

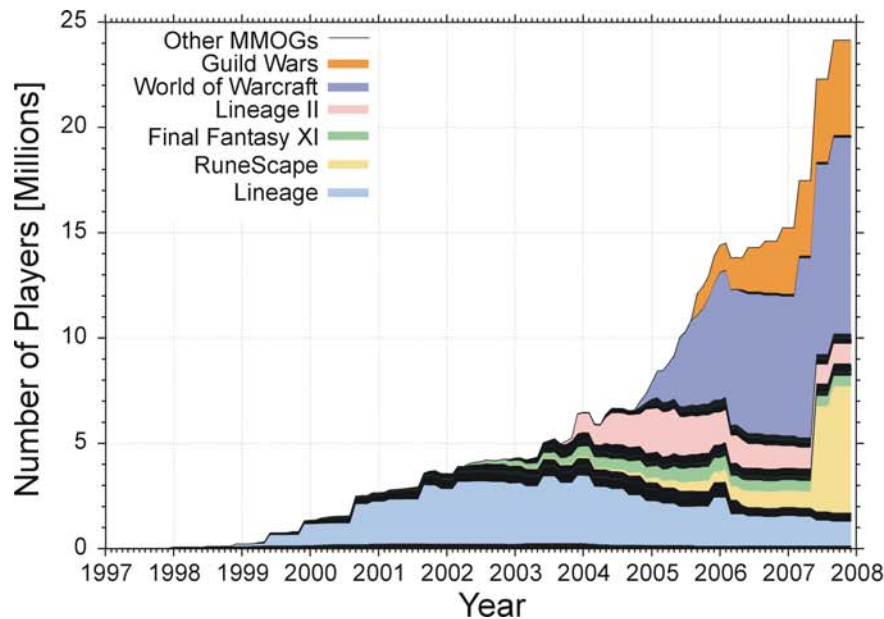
POGGI: Puzzle-Based Online Games on Grid Infrastructures

Alexandru Iosup

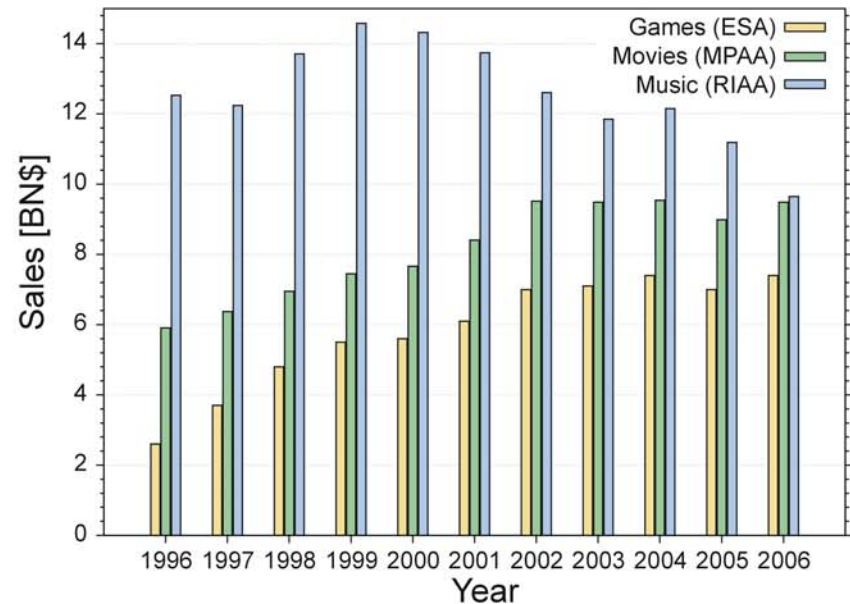
Parallel and Distributed Systems Group
Delft University of Technology

MMOGs are a Popular, Growing Market

- 25,000,000 active players (est. 60,000,000 by 2012)
- Over 150 MMOGs in operation
- Market size 7,500,000,000\$/year



Sources: MMOGChart, own research.



Sources: ESA, MPAA, RIAA.

What is an MMOG?

