Cost-aware Virtual Machines Placement Problem under constraints over a Distributed Cloud Infrastructure

Eya DHIB, Khaled BOUSSETTAy, Nawel ZANGAR and Nabil TABBANE

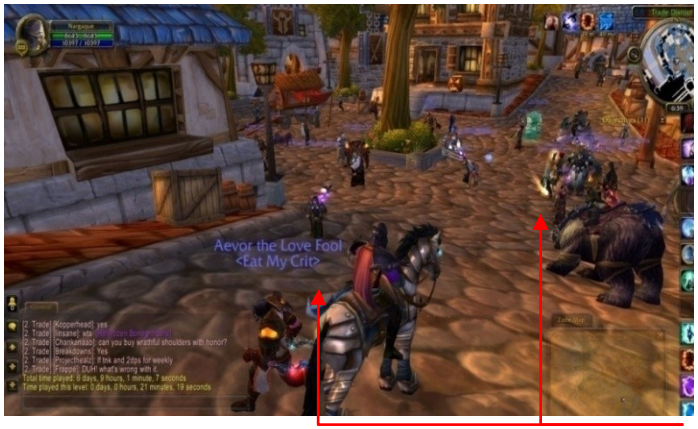
MEDIATRON Laboratory, SUP'COM, Tunisia
L2TI Laboratory, Galilée Institut, Paris 13 university, France

Summary

1. Massively Multiplayers Online Gaming (MMOG)
2. Distributed MMOG architecture
3. Cost-aware Virtual Machines Placement Problem
4. Experiments results
5. Conclusion & perspectives

MMOG

- Massively Multiplayers Online Games
- Popular large scale game service (20 millions worldwide players in 2010*)



Avatars

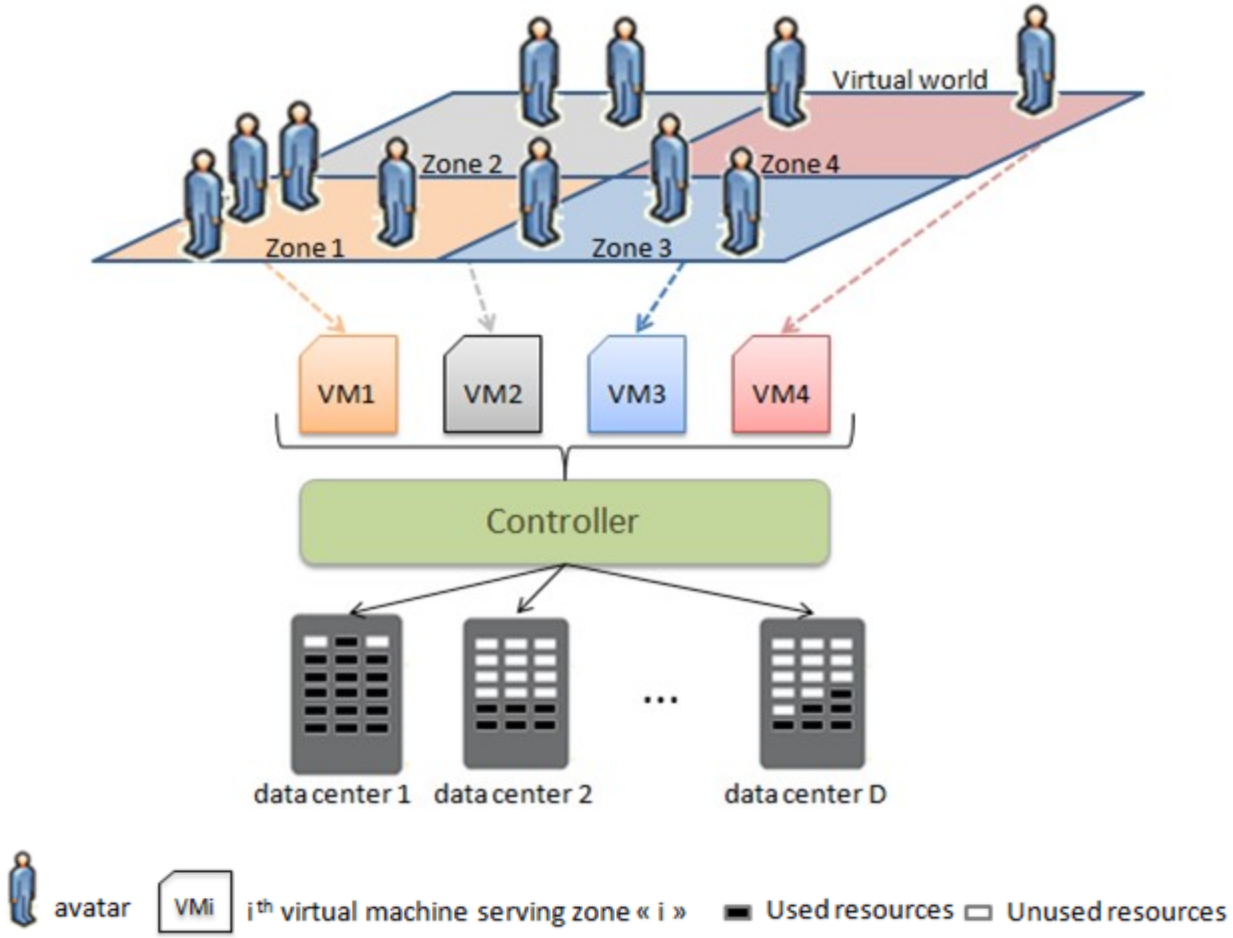
- Delay-sensitive game service:

