On the Linearity of Performance and Energy at Virtual Machine Consolidation: the CiS^2 Index for CPU workload in Server Saturation

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Introduction

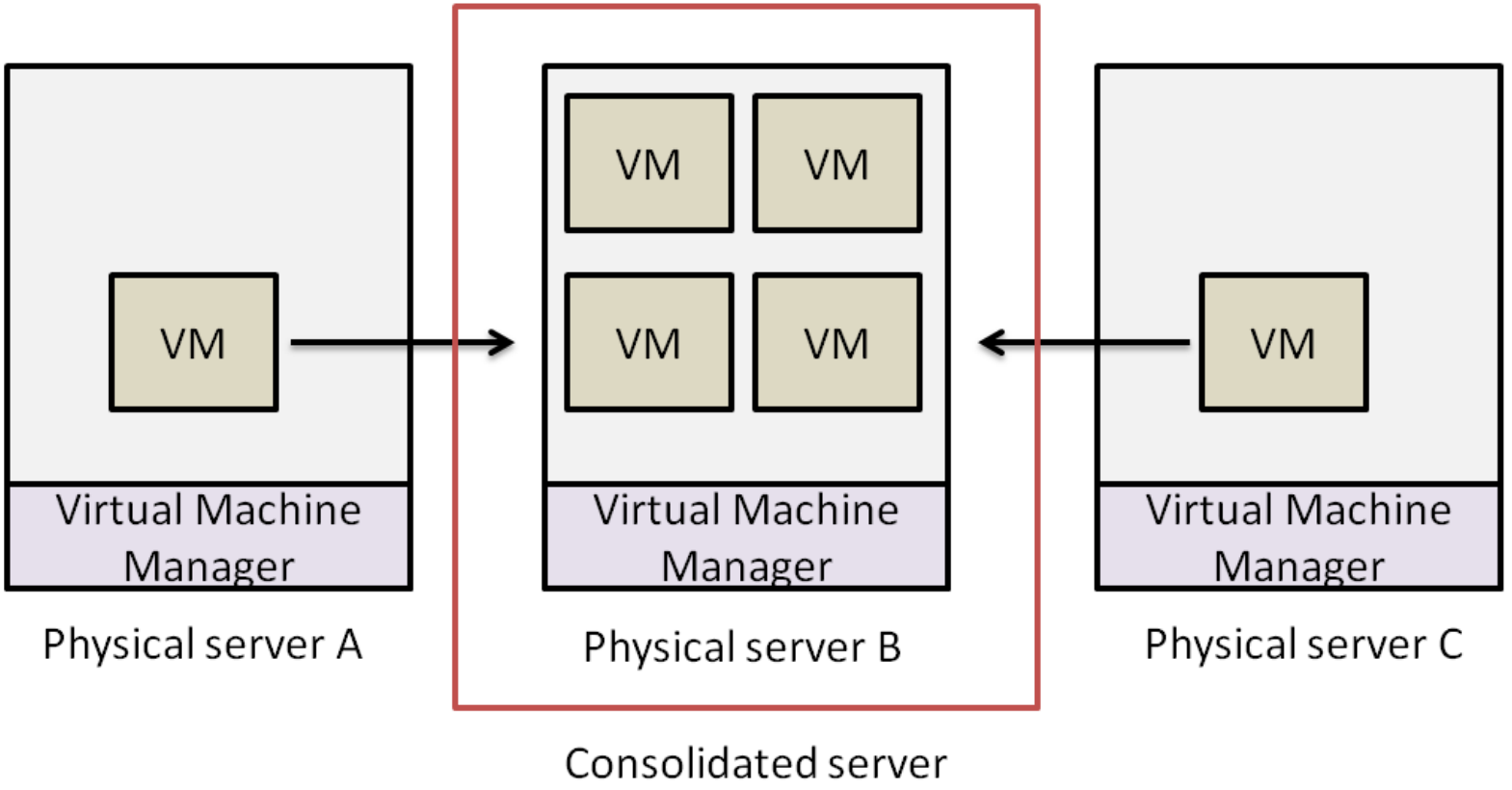
Nowadays

Utilization of cloud services increased → servers' resources utilization and servers' power consumption increased

Current solution

Virtualization is gaining an increasing importance → **Virtual Machine Consolidation**

Introduction



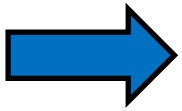
Introduction

Virtual Machine Consolidation:

↓ power consumption

energy?

