

# Energy Efficient Cloud

by VM Migration?

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Let's first look back...

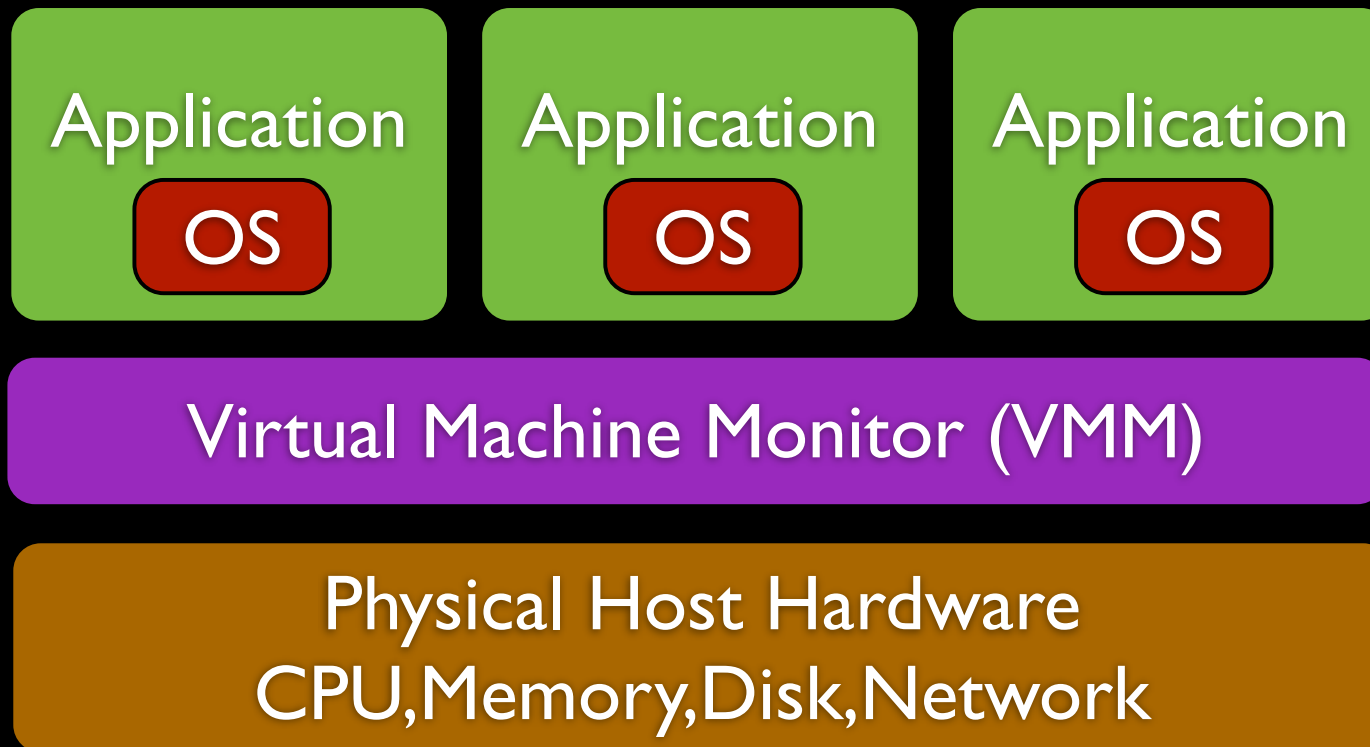
**What makes cloud so  
different?**

**Virtualization**

# Virtualization

*Add a layer between the applications and the hardware.*

# Virtualization



# Virtualization

Lots of benefits...



