Massivizing Social Games: Yesterday, Today, and The Next Five Years

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A Scientist and a Gamer Meet in a Bar…

- Civilization arises in and as play, and never leaves it.
  Huizinga, Homo Ludens, 1938, p.178

- Science and scholarship are much like games. Players are drawn into games because of their challenges, and playing involves creating, testing and revising strategies as well as the skills necessary for progressing in the game.
  Mayra, Game Studies, 2009, p.3
Traditional Gaming

*Play is a voluntary activity or occupation executed within certain fixed limits of time and place, according to rules freely accepted but absolutely binding, having its aim in itself and accompanied by a feeling of tension, joy, and the consciousness that it is “different” from “ordinary life”*

Huizinga, Homo Ludens, 1938, p.28

Chess players, Lucas van Leyden, c.1508

Awari, solved by J. Romein et al., c.2000
A Brief History of Computer Games

1970s: The Device Era
1980s: The Hero Era
1981: Handheld Crash
1983: Videogames Crash
1990s: The Tech & Genre Era
What’s in a name? MSG, MMOG, MMO, …

Massively Social Gaming
(online) games with massive numbers of players (100K+), for which social interaction helps the gaming experience

1. Virtual world
   Explore, do, learn, socialize, compete
   +

2. Content
   Graphics, maps, puzzles, quests, culture
   +

3. Game data
   Player stats and relationships

Romeo and Juliet
FarmVille, a Massively Social Game

FarmVille

ZYNGA GAME

AVerAGE NUMBER OF ACTIVE PLAYERS

FarmVille

Cafe World

Mafia Wars

FishVille

Zynga Poker

27 million daily / 75 million monthly

THAT’S A LOT

FarmVille boasts 118 million total installs. It has more monthly active users than the population of France.

AVERAGE SESSION

33 minutes

PLAYER PROFILE

N/A average age

60% female, 40% male

MOST POPULAR TIME TO PLAY (EST)

8-9 AM

Sources: CNN, Zynga.
MSGs are a Popular, Growing Market

- 25,000,000 subscribed players (from 250,000,000+ active)
- Over 10,000 MSGs in operation
- Subscription market size $7.5B+/year, Zynga $600M+/year

Sources: MMOGChart, own research. Sources: ESA, MPAA, RIAA.
Agenda

1. What’s in a Name?

2. Three Current Challenges
   1. Platform Scalability Challenge
   2. Content Generation Challenge
   3. Gaming Analytics Challenge

3. The Next Five Years

4. Conclusion
Research Challenge: Solve the Platform Problem of MMOGs

The Platform Problem of MMOGs

Scaling quickly to millions of players
- 1M in 4 days, 10M in 2 months
- Up-front and operational costs
- Performance, Scalability, & Cost
Computational Model for the Server

- Single sequential loop
- 3 steps in each loop:
  1. Game-world state update
  2. Entity interaction computation (dominant for MSGs)
  3. Entity state updates
- Load generated by (2) non-deterministic <-> human factor

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
Model for Entity Interaction Computation

- Player to Player/Player to Environment interaction
  - **Low** interaction: $O(n)$, e.g. RTS
  - **Medium** interaction: $O(n \cdot \log(n))$ – RPG quest maps
  - **High** interaction: $O(n^2)$ – RPG war maps, FPS
  - **Very High** interaction: $O(n^2 \cdot \log(n))/O(n^3)$, unit-target matching, team path-finding, maxflow alg., …
Load Impact on Game Experience

Responsive game

Unresponsive game

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
Online games hosting model

• Generic Online Games (non-MM)
  • Static: dedicated isolated single servers

• MMOGs
  • Static: dedicated clusters - using parallelization

• Problems with these approaches
  1. Large amount of over-provisioning
  2. Non-efficient coverage of the world

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
Background on Cloud Computing

• “The path to abundance”
• On-demand capacity
• Pay what you use
• Great for web apps (EIP, web crawl, DB ops, I/O)

VS

• “The killer cyclone”
• Not so great performance for compute- or data-intensive applications
• Long-term perf. variability

2- Iosup et al., On the Performance Variability of Production Cloud Services, CCGrid 2011.
Proposed hosting model: dynamic

• Using data centers for dynamic resource allocation

• Main advantages:
  1. Significantly lower over-provisioning
  2. Efficient coverage of the world is possible

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
**MSG Ecosystem: Model**

**Game operators**
- Past player activity/business model \(\rightarrow\) **Predicted load \(\rightarrow\)** requests

**Data centers**
- **Local** time-space **renting policy \(\rightarrow\)** offers
- Time-Space renting policy, e.g., 1 node-hour
- Resource allocation: central request-offer matching
- Rules for ranking request-offer match:
  1. The offer size and type vs. the request
  2. The geographical proximity offer-request
  3. The finer grained resources (quantity & time)