↑ performance degradation



TRADEOFF

Research question: **How to measure the energy-performance trade-off of Virtual Machine Consolidation?**

State-of-art

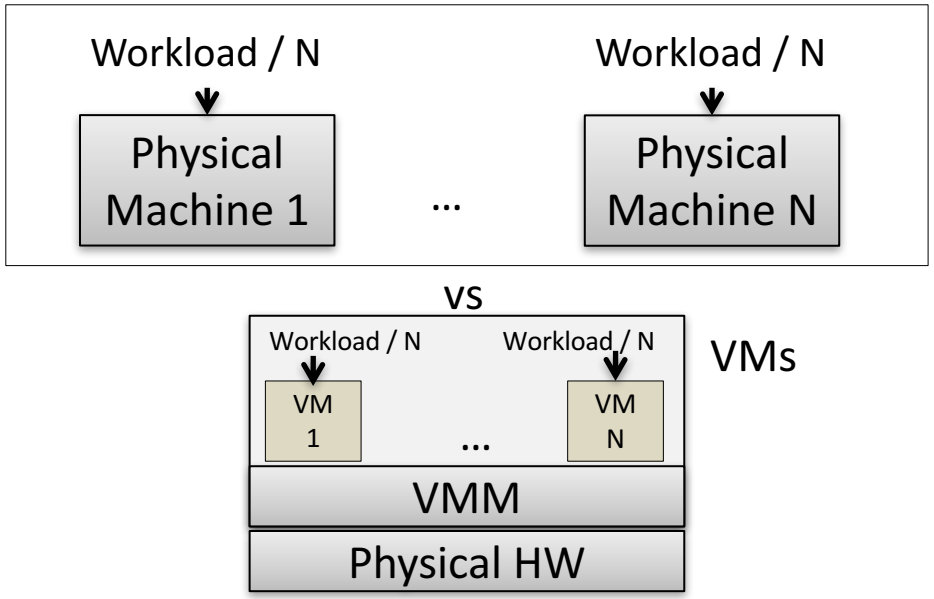
- Research works proposing techniques to reduce the energy consumption and minimize the performance degradation
  - **Too many factors**
- **No works** attempting to quantify the energy-performance trade-off

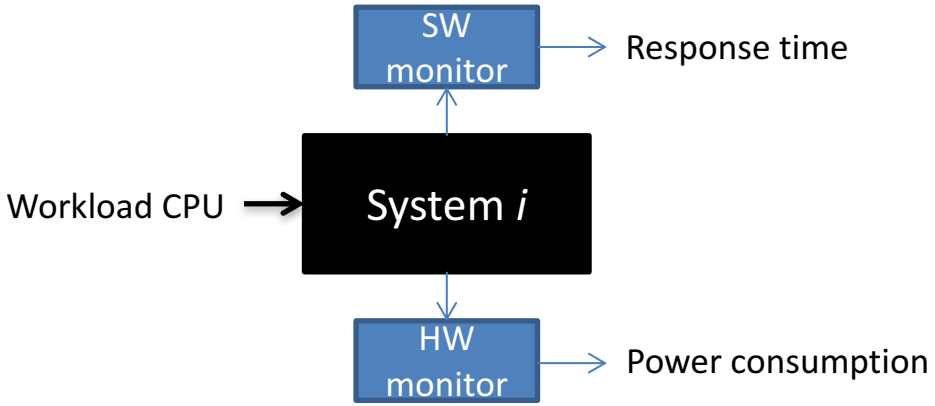
Proposal: the CiS^2 Index for CPU workload in Server Saturation

