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# An Analysis of First Fit Heuristics for the VM Relocation Problem

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# Overview / Outline

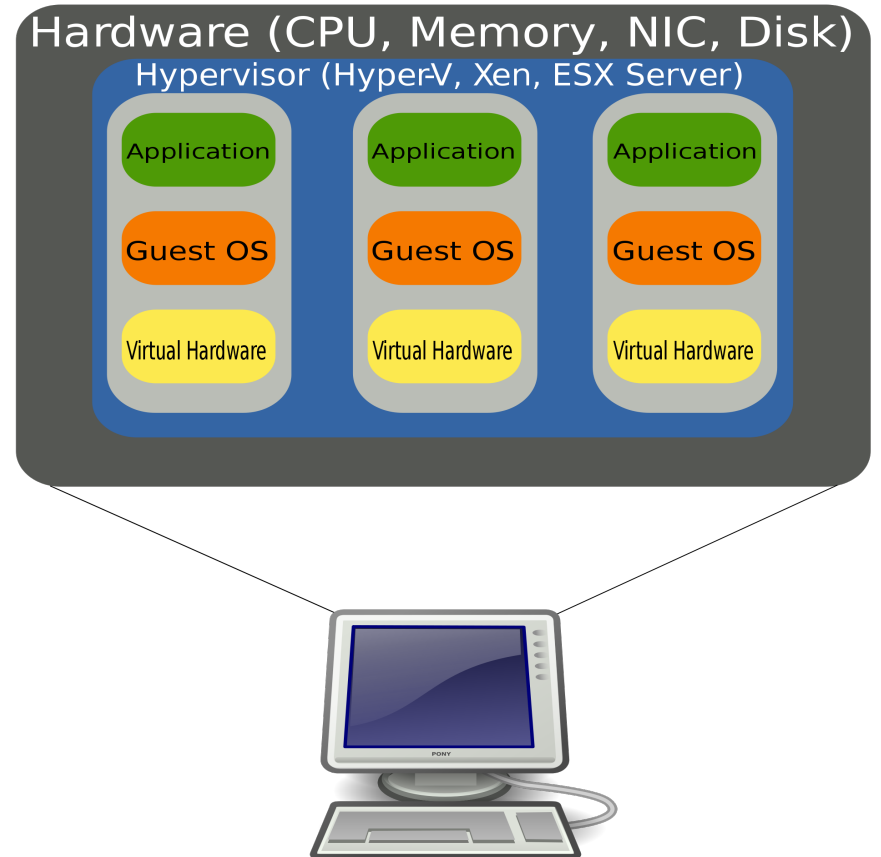
- Background
- Problem + Question
- Proposed Solution
- Experiments
- Conclusions

# Background



Src: <http://www.google.com/about/datacenters>

# Background



# Background

VM Resource Allocation.

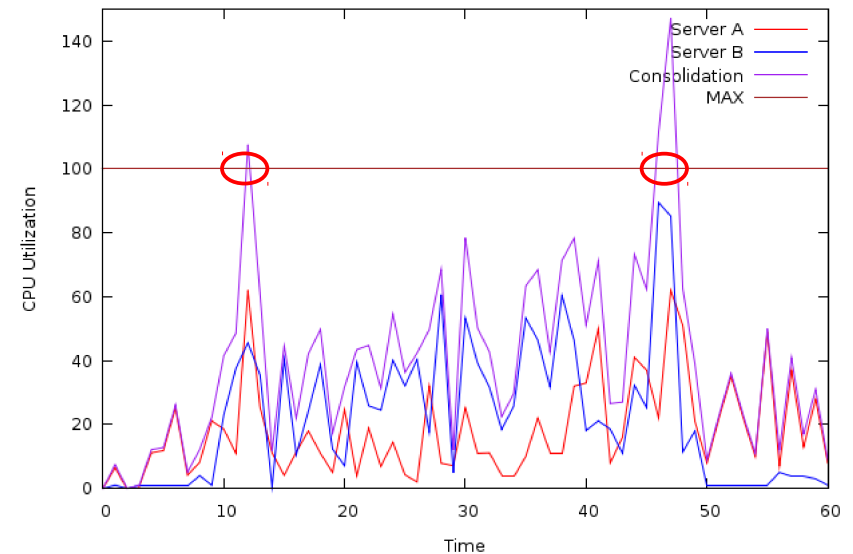
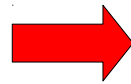
- Fixed, non-shared
- Oversubscription

# Background

## VM Resource Allocation.

- Fixed, non-shared
- Oversubscription

*Stress situation*



# Background

Dealing with Stress Situations.

- Do nothing
- Reallocate resources locally
- Migrate VMs away (to free resources)



# Background

Dealing with Stress Situations.

- Do nothing
- Reallocate resources locally
- *Migrate VMs away* (to free resources)



*Which VMs?*  
*Where?*

# Problem

VM Relocation Problem.

*Given a set of stressed, non-stressed and suspended hosts, find a set of VM migrations that will eliminate the stress situations.*

# Problem

VM Relocation Problem.

*Given a set of stressed, non-stressed and suspended hosts, find a set of VM migrations that will eliminate the stress situations.*



*Let's apply Bin Packing heuristics (e.g., First Fit Decreasing).*

# Problem

VM Relocation  $\neq$  Bin Packing.

- 1) Hosts (bins) are already loaded (packed).
- 2) Minimization of hosts (bin) used may not be the only goal to pursue.

# Question

If different VM Relocation heuristics consider VMs and host for migration based on different criteria...

*... do they produce better assignments (and achieve better long-term outcomes) when considering their particular goals?*

# Solution

Assumptions & Limitations.

