




Is Server Consolidation Beneficial to MMORPG? A Case Study of World of Warcraft

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MMORPG

Massively Multiplayer Online Role-Playing Game

- General property
 - A genre of computer role-playing games in which players assume the role of a character and a very large number of players interact with one another within a virtual game world.
 - Nonstandard architecture
 - There is no standard architecture or even *de facto* architecture for online game systems.
 - This fact encourages or even forces a game operator to invest dedicated architecture for each game.
 - Sharded design
 - Depending on the number of players, an MMORPG may be separated into many identical game worlds, and players in one world can not interact with those in another.
 - The design worsens the server over-provisioning phenomenon.
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World of Warcraft



- WOW is the most popular MMORPG in the world, designed by BLIZZARD Entertainment.
- The figures are in Winter Grasp Lake battle field.
- There are many players/avatars interacting, combating, chatting and dying within the battle field.



Realm



- Each separated game world in WOW is called “realm”.



Outline

MMORPG

Massively multiplayer online role-playing game

Motivations

Cost down and energy-saving

Contributions

Why server consolidation is appropriate for MMORPG and propose a zone-based strategy to facilitate server consolidation.

Observations

Variability, Regularity and Predictability

Methods

A zone-based server consolidation strategy

Results & Conclusions

The server number required can be reduced by 52% and the total energy consumption can be reduced by 62%.



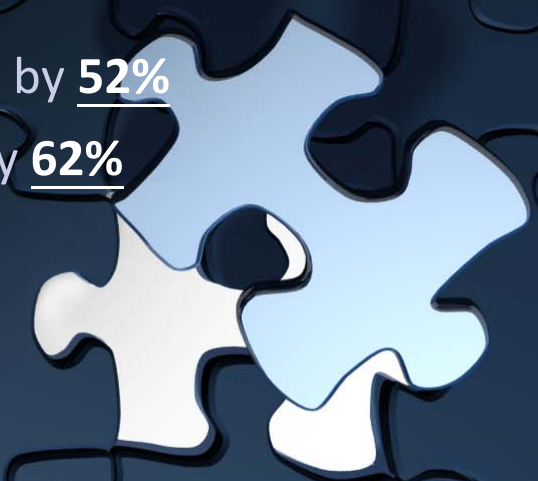
Motivations

- Cost down
 - Number of servers
 - HR (human resource) costs
- Energy-saving
 - Reduce number of idle or light-loading servers
 - Controlling server utilization for the best cost performance which is a relation between energy consumption and computation performance. for example, computation throughput per energy consumption.
 - Cooling



Contributions

- We elaborate why server consolidation is appropriate for MMORPG.
- A zone-based server consolidation strategy
- Applying real-life trace simulation to verify benefits of the proposed strategy
- The results show that, with a per-hour dynamic zone-based server consolidation strategy,
 - The server number requirement can be reduced by 52%
 - The total energy consumption can be reduced by 62%



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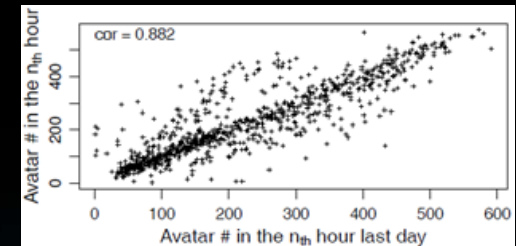
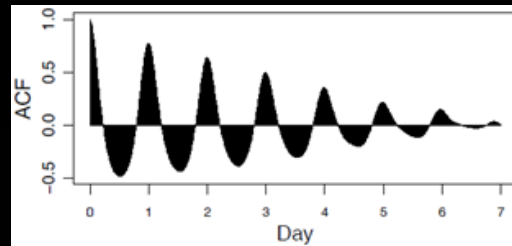
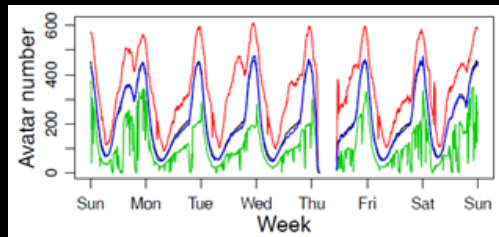
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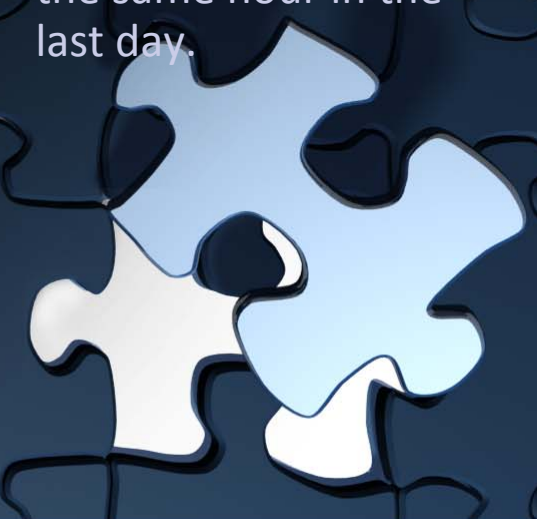