Delay ⟶ Resources ⟶ Cost

➔How maintain tradeoff between cost and delay for better game experience?

* J. Wu, The world of MMORPG: a tale of two regions, 2010, strategyanalytics.com

Distributed MMOG architecture



Cost-aware Virtual Machines Placement Problem (1/2)

- **Goal:**
  - Find optimal VMs placement that minimize resources allocation cost under delay constraint.

- **Notifications:**
  - multiple multidimensional knapsack problem
    - M Datacenters = **M knapsacks**
    - V VMs = **V items** to be placed in the knapsacks
    - $w_{m,v} = (w^1_{m,v}, w^2_{m,v}, ..., w^K_{m,v})$: **required resources** vector
      ($w^1_{m,v}$: CPU, $w^2_{m,v}$: memory, $w^3_{m,v}$: bandwidth, $w^4_{m,v}$: space disk)
    - $b_m = (b^1_m, b^2_m, ..., b^K_m)$: **capacity resources** vector
      (b^1_m : CPU, b^2_m : memory, b^3_m : bandwidth, b^4_m : space disk)

Cost-aware Virtual Machines Placement Problem (2/2)

- **Notifications:**
  - $c_{m,v}$: **allocation cost** of v^{th} item if placed in m^{th} knapsack
  - $x_{m,v}$: **decision variable**

    - {1}: if v^{th} item is placed in m^{th} knapsack

    - {0}: otherwise
  - $D_{m,v}$: **response delay** of v^{th} item if placed in m^{th} knapsack
  - Dt_{max} : **threshold** delay

