate temperature distribution using Neural Networks trained with data from CFD simulations

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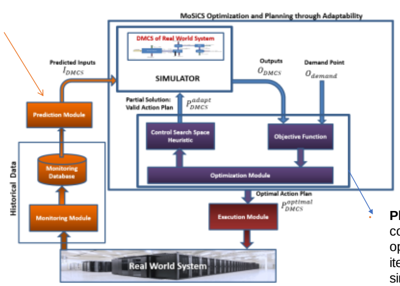
DC Flexibility Management and Optimization

- Self Adaptive Scheduler as an extension of the IBM MAPE-K architecture

Analysis Stage computes predictions of the future system inputs based on historical data



Planning Stage computes an optimal plan by iteratively simulating the DMCS model

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H2020 Catalyst Project

Project Objectives:

- Develop optimized smart energy management for increased DC energy efficiency and mutualized services to energy ecosystem
  - Deliver flexibility services to the energy grids
  - Utilize and trade the wasted DC heat to lower the overall system-level energy distribution footprint, reduce DC energy costs and create a new DC income source over longer times
- Define energy DR prediction mechanisms for interfacing on-site renewable energy sources to cover DC energy requirements and increase the resiliency and security of energy supply

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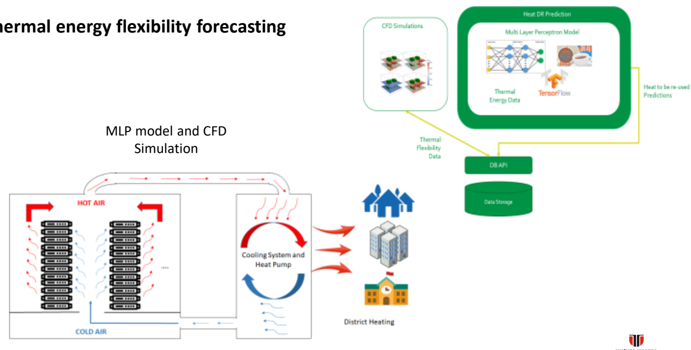
H2020 Catalyst Project

Thermal energy flexibility forecasting

MLP model and CFD Simulation



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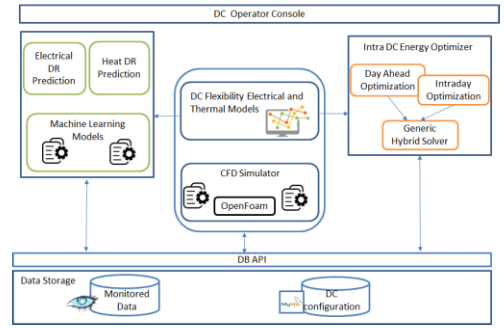
H2020 Catalyst Project

- Overview of optimization process implementation and integration



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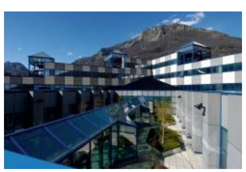
H2020 Catalyst Project

- Test the solution on 4 pilot Datacentres

QARNOT

SBP: Schuberg Philis DC



PSM: Green Pont Saint Martin DC

PSNC: Poznan Supercomputing Centre DC

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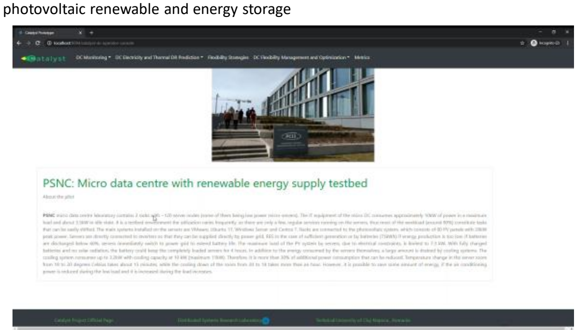
H2020 Catalyst Project

- Evaluate the electrical energy flexibility of a PSNC Pilot DC offered by the usage of photovoltaic renewable and energy storage



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PD 2019 CoolDC Project

- Facilitate the transition to **liquid cooling systems**

- Project Objectives:
  - Study the correlation among workload distribution, temperature setpoints, thermal flexibility of DCs with liquid cooling and DH heat demand aiming to assess the heat re-use potential
  - Development of models for estimating the baseline heat profiles and forecasting the thermal flexibility of DCs featuring liquid cooling
  - Development of novel hybrid optimizer for thermal aware workload scheduling to shift thermal flexibility and maximize the quality of the heat to be re-used

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