Aim: to measure the energy-performance trade-off

Experimentation methodology

Benchmarking and Monitoring



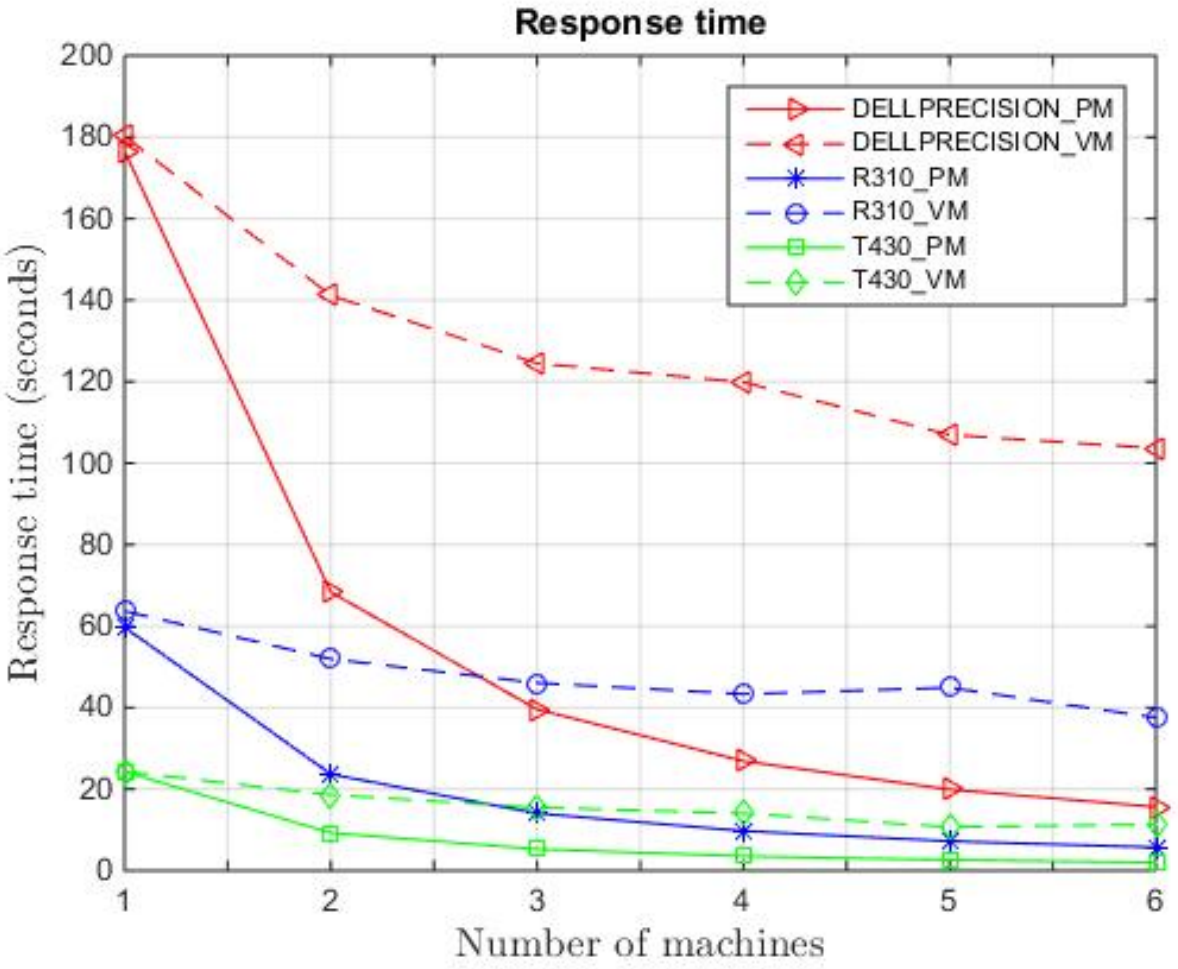


Workload: Sysbench CPU
VMM: Kernel-based virtualization
Three different servers

$$\%U_{CPU} \approx 100\%$$

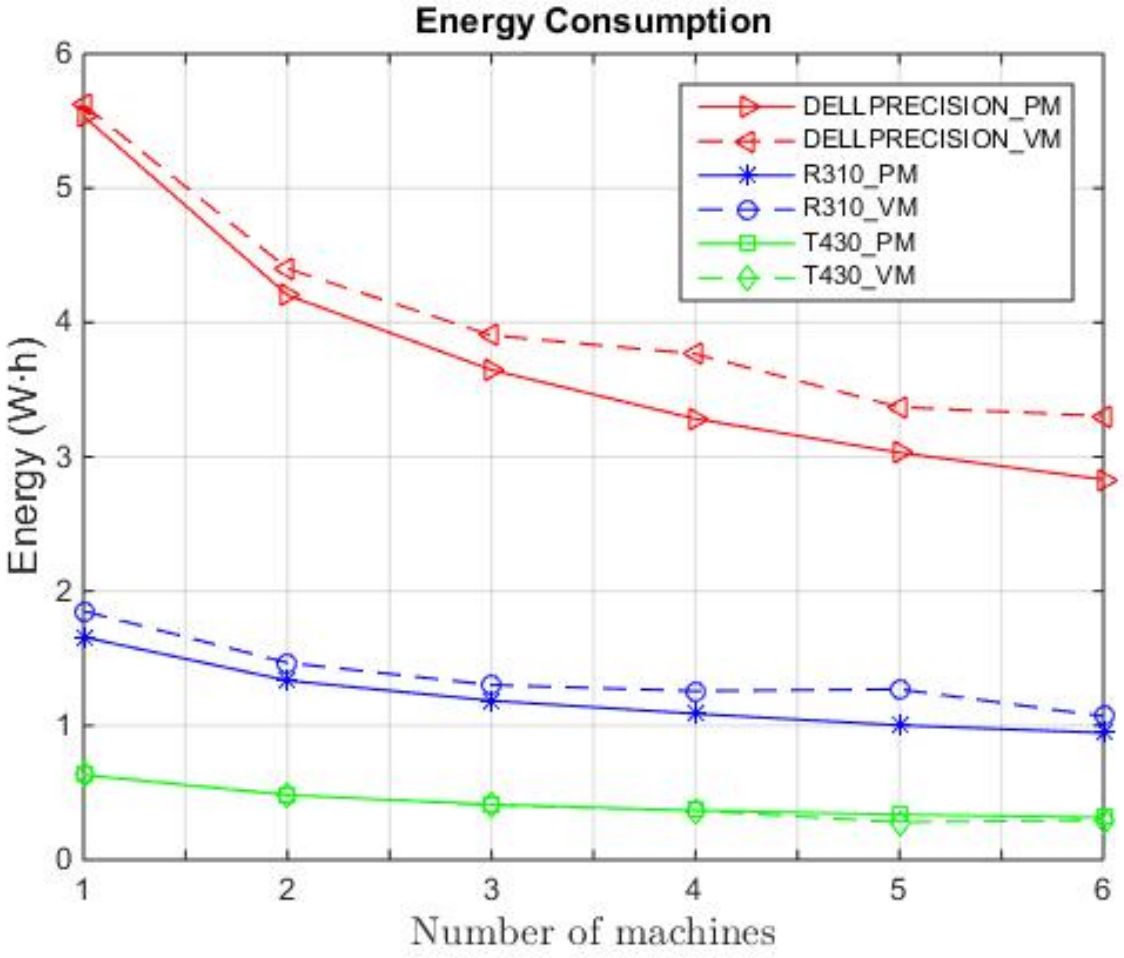
Observed phenomena

Measured metrics



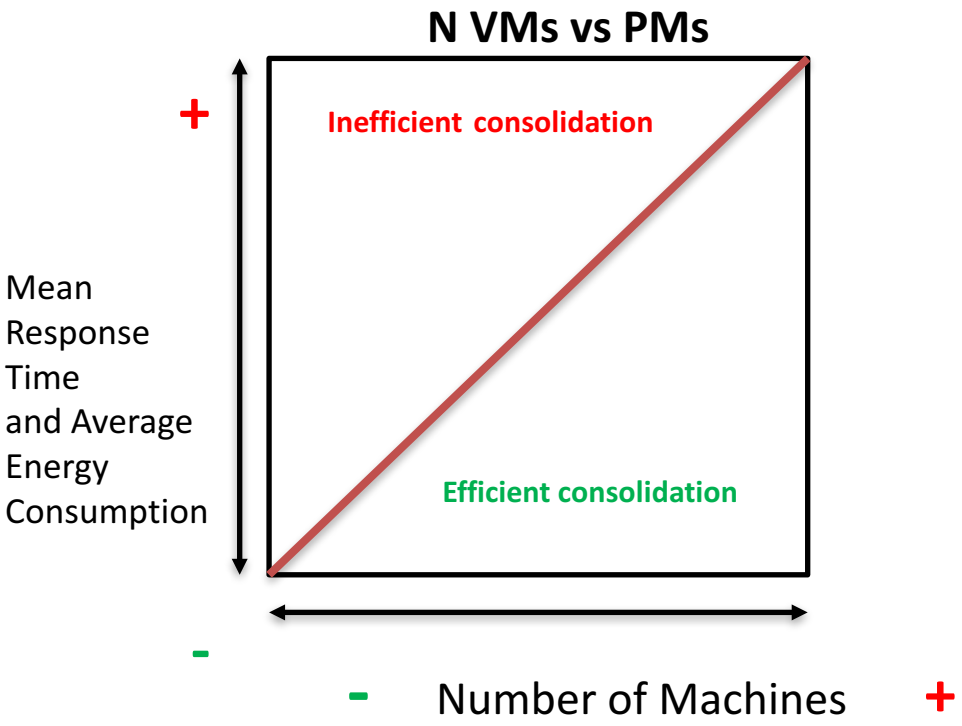