**Load balancing**

**Consolidation**

# Virtualization

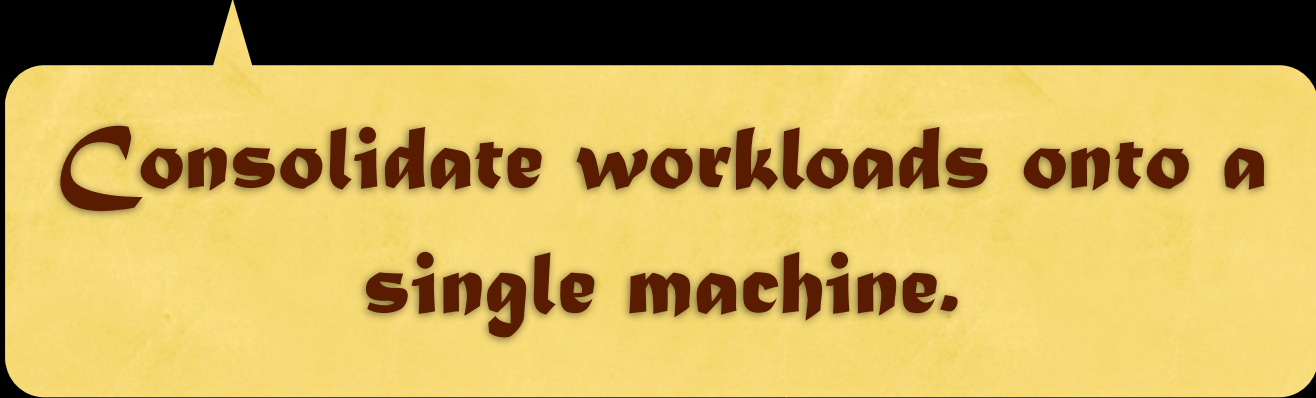
Lots of benefits...



**Load balancing**

**Consolidation**

# Consolidation



**Consolidate workloads onto a  
single machine.**

Switch off those idle machines

Jian made a simple metaphor yesterday...

(There should be applause right here...)

**How does  
consolidation work?**

**Migrations**



# Migrations

*Migrate the whole OS with  
running applications*

**Memory migrations**

# Migrations

*Migrate the whole OS with  
running applications*

## Memory migrations

# Memory migrations

Stop & Copy

Push

Pull



Difficult

# Memory migrations

✓ Stop & Copy

✓ Push

Pull



Difficult

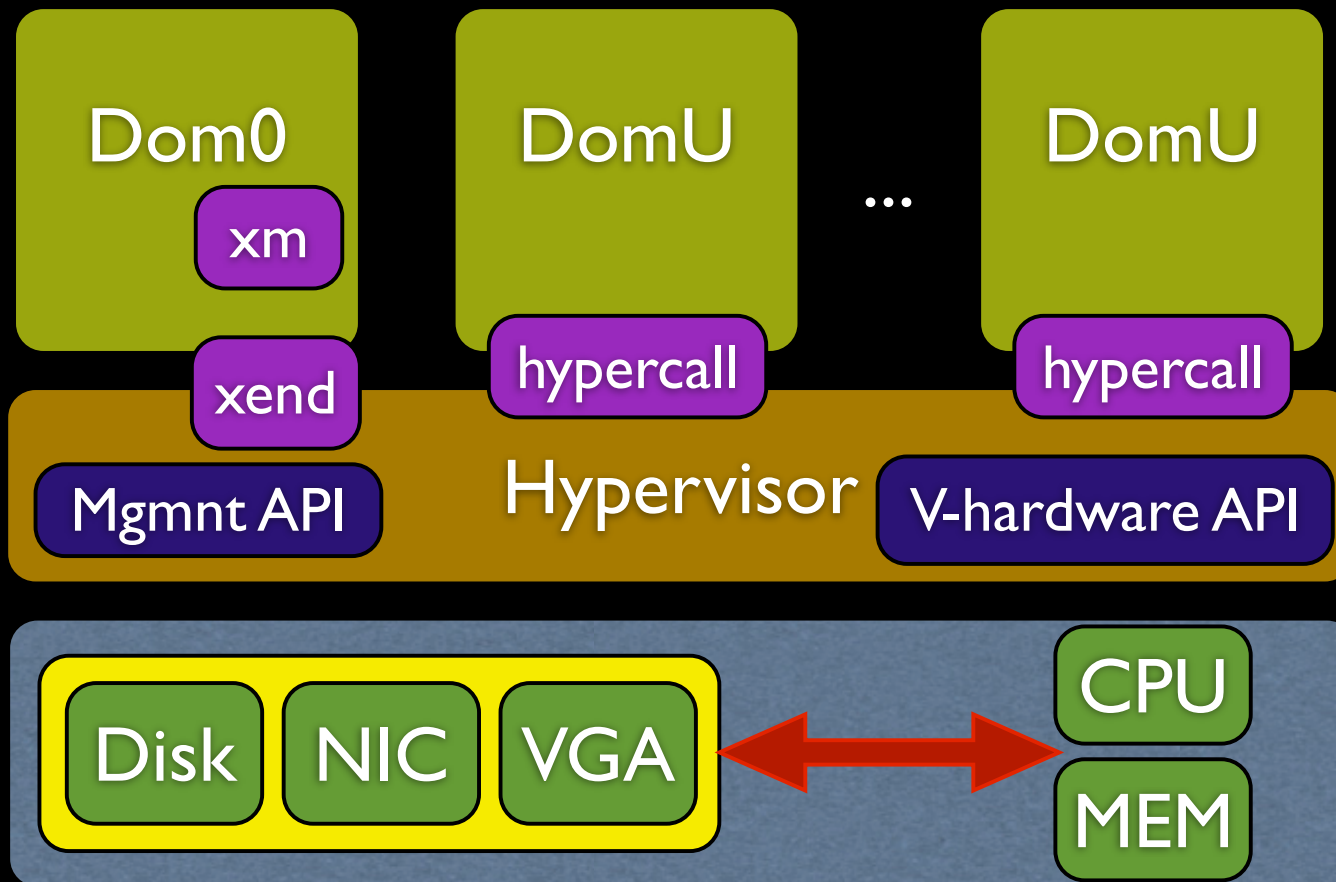
Let's then look back...

