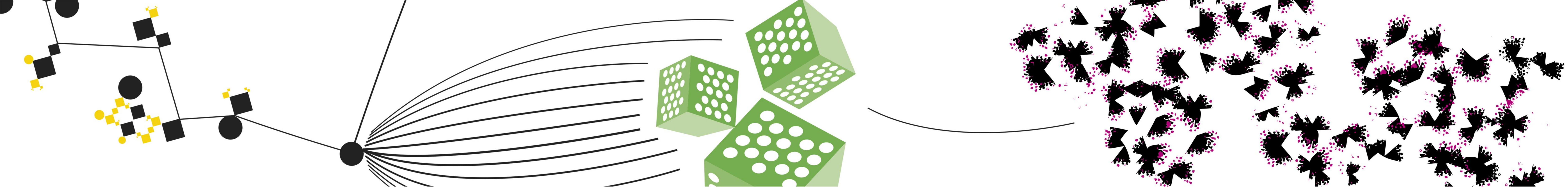

Models for Power and Performance Analysis in Data Centres

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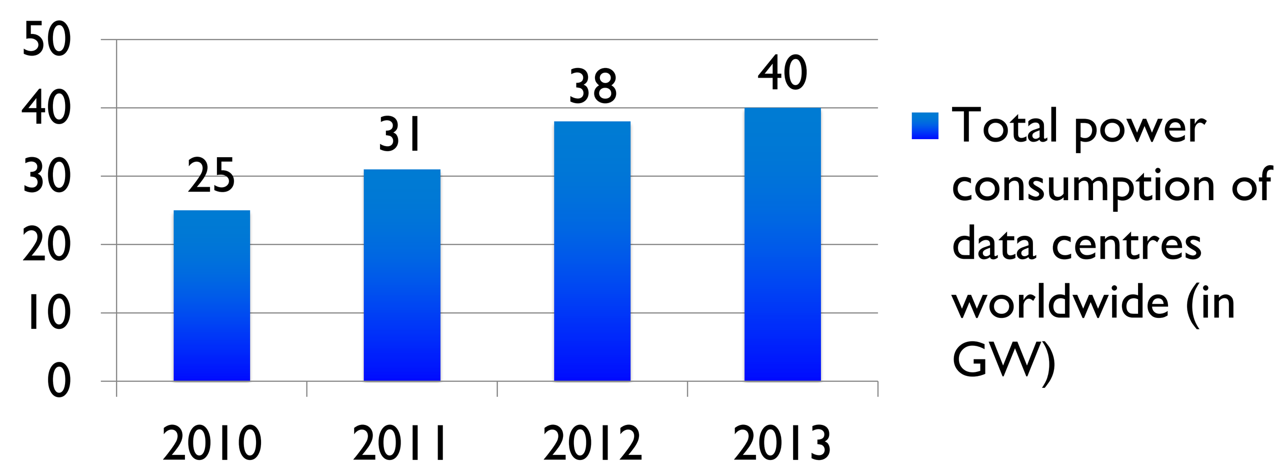
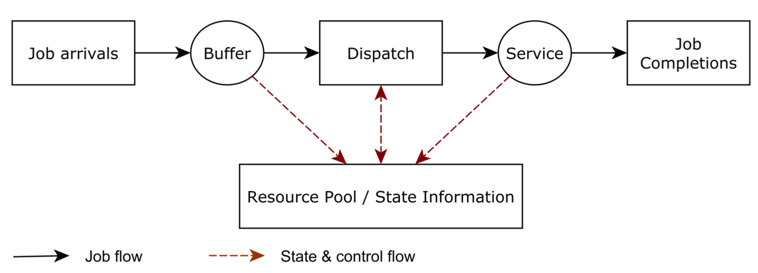
How to obtain better insight in power consumption and performance already in design phase of a data centre?