Observations

Why can we consolidate game servers?



- Variability
- The number of players constantly fluctuates between 0 – 600 in each day.
- Regularity
- Examined by auto-correlation function (ACF) at corresponding time scales.
- Predictability
- Prediction based on the same hour in the last day.



Observations cont.

- Spatial locality property
 - Players tend to interact with others (by chatting, trading, fighting, or teaming up to fight others, etc) in their vicinity in the game's virtual world.
 - Thus, we consider such a zone a perfect unit for workload dispatching based on virtualization



Observations cont.

- An online game operator usually host dozens of games at the same time.
 - For example, SNDA, one of the most biggest companies in China, hosts more than 20 MMORPGs.
 - Since the subscribers of a game may fluctuate greatly over its course of operation, it is important to reuse the same infrastructure automatically.



Implication from Observations

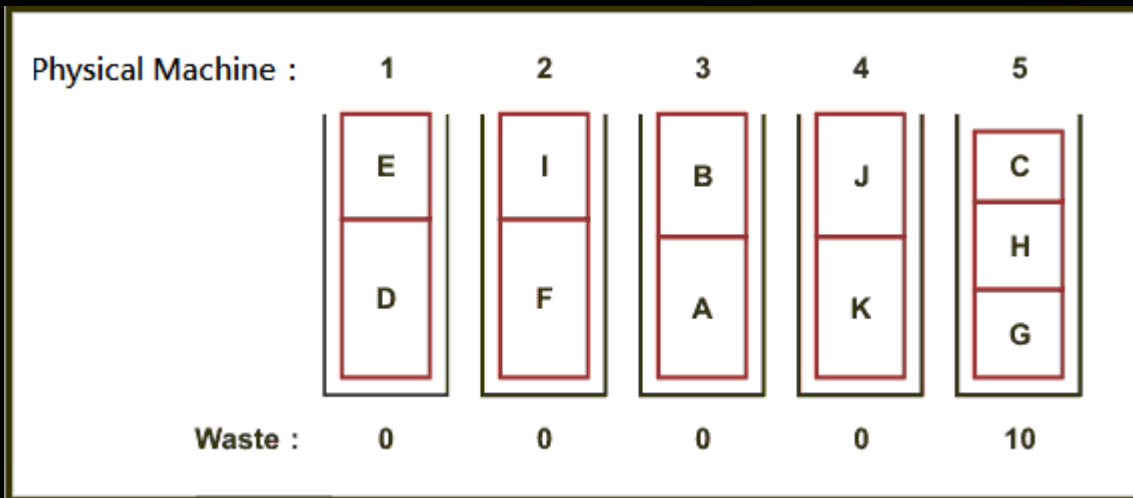
Concentrating and dispersing zone-based
workload depend on server loading
automatically!!



Methods

First Fit Decreasing (FFD)

VM:	D	F	A	K	B	J	E	I	G	H	C
Weight :	90	80	70	60	50	40					



- We put the VMs into decreasing workload order first.
- Putting each VM sequentially into first PM with enough free space.



Methods cont.