**How virtualization is  
implemented on Xen?**

Let's then look back...

**How virtualization is  
implemented on Xen?**

# Xen



# **How migrations are enabled on Xen?**

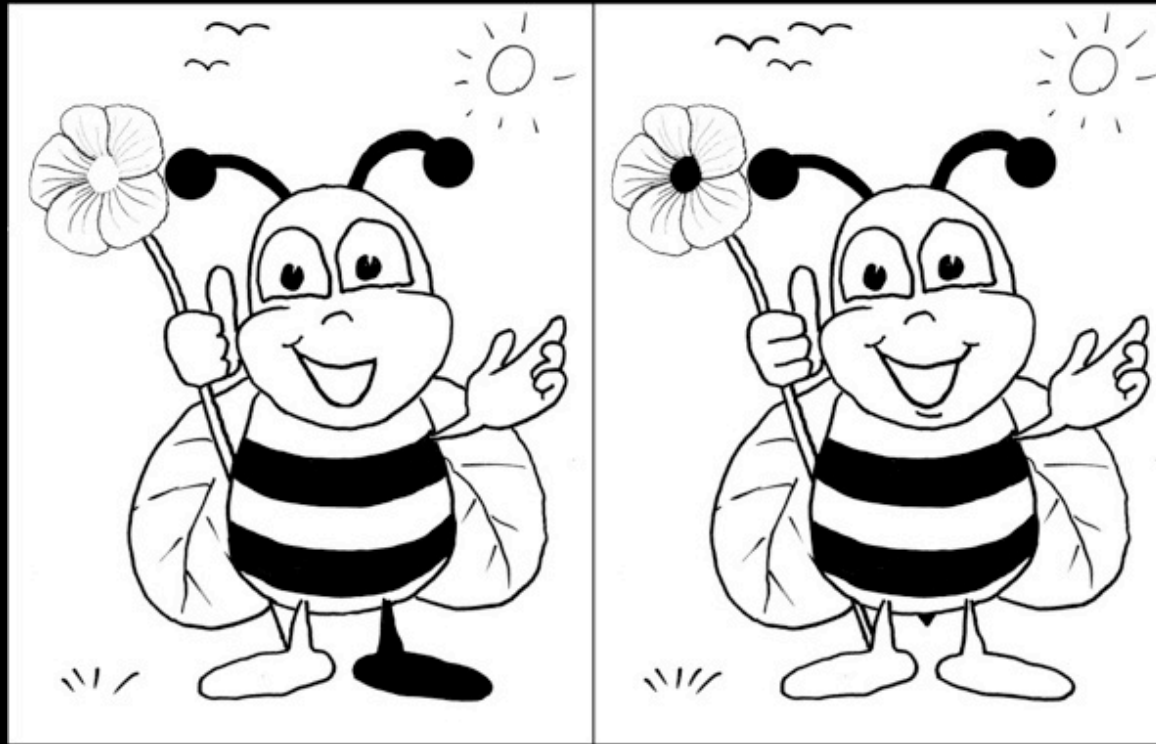
**Cold Relocation v.s.  
Warm v.s. Live**