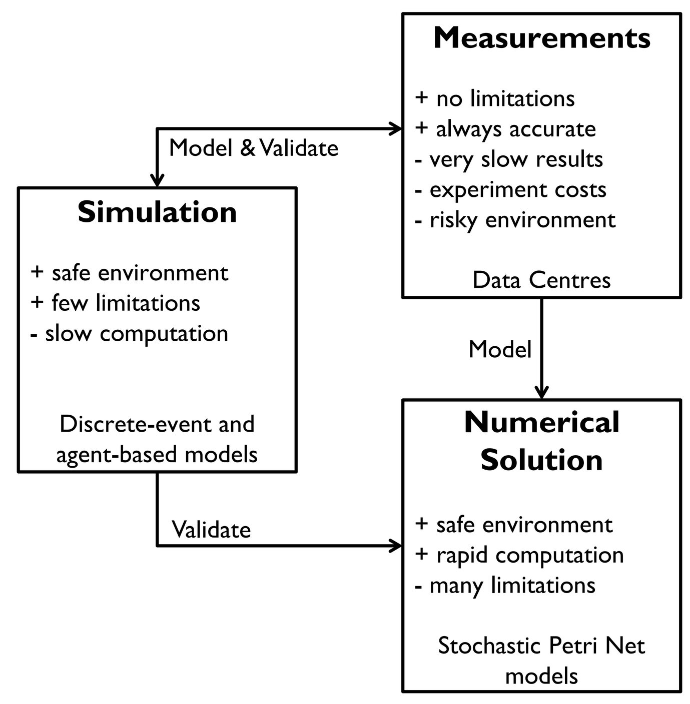
Design high-level models for both **power consumption** and **performance** for give data centre configuration and job streams. Analyse these models to obtain insight in the **power-performance trade-off**, which is caused by **power management**.



Approach

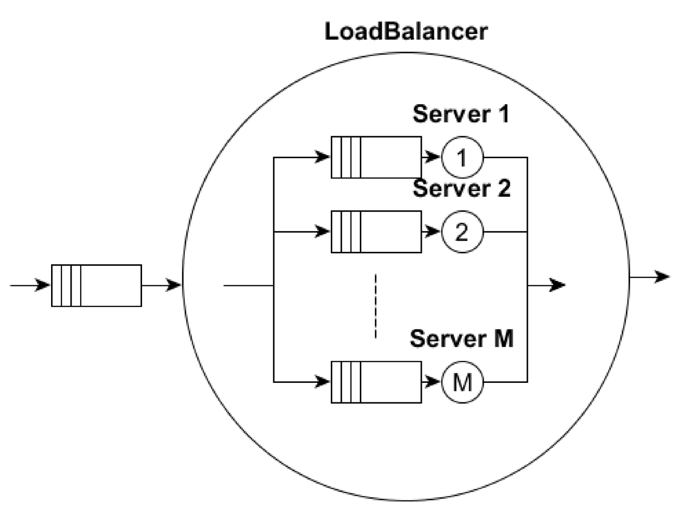
Accurate high-level models for simulation and numerical solution are obtained from "real world" data centres via a modelling and validation cycle. The basic model below distinguishes the most relevant parts to be modelled.