Zone-based server consolidation

Parameter	Value
Simulated period	2 months
Server capacity	7500 avatars
Realm number (r)	100
Server number (s)	100
Zone per realm (z)	83
Avatar number per realm	$\mathcal{N}(2640, 1500^2)$
Power consumption per server	300 W (idle), 750 W (peak)
VM allocation algorithm	First-Fit Decreasing

- Assume that each server can accommodate 7500 avatars and the real-life trace of TW-Light's Hope realm is manipulated to r traces of r realms with normal distribution.
- Assume that we have r realms and z zones (VMs) per realm, thus we have totally $n = r \times z$ zones.
- Assume we have $s = 100$ servers, then designate zone p ($1 \leq p \leq n$) on server q ($1 \leq q \leq s$) by using FFD.



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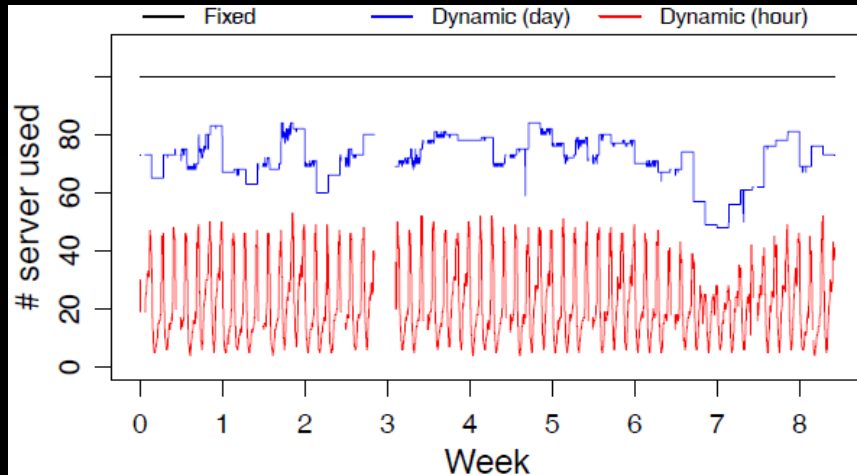
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Simulation Results