# **How migrations are enabled on Xen?**

**Cold Relocation v.s.  
Warm v.s. Live**

## Warm v.s. Live



Similarities & Differences

# Some measurement work

Laurent Lefèvre, Anne-Cécile Orgerie

*Designing and evaluating an energy efficient Cloud*

The Journal of Supercomputing (2010) Volume: 51, Issue: 3, Pages: 352-373

# Experiment Settings...

2 HP Proliant 85 G2 Servers  
(2 dual core CPUs per node)

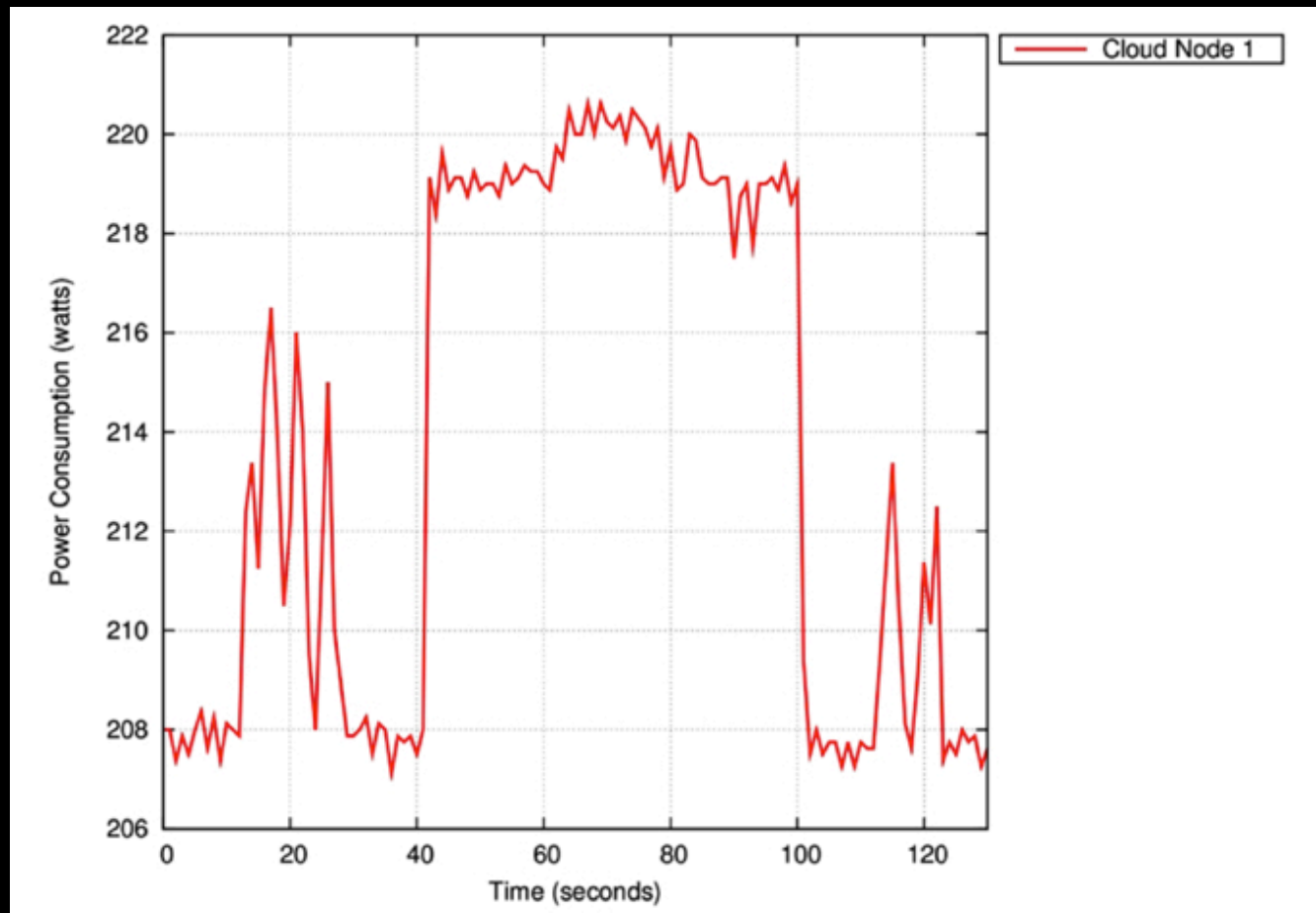
XenServer 5.0

CPU 100% job (last 300 seconds)