*Source: Nae, Iosup, and Prodan, ACM SC 2008*
Experimental Setup [1/3]
Discrete-Event Simulator

- **Input**
  - Traces from RuneScape, a real top-5 MMOG
    - 7 countries, 3 continents
    - More than 130 game worlds
    - Geographical location
    - Number of clients
    - Over 10,000 samples at 2 min. interval, 2 weeks

- **Output** (for every time-step)
  - Resource allocation decisions
  - Resource allocation
  - Performance metrics
### Experimental Setup [2/3]

**Environment**

- 1 game operator
- 17 data centers
- 11 data center time-space renting policies

<table>
<thead>
<tr>
<th>Location</th>
<th>Data Centers</th>
<th>Machines (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>2</td>
<td>8 machines</td>
</tr>
<tr>
<td>Sweden</td>
<td>2</td>
<td>8 machines</td>
</tr>
<tr>
<td>U.K.</td>
<td>2</td>
<td>20 machines</td>
</tr>
<tr>
<td>Netherlands</td>
<td>2</td>
<td>15 machines</td>
</tr>
<tr>
<td>U.S. (West)</td>
<td>2</td>
<td>35 machines</td>
</tr>
<tr>
<td>Canada (West)</td>
<td>1</td>
<td>15 machines</td>
</tr>
<tr>
<td>U.S. (Central)</td>
<td>1</td>
<td>15 machines</td>
</tr>
<tr>
<td>U.S. (East)</td>
<td>2</td>
<td>32 machines</td>
</tr>
<tr>
<td>Canada (East)</td>
<td>1</td>
<td>10 machines</td>
</tr>
<tr>
<td>Australia</td>
<td>2</td>
<td>8 machines</td>
</tr>
</tbody>
</table>

(Source: Nae, Iosup, and Prodan, ACM SC 2008)
Experimental Setup [3/3]
Performance Metrics

• **Resource over-allocation [%]**
  • The wasted resources vs. optimal allocation at each simulation time step for all utilized machines (cumulative)

• **Resource under-allocation [%]**
  • The amount of resources needed but not allocated, for all machines (computed individually)

• **Significant under-allocation events (count)**
  • Number of times the resource under-allocation is >1%, for a period of 2 minutes → **people leave**

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
Static vs. Dynamic Allocation

Q: What is the penalty for static vs. dynamic allocation?

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
Impact of Interaction Compute-Intensiveness

Q: How are different MMOG types handled under dynamic resource provisioning?

- Player-world interaction models
  - Low ~ $O(n)$, Medium, High, Very High ~ $O(n^3)$

A: Over-allocation, Under-allocation worse with increase in interaction compute-intensiveness

[Source: Nae, Iosup, and Prodan, ACM SC 2008]
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(Procedural) Game Content (Generation)

Derived Content
- NewsGen, Storification

Game Design
- Rules, Mechanics, …

Game Scenarios
- Puzzle, Quest/Story, …

Game Systems
- Eco, Road Nets, Urban Envs, …

Game Space
- Height Maps, Bodies of Water, Placement Maps, …

Game Bits
- Texture, Sound, Vegetation, Buildings, Behavior, Fire/Water/Stone/Clouds


Massivizing Social Games: Yesterday, Today, and the Next Five Years – A. Iosup
Research Challenge:
Solve the Content Problem of MMOGs

The Content Problem of MMOGs
Generating content on time for millions of players
- Player-customized: Balanced, Diverse, Fresh
- Up-front and operational costs
- Response time, Scalability, & Cost
The New Content Generation Process*

Only the puzzle concept, and the instance generation and solving algorithms, are produced at development time.

* A. Iosup, POGGI: Puzzle-Based Online Games on Grid Infrastructures, EuroPar 2009 (Best Paper Award)
Puzzle-Specific Considerations
Generating Player-Customized Content

**Puzzle difficulty**
- Solution size
- Solution alternatives
- Variation of moves
- Skill moves

**Player ability**
- Keep population statistics and generate enough content for most likely cases
- Match player ability with puzzle difficulty
- Take into account puzzle freshness

Target: [ ] Pins: X ABC D E

X: Right A: Right B: Up X: Up
(Best solution: 4 moves)

B: Up X: Up B: Left C: Down C: Left
B: Down B: Right B: Down E: Right E: Down
E: Right B: Up A: Up B: Left C: Down
C: Right E: Down X: Left E: Left X: Down
X: Left
(Best solution: 21 moves)
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Continuous Analytics for MMOGs