Modelling & validation cycle

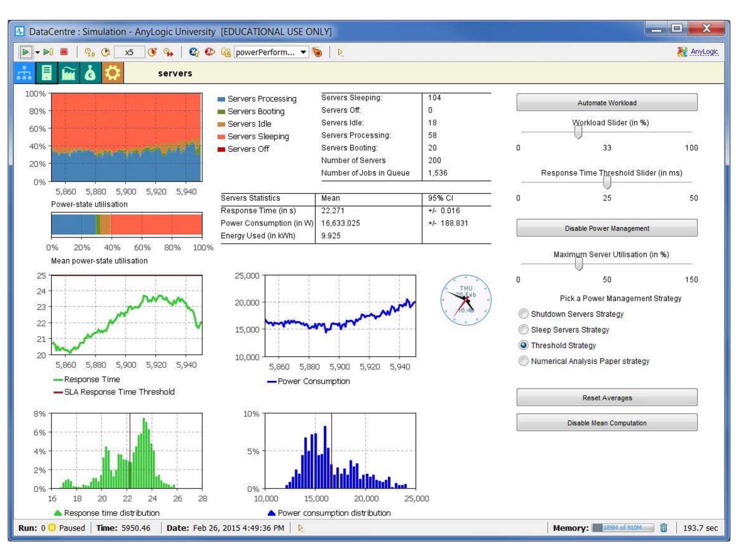
Simulation



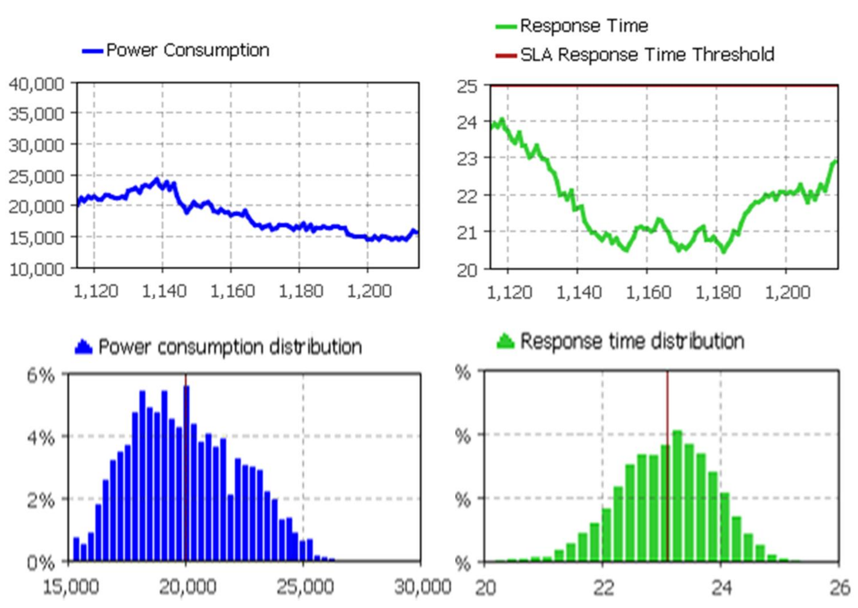
Queueing model

The simulation framework, implemented in AnyLogic, consist of cooperating **discrete-event** and **agent-based** models for data centres, allowing:

- Various configurations
- Different workload
- Heterogeneous servers
- Different power management strategies



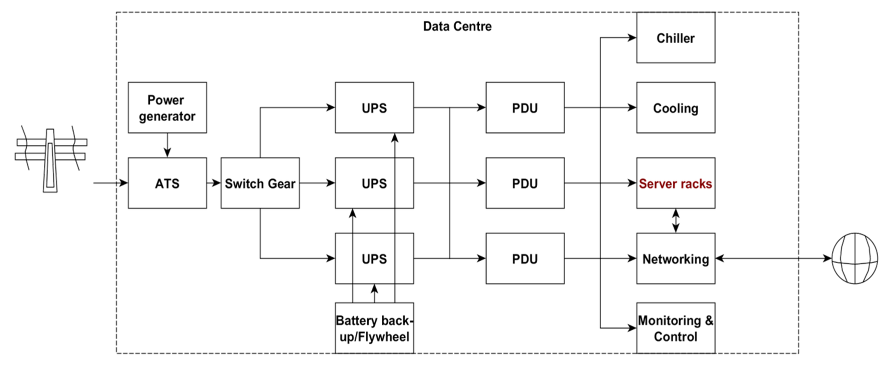
Tool with dashboard



Results

Averages are computed in a few seconds.

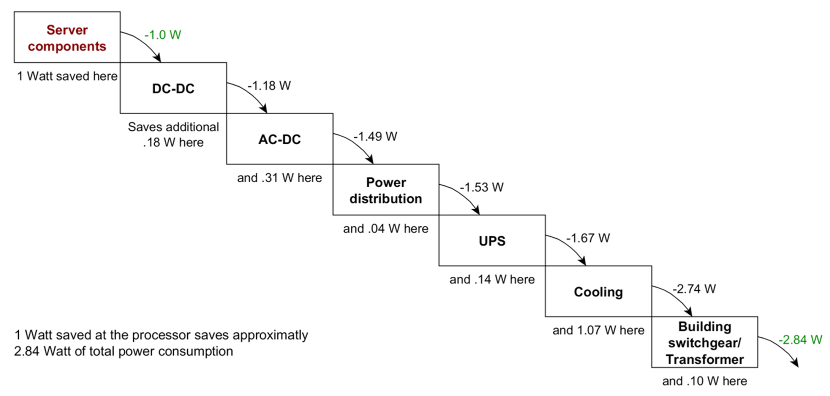
Data Centres



Typical power consuming components

How to reduce energy consumption in a data centre?