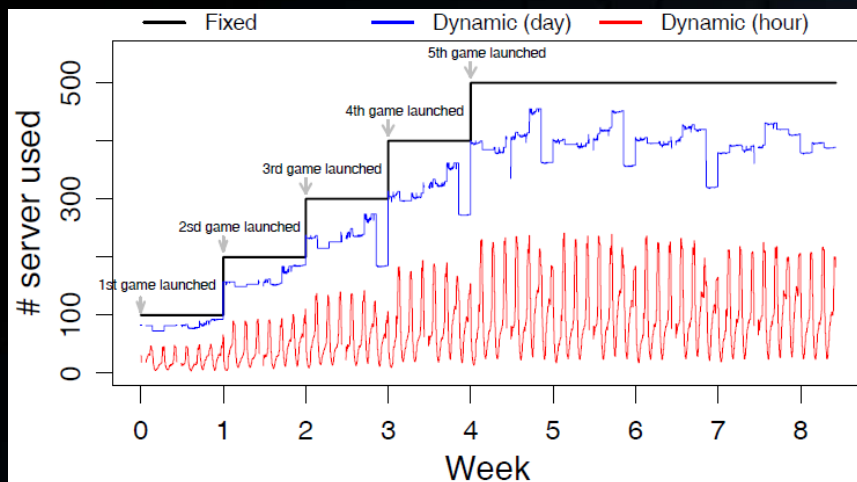
Single game and multiple games test



Fixed: state-of-the-art strategy

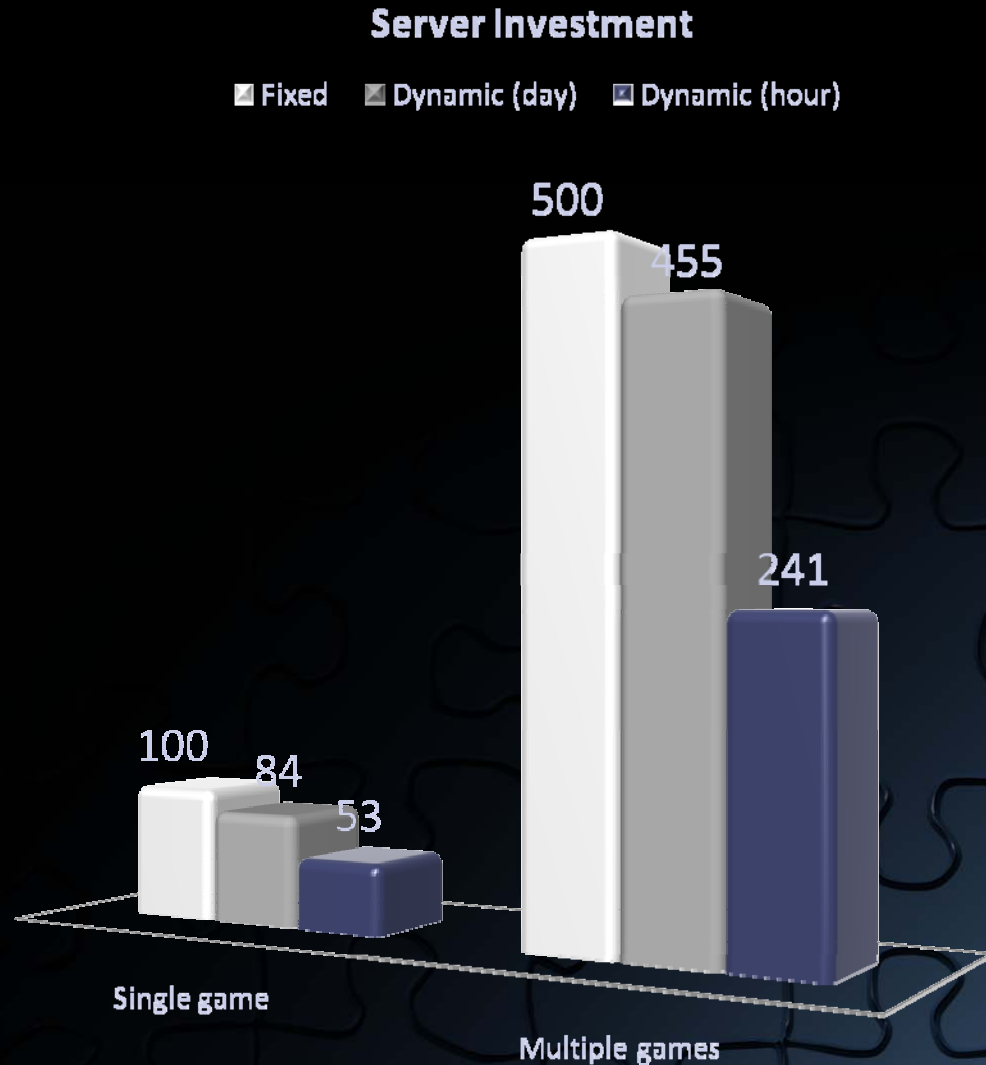
Dynamic (day): predict future one day workload and reallocate VMs on the servers per day (6 am).

Dynamic (hour): predict future one hour workload and reallocate VMs on the servers per hour.



Results

Server Investment



Single game simulation (100 realms)

Fixed: The fixed policy constantly uses 100% (100) servers.

Dynamic (day): it requires around 84% (84) servers.

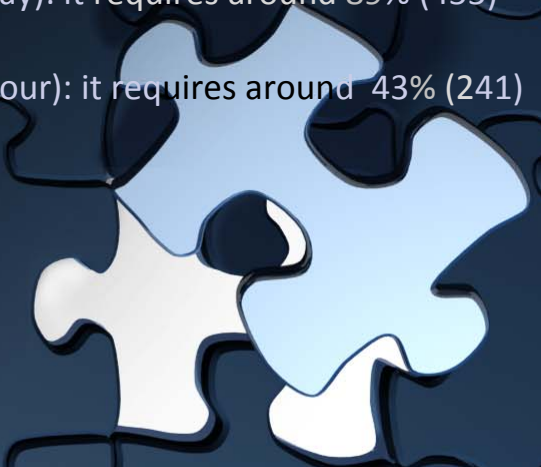
Dynamic (hour): it requires around 53% (53) servers.