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Boot, Run & Halt  $t=[10, 30]$  VM is launched

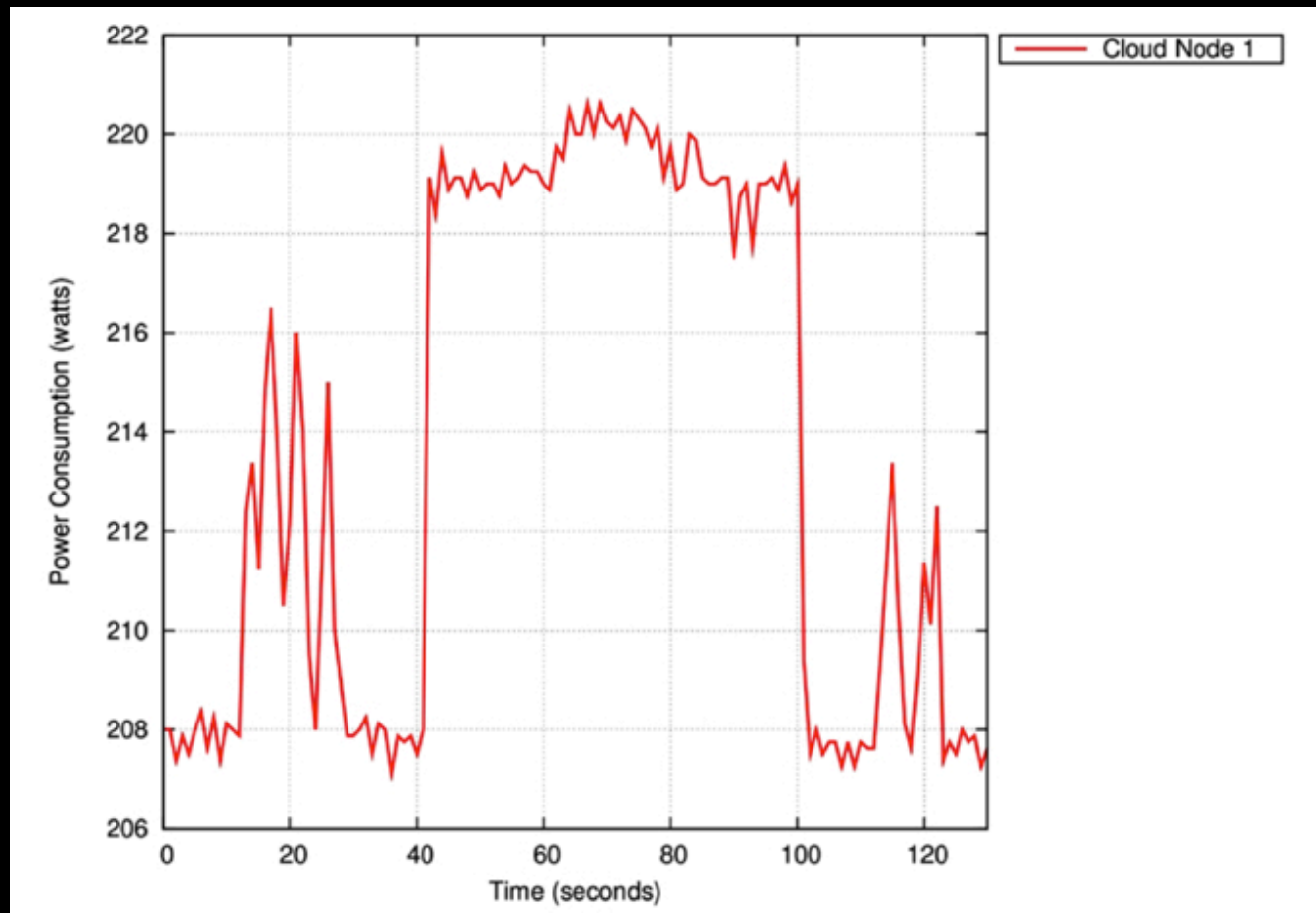
$t=[40, 100]$ , CPU 100%