- **Power management** aims to switch servers into a lower power state to reduce power consumption, while performance is kept intact.
- **Virtualisation** creates virtual resources from available physical resources.
- **Per server monitoring and control** of temperature, humidity, etc. to increase cooling efficiency.
- and many more …

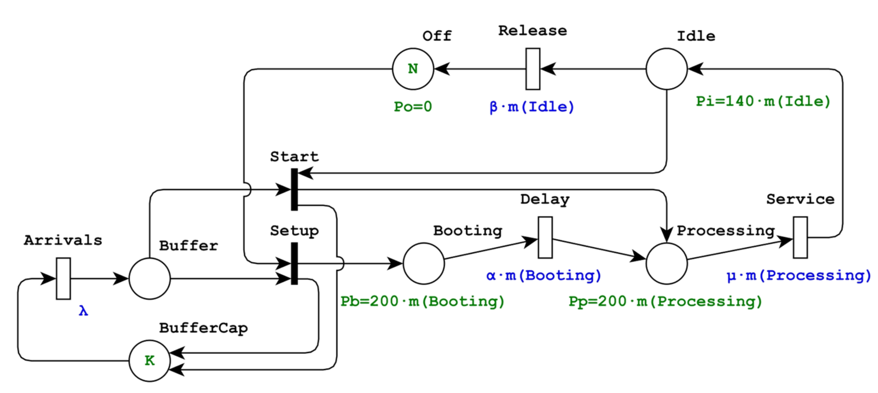


The cascade effect

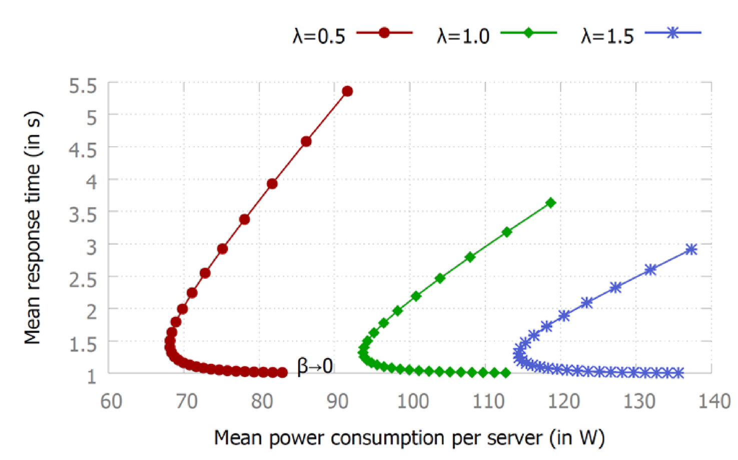
Numerical Solution

This framework, that is implemented in Möbius, consist of **Stochastic Petri Net** models, that generate **Markov chains** to obtain metrics via a numerical solution. The models support data centres with:

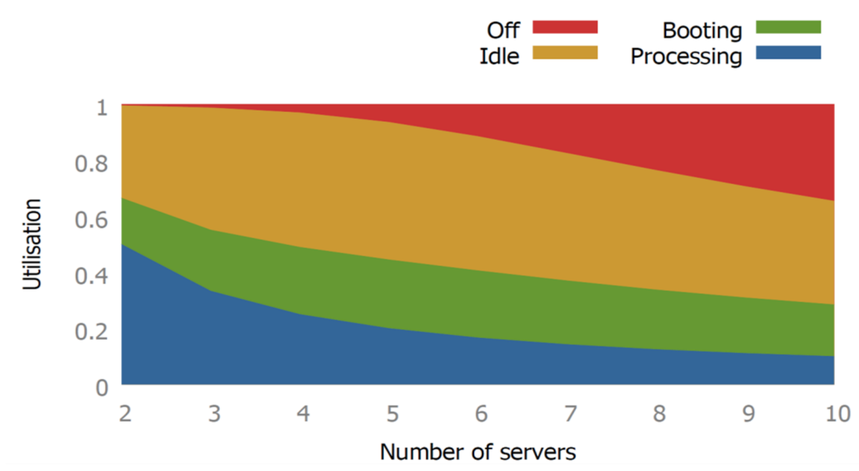
- Various configurations
- Exponential distributed workload
- Homogeneous servers
- One power management strategy



Stochastic Petri Net model



Power-performance trade-off



Cumulative utilisation plot

Averages are computed in less than a second.

Conclusions

- Simulation models and numerical solutions of simple stochastic Petri net models of data centres lead to insight into important power and performance indicators.
- Insight is provided into the power-performance trade-offs caused by different power management strategies.

Literature

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