Multiple game simulation (500 realms)

Fixed: The fixed policy constantly uses 100% (500) servers.

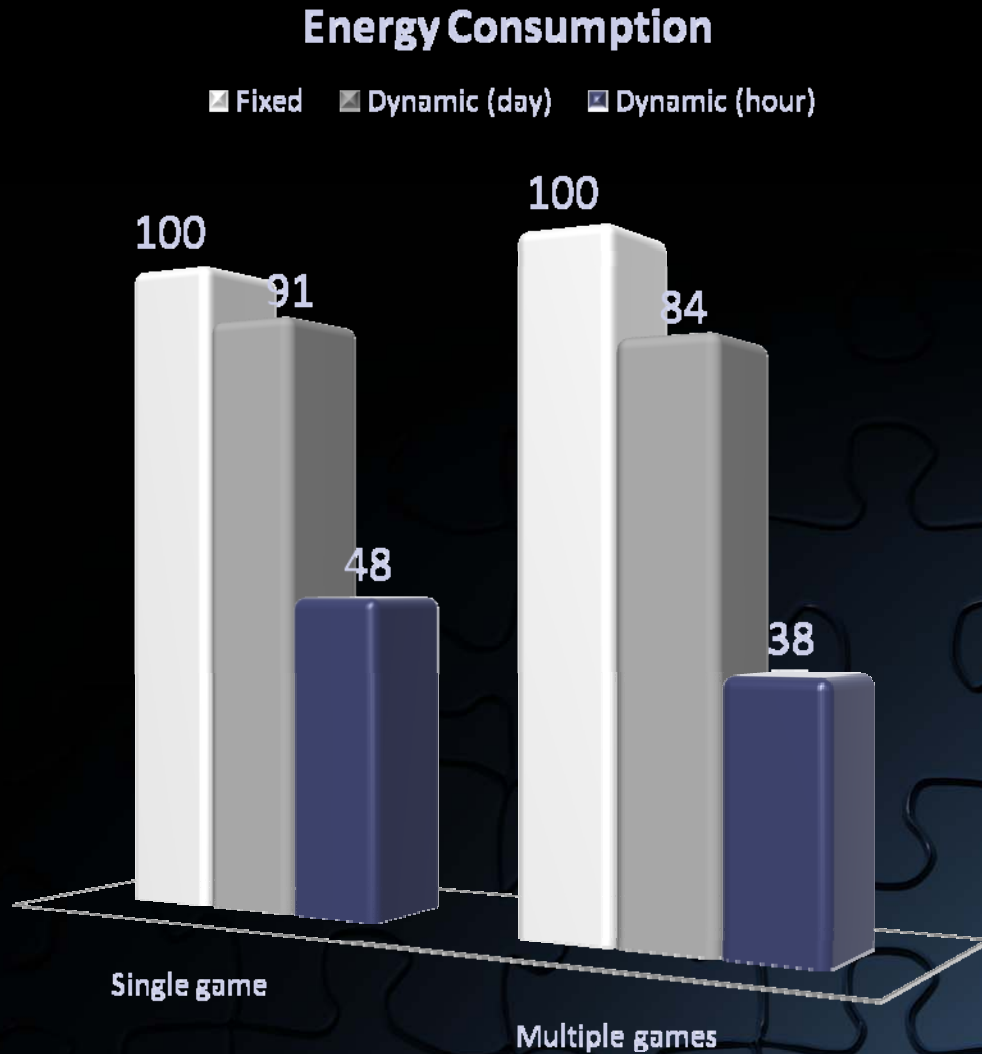
Dynamic (day): it requires around 89% (455) servers.

Dynamic (hour): it requires around 43% (241) servers.



Results

Energy Consumption



Single game simulation

Dynamic (day): it requires around 91% energy consumption of fixed policy.

Dynamic (hour): it requires around 48% energy consumption of fixed policy.

Multiple game simulation

Dynamic (day): it requires around 84% energy consumption of fixed policy.