Observed phenomena

Measured metrics



Proposal

CiS^2 Index



The performance degradation of *N* virtual machines in consolidation should be linear → $EF_p = N$

The amount of energy consumed for a number of consolidated virtual machines allocated in the same physical machine should be similar to the corresponding same number of identical physical machines → $EF_{EN} = 1$

$$EF_p = \frac{\overline{R_{VM}}}{\overline{R_{PM}}}$$

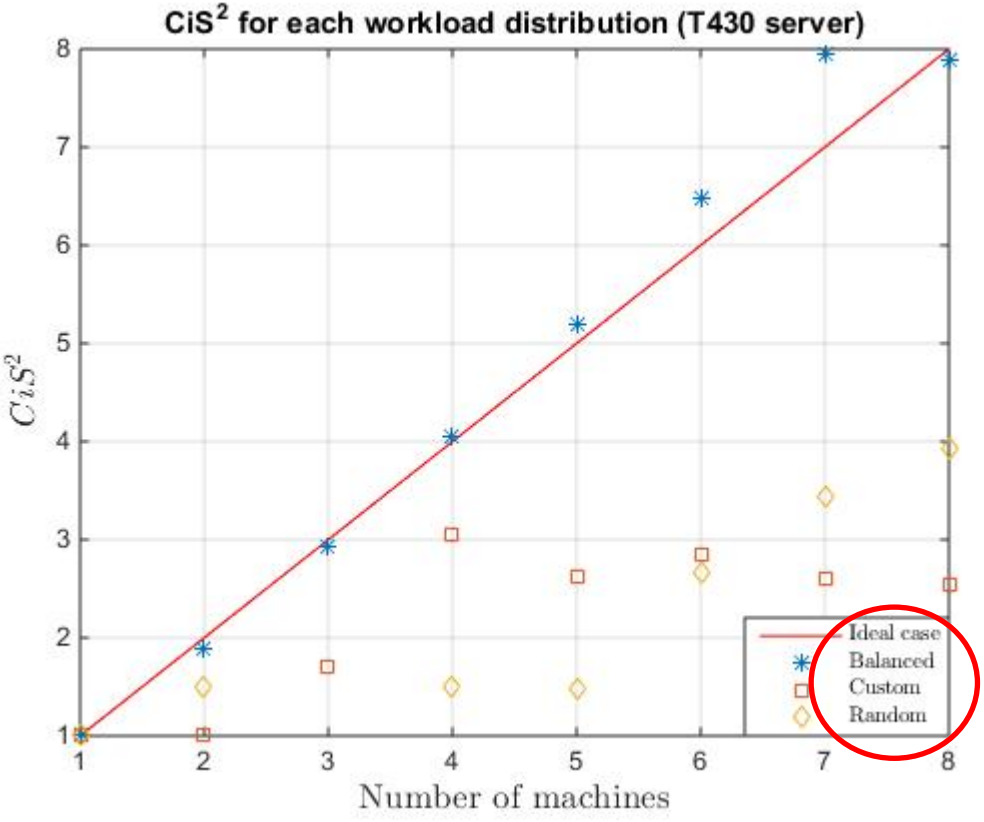
$$EF_{EN} = \frac{\overline{EN_{VM}}}{\overline{EN_{PM}}}$$

$$\mathrm{CiS}^2 = EF_p \cdot EF_{EN}$$

To compare performance and energy efficiency together for an increasing number of virtual machines to be consolidated in a server during CPU saturation