$t=[110, 120]$ , VM is destroyed

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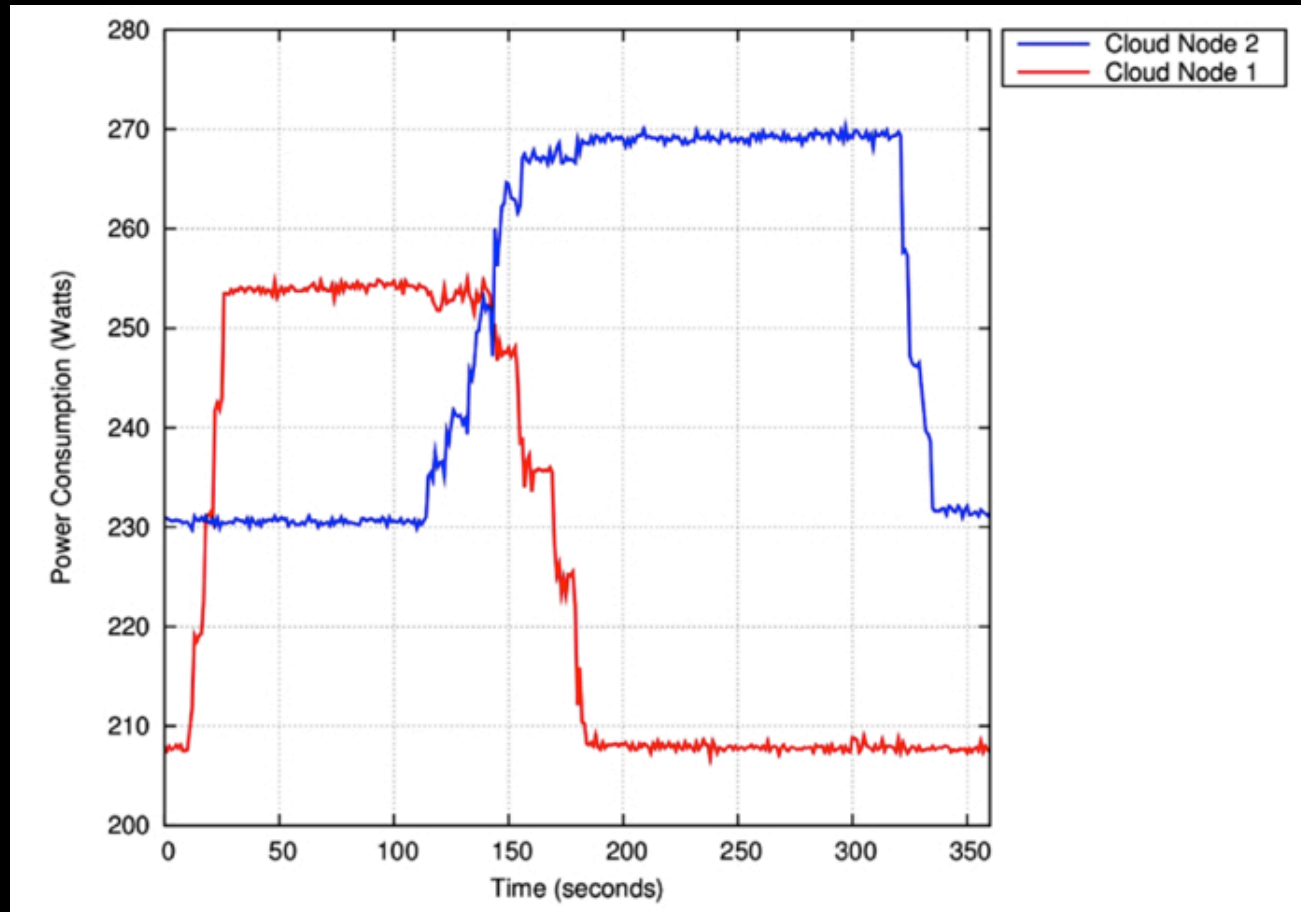
Boot, Run & Halt