MMOG Data = raw and derivative information from the virtual world (millions of users)

Continuous Analytics for MMOGs = Analysis of MMOG data s.t. important events are not lost

- Data collection
- Data storage
- Data analysis
- Data presentation
- … at MMOG rate and scale
Continuous Analysis for MMOGs
Main Uses By and For Gamers

1. Support player communities
2. Understand play patterns (decide future investments)
3. Prevent and detect cheating or disastrous game exploits (think MMOG economy reset)
4. Broadcasting of gaming events
5. Data for advertisement companies (new revenue stream for MMOGs)
Research Challenge: Solve the Analytics Problem of MMOGs

The Analytics Problem of MMOGs

Analyzing the behavior of millions of players, on-time
- Data mining, data access rights, cost v. accuracy, …
- Reduce upfront costs
- Low response time & Scalable
The CAMEO Framework*

1. **Address community needs**
   - Can analyze skill level, experience points, rank
   - Can assess community size dynamically

2. **Using on-demand technology: Cloud Comp.**
   - Dynamic cloud resource allocation, Elastic IP

3. **Data management and storage: Cloud Comp.**
   - Crawl + Store data in the cloud (best performance)

4. **Performance, scalability, robustness: Cloud Comp.**

* A. Iosup, CAMEO: Continuous Analytics for Massively Multiplayer Online Games on Cloud Resources. ROIA, Euro-Par 2009 Workshops, LNCS 6043, (2010)
CAMEO: Exploiting Cloud Features

- Machines close(r) to server
  - Traffic dominated by small packets (latency)

- Elastic IP to avoid traffic bans
  (legalese: acting on behalf of real people)

Agenda

1. What’s in a Name?
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3. The Next Five Years
   1. Cloudification
   2. Mobile Social Gaming
   3. Content, Content, Content
   4. Social Everything!
4. Conclusion
Cloudification: PaaS for MSGs

(Platform Challenge)
Build MSG platform that uses (mostly) cloud resources

- Close to players
- No upfront costs, no maintenance
- Compute platforms: multi-cores, GPUs, clusters, all-in-one!
- Performance guarantees
- Code for various compute platforms—platform profiling
- Load prediction miscalculation costs real money
- What are the services?
- Vendor lock-in?
- My data
Mobile Social Gaming and the SuperServer

(Platform Challenge)

Support MSGs on mobile devices

- Mobiles everywhere (2bn+ users)
- Gaming industry for mobiles is new Growing Market
- SuperServer to generate content for low-capability devices?
- Battery for 3D/Networked games?
- Where is my server? (Ad-hoc mobile gaming networks?)
- Security, cheat-prevention
Content, Content, Content

(Content Challenge)
Produce and distribute content for 1BN people

- Game Analytics → Game statistic
- Crowdsourcing
- Storification
- Auto-generated game content
- Adaptive game content
- Content distribution/
  Streaming content
Social Everything!

- **Social Network** = undirected graph, **relationship** = edge
- **Community** = sub-graph, density of edges between its nodes higher than density of edges outside sub-graph

(Analytics Challenge)

Improve gaming experience

- Ranking / Rating
- Matchmaking / Recommendations
- Play Style/Tutoring

Self-Organizing Gaming Communities

- Player Behavior

Massivizing Social Games: Yesterday, Today, and the Next Five Years – A. Iosup
Massive Social Gaming

- Million-user, multi-bn market
- Sim, Content, Analytics

Current Technology

- Upfront payment
- Cost and scalability problems
- Makes players unhappy

Our Vision

- Scalability & Automation
- Economy of scale with clouds

Ongoing Work

- Content: POGGI Framework
- Platform: edutain@grid
- Analytics: CAMEO Framework

Publications Gaming and Clouds

2008: ACM SC
2009: ROI A, CCGrid, NetGames, EuroPar (Best Paper Award), ...
2010: IEEE TPDS, Elsevier CCPE
2011: Book Chapter CAMEO, IEEE TPDS, IJ AMC

Graduation (Forecast)

2010/2011: 2PhD, 4Msc, 4BSc

The Future

- Happy players
- Happy cloud operators
Thank you for your attention! Questions? Suggestions? Observations?

More Info:
- [http://www.st.ewi.tudelft.nl/~iosup/research.html](http://www.st.ewi.tudelft.nl/~iosup/research.html)
- [http://www.st.ewi.tudelft.nl/~iosup/research_gaming.html](http://www.st.ewi.tudelft.nl/~iosup/research_gaming.html)

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