Cost-aware Virtual Machines Placement Problem

$$minimize(\sum_{m=1}^{M}\sum_{v=1}^{V} c_{m,v}x_{m,v}) \quad (1)$$

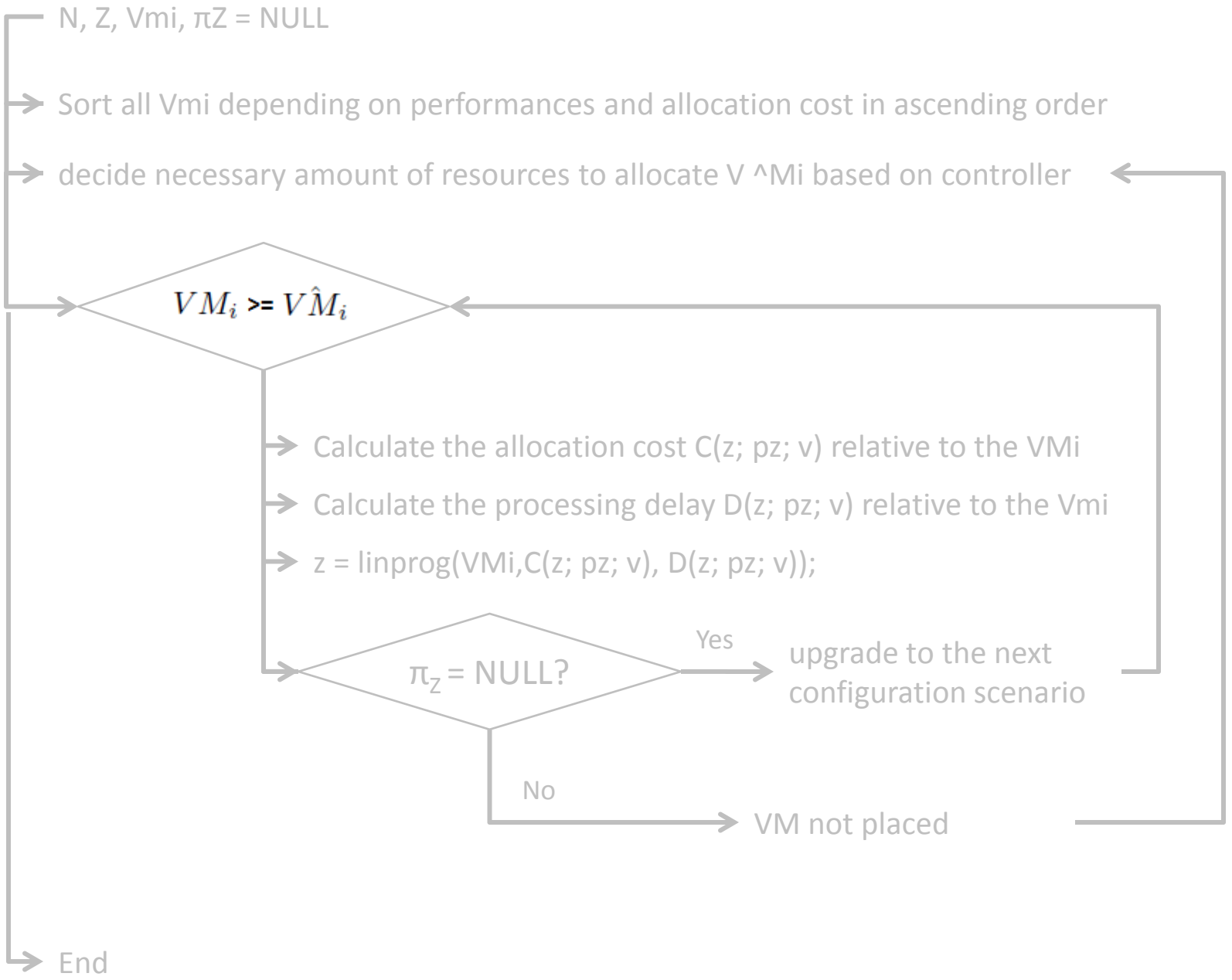
$$D_{m,v}\ x_{m,v} \leq Dt_{max}, \forall m, \forall v \quad (2)$$

$$\sum_{v=1}^{V} w_{m,v}^{k} x_{m,v} \leq b_{m}^{k}, m = 1..M, k = 1..4 \quad (3)$$