- Homogeneous hosts
- Hosts' load level based only on CPU
- Independent VMs

# Solution

Basic VM Relocation Solution.

For each stressed hosts:  
*select VM for migration*  
*select target host*  
issue migration

# Solution

VM Selection.

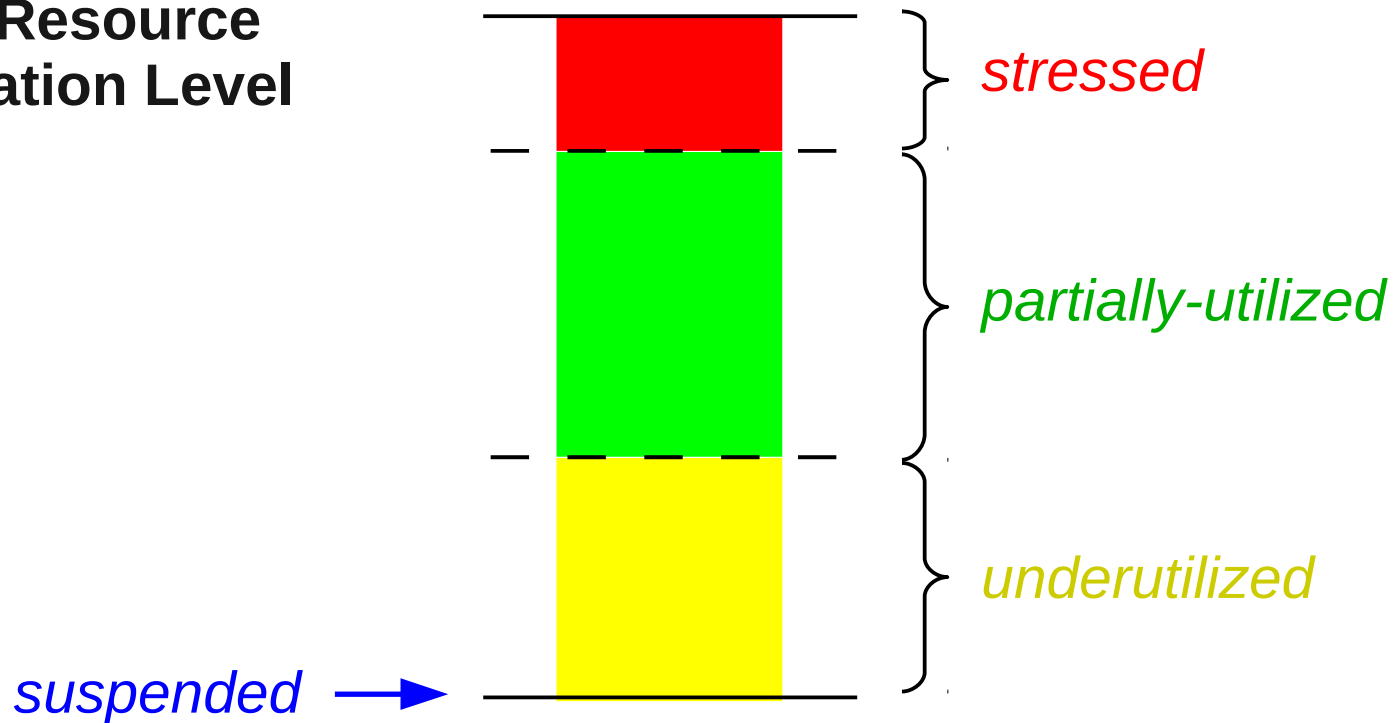
- A) Sort VMs in decreasing order by CPU load
- B) Sort VMs in increasing order by CPU load



# Solution

Target Host Selection.

Host Resource  
Utilization Level



# Solution

Target Host Selection.

- 1) *Increasing*      ↑    ↑    —
- 2) *Decreasing*    ↓    ↓    —
- 3) *Mixed*            ↑    ↓    —

# Solution

VM Relocation policies.

<b>Policies</b>	<b>VM sorting</b>	<b>Target sorting</b>
FFDI	A	1
FFDD	A	2
FFDM	A	3
FFII	B	1
FFID	B	2
FFIM	B	3

# Experiments

Design.

- Data centre simulation tool: DCSim
- 10 simulation days, 5 repetitions
- Hosts' HW: 4 CPU cores, 8 GB RAM
- Load Thresholds: 85% , 50%

# Experiments

Design.

- # VMs: 300, 400, 452, 500
- VMs HW: *variable CPU demand*  
(1 CPU core max), 1 GB RAM
- VMs' workload: dynamic, trace-driven  
(ClarkNet, EPA, Google Cluster Data trace)

# Experiments

Metrics.

- Average Active Hosts
- Host Utilization
- (Data Centre) Power Consumption
- Dropped Requests
- # Migrations

# Experiments

## Results Summary.

- **FFDI**
  - used the most hosts
  - lowest host utilization
  - highest power consumption
  - + lowest dropped requests
  - + lowest # migrations
- **FFID** behaved opposite to **FFDI**.

# Experiments

## Results Summary.

- **FFII**, **FFIM** and **FFDD** achieved average results (between **FFDI** and **FFID**).
- **FFDM** followed one step behind, but did so issuing less migrations.



# Conclusions

## Part I. Observations.

- No one policy scored best in every metric.
- Policies succeeded to different extents depending on the scenario and the metrics observed.

# Conclusions

## Part II. Interpretation.

- One single policy won't satisfy all goals.
- Tweaking VM and host sorting strategies can result in better trade-offs.
- Dynamically switching policies *may offer* better overall results.



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