Dynamic (hour): it requires around 38% energy consumption of fixed policy.



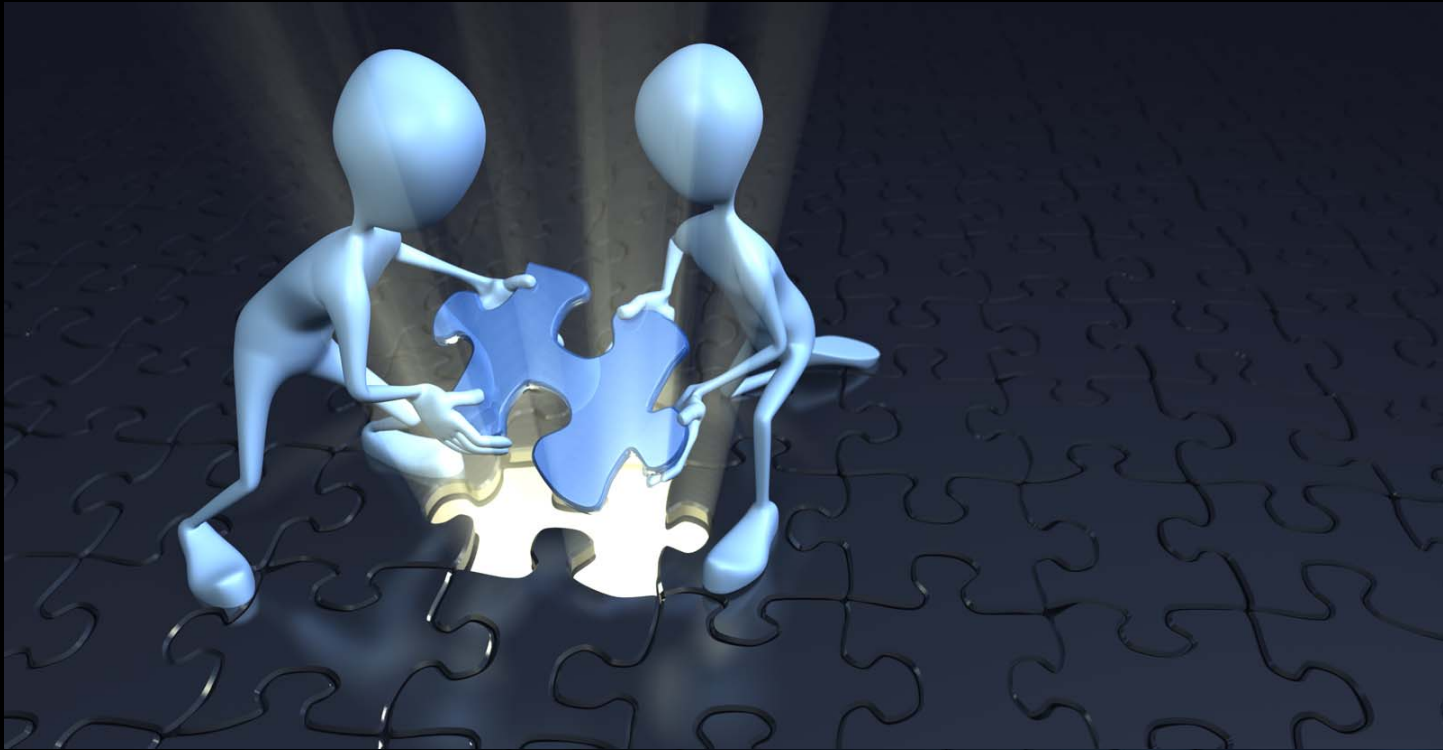
Results

Summary

	Single game		Multiple games	
	Dd	Dh	Dd	Dh
Server Investment	84%	53%	91%	48%
Energy Consumption	89%	43%	84%	38%

- Benefits in the simulations, Dh is dynamic (hour) and Dd is dynamic (day).
- We can notice that in dynamic per hour strategy, the experiment results are more beneficial than in dynamic per day strategy.
- Note that the effect could be more prominent if an operator hosts more games at the same time.





Thanks for your attention.