# Idle VM does not consume energy

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6 VM's Migrations

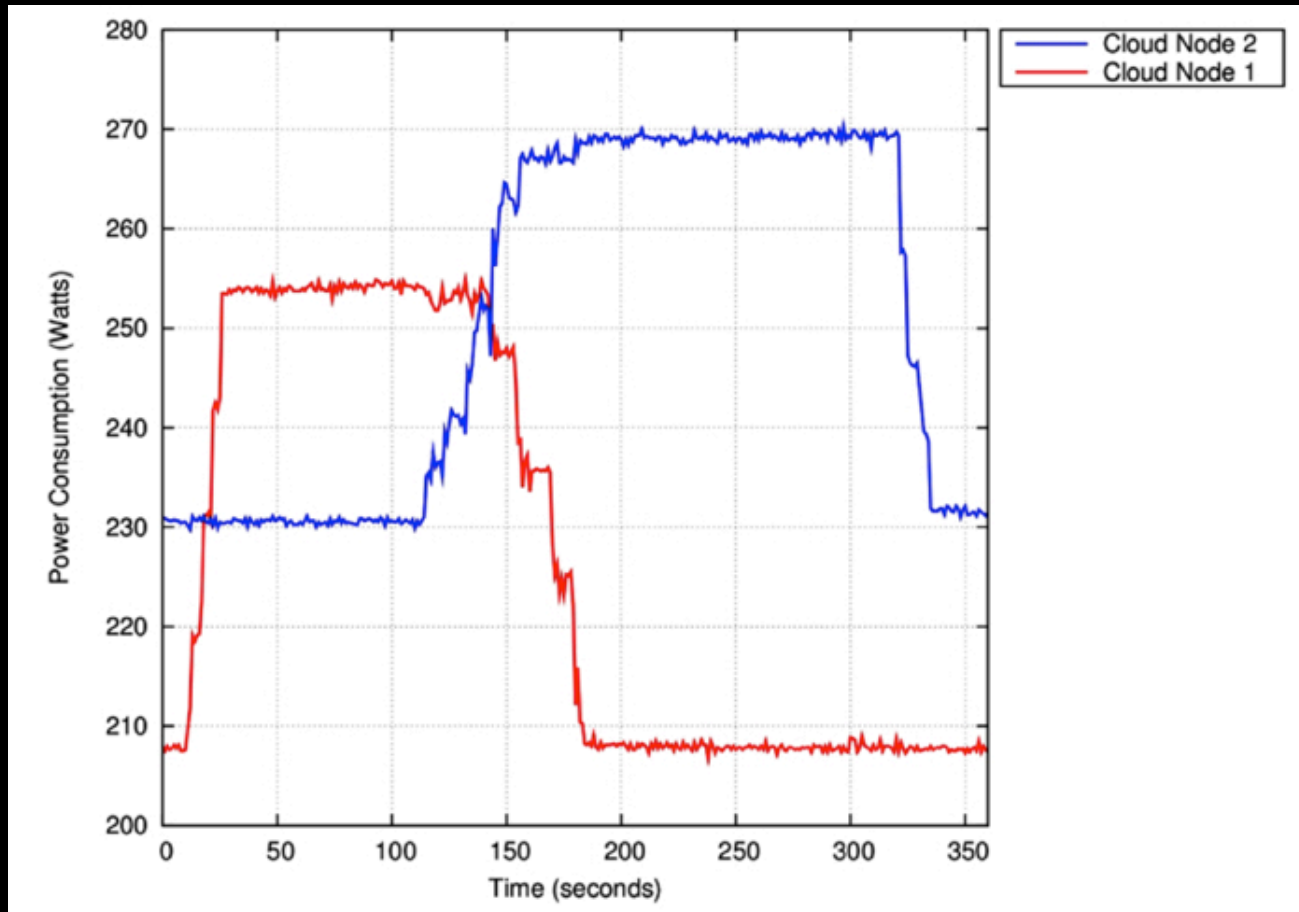
Starting from  $t=10$ , a VM is launched every 10 seconds

Migrations happen at  $t = 110$  seconds

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6 VM's Migrations

# Migrations happen one by one

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**When to switch off  
idle machines?**

$T_s$

$T_s \rightarrow$

$$T_s \times P_{idle} = E_{on \rightarrow off} + E_{off \rightarrow on} \\ + P_{off} \times (T_s - \delta_{on \rightarrow off} - \delta_{off \rightarrow on})$$

$T_s$ 

$$T_s \times P_{idle} = E_{on \rightarrow off} + E_{off \rightarrow on} \\ + P_{off} \times (T_s - \delta_{on \rightarrow off} - \delta_{off \rightarrow on})$$

$$\frac{E_{on \rightarrow off} + E_{off \rightarrow on} - P_{off} \times (\delta_{on \rightarrow off} + \delta_{off \rightarrow on})}{P_{idle} - P_{off}}$$

## Estimations

$$T_t = \frac{\sum_{i=1}^n T_{t-i}}{n} + \overline{error}$$

**Q & A?**