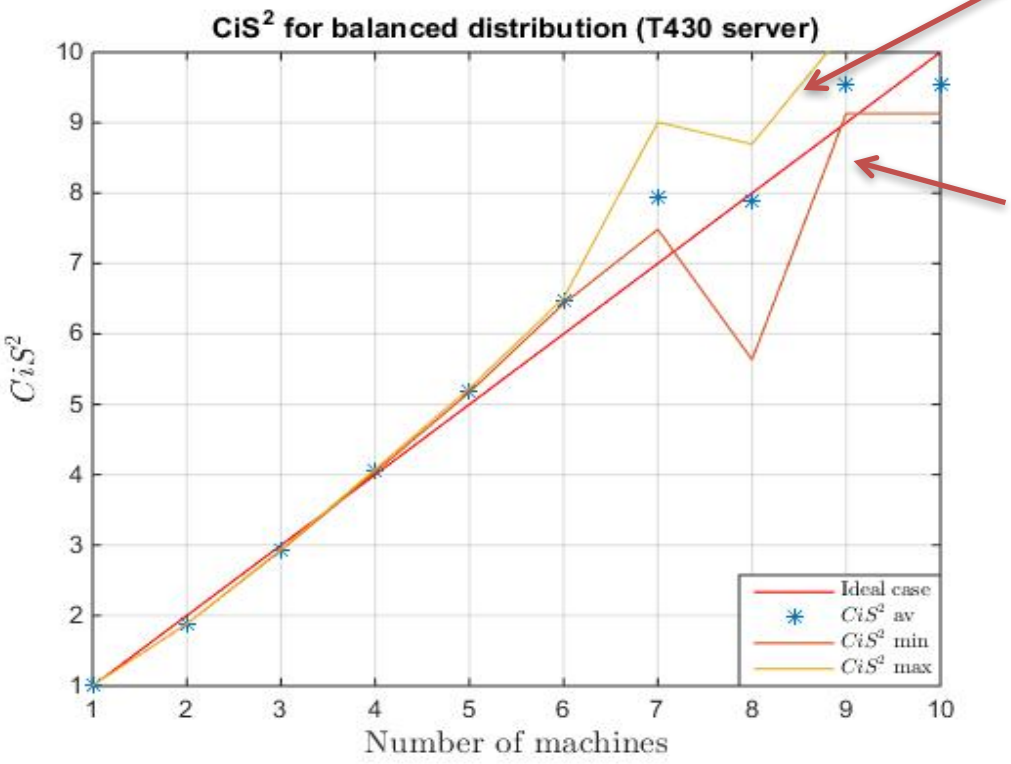
Results and discussion

CiS^2 Index for different workload distribution



Results and discussion

CiS^2 Index for balanced workload

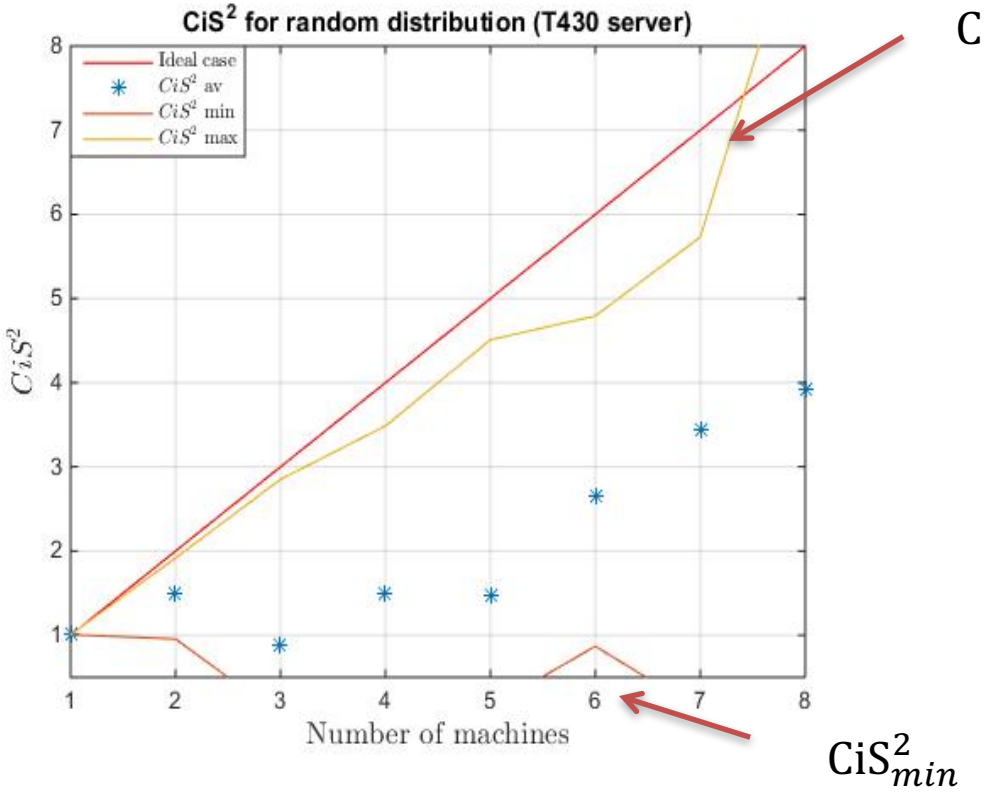


CiS^2_{max}

CiS^2_{min}

Results and discussion

CiS^2 Index for random workload

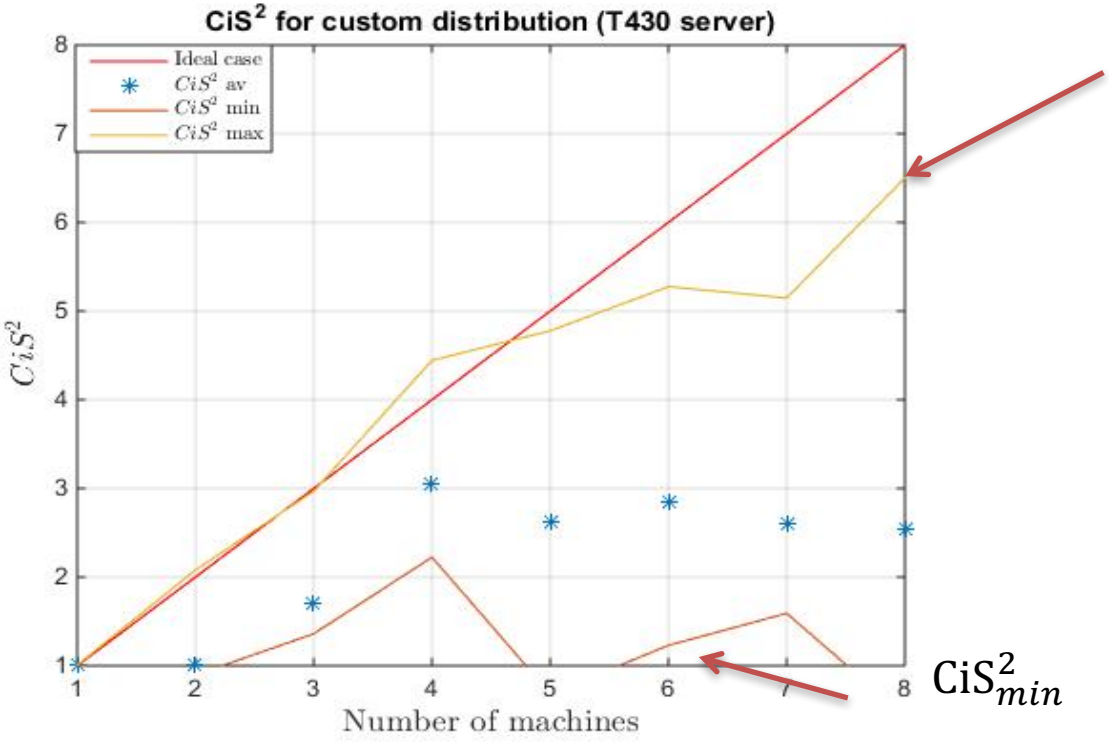


CiS^2_{max}

CiS^2_{min}

Results and discussion

CiS^2 Index for custom workload



CiS^2_{max}

CiS^2_{min}

Conclusions and future lines

- We research the linearity of the performance and energy in Virtual Machine Consolidation: **the CiS^2 Index**
- There are more efficient consolidations than other, in terms of performance and energy
- CiS^2 values show how far a consolidation scenario is from the ideal values
- CiS^2 values depend on the workload distribution, favoring the non-uniformly

In the near future…

- To compare CiS^2 index with SPEC_virt index under the same conditions
- Several saturation devices
- To study the factors that provoke a lower efficiency: virtualization overhead

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