$$\sum_{m=1}^{M} x_{m,v} = 1 \quad (4)$$

$$x_{m,v} \in \{0,1\} \quad (5)$$

Cost-aware VMs placement algorithm



Experiments scenario

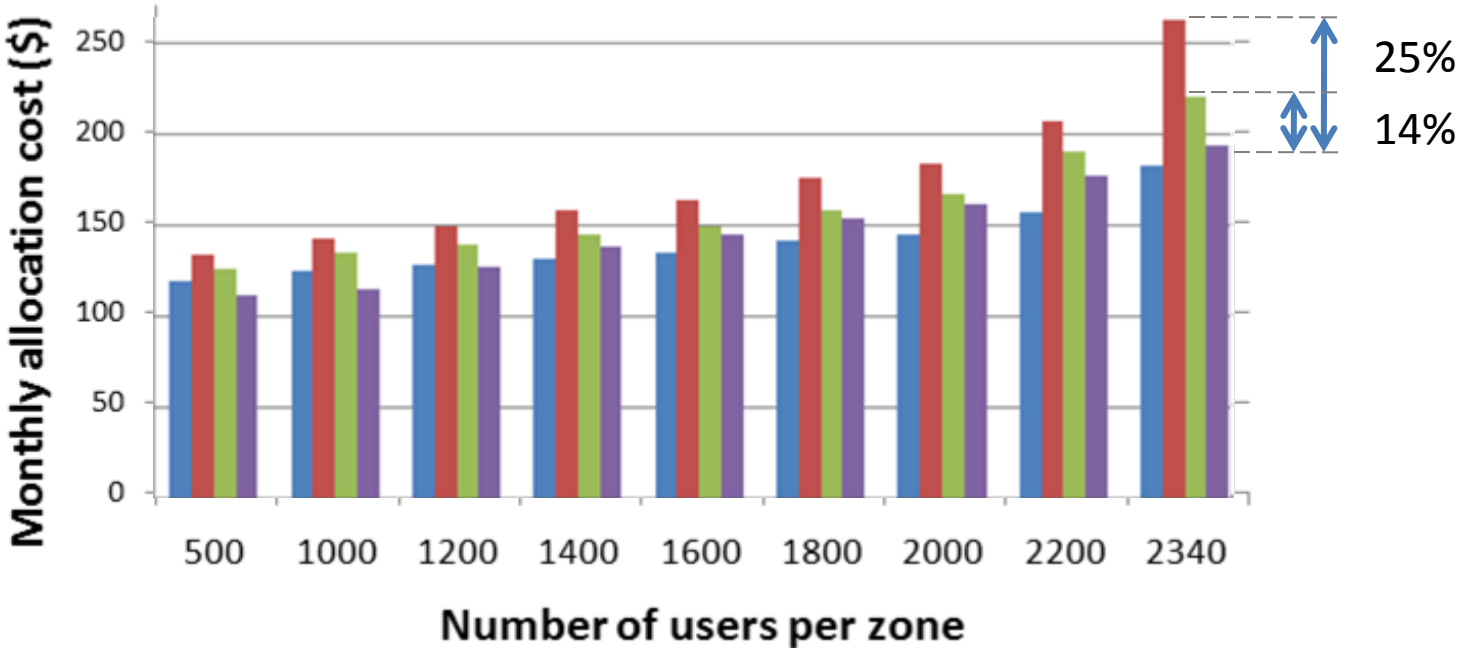
Architecture

AMAZON EC2 : M = 33 datacenters distributed all over the world

- 10 Physical servers
  - 2048 Mb memory
  - 10^5 Mb storage space
  - 10^4 Mb bandwidth
  - 4 processors; 100 MIPS
- Several VMs
- VMs characteristics offered by AMAZON EC2 platform
- V : "World of Warcraft" (WoW) Cloud game
- Delay threshold = 500 ms

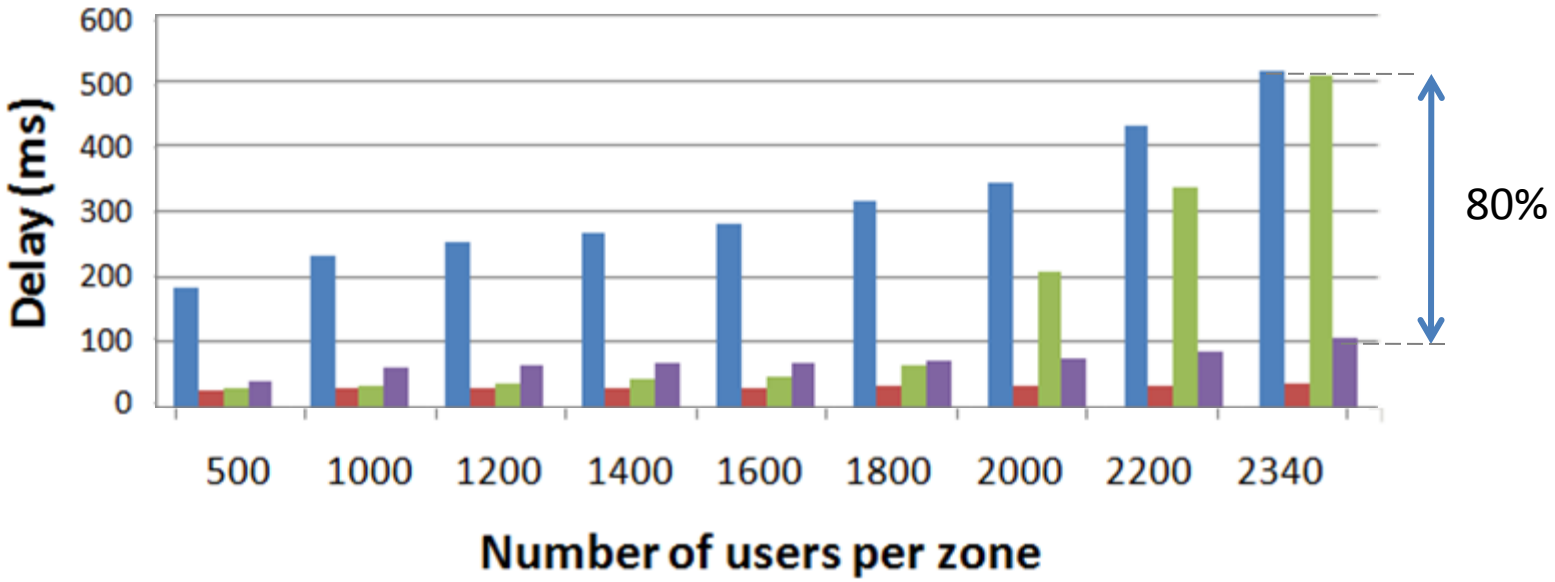
Experiments results: Cost

- Random — **arbitrary VMs placement** over data centers
- GAC — **powerfull VMs** placement in **first closest** datacenter: **No attention to cost**
- MAC — **costless VMs** placement in first available datacenter: **No attention to delay**
- Contribution — VMs placement **with attention to cost and delay**



Experiments results: Delay

- Random — **arbitrary VMs placement** over data centers
- GAC — **powerfull VMs** placement in **first closest** datacenter: **No attention to cost**
- MAC — **costless VMs** placement in first available datacenter: **No attention to delay**
- Contribution — VMs placement **with attention to cost and delay**



Experiments results: Comparision

	GAC	Random	MAC	Contribution
Cost	Highest	High	Cheapest	Cheap
Delay	Shortest	Long with high number of players	Longest	Short

Conclusion & perspectives

- **Contribution:**
  - **Improvement of resources management** for a Cloud gaming service.
  - Optimizing the overall resources allocation cost and placement under delay constraint.
- **Results:**
  - successfully the balance between allocation cost, resources placement and delays.
- **Perspectives:**
  - Impact of VMs placement problem on the Quality of Experience (QoE) of Cloud gaming users.
  - Dynamic VMs placement problem for MMOG over time

Thank you

Questions ?