1. Content

Graphics, maps,
puzzles, quests
+

2. Virtual world simulation

Explore, do, learn,
socialize, compete

Myth vs. Reality

- Avg player 30 years-old
- 50% explore/socialize



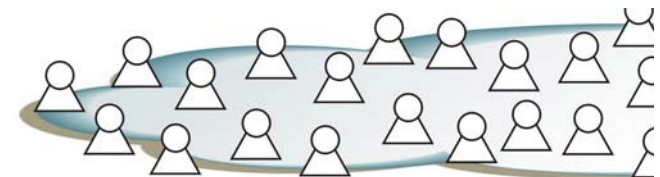
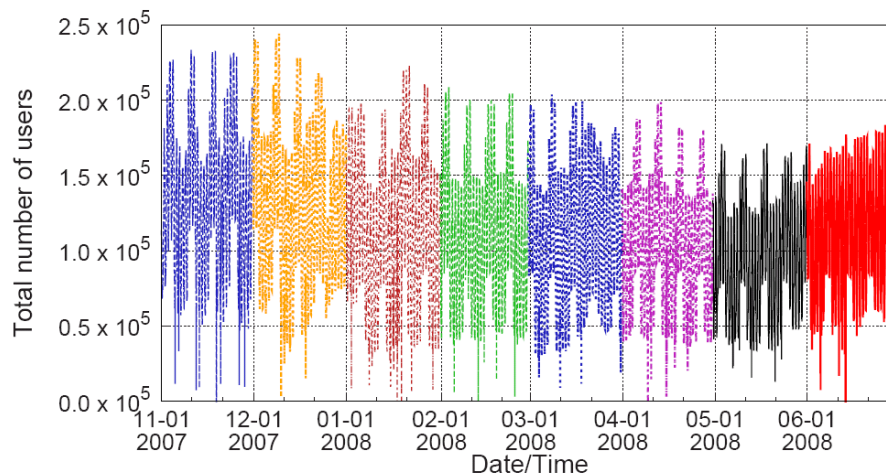
Romeo and Juliet

Research Objective: Solve the Content Problem of MMOGs

The Content Problem of MMOGs

Generating content on time for millions of players

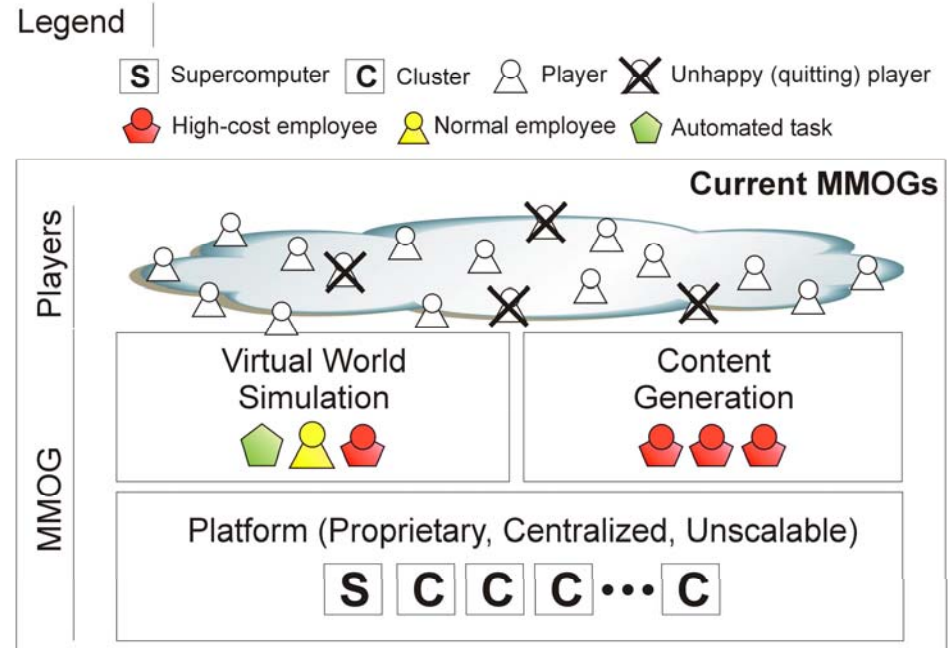
- Player-customized: Balanced, Diverse, Fresh
- Reduce upfront costs
- Low response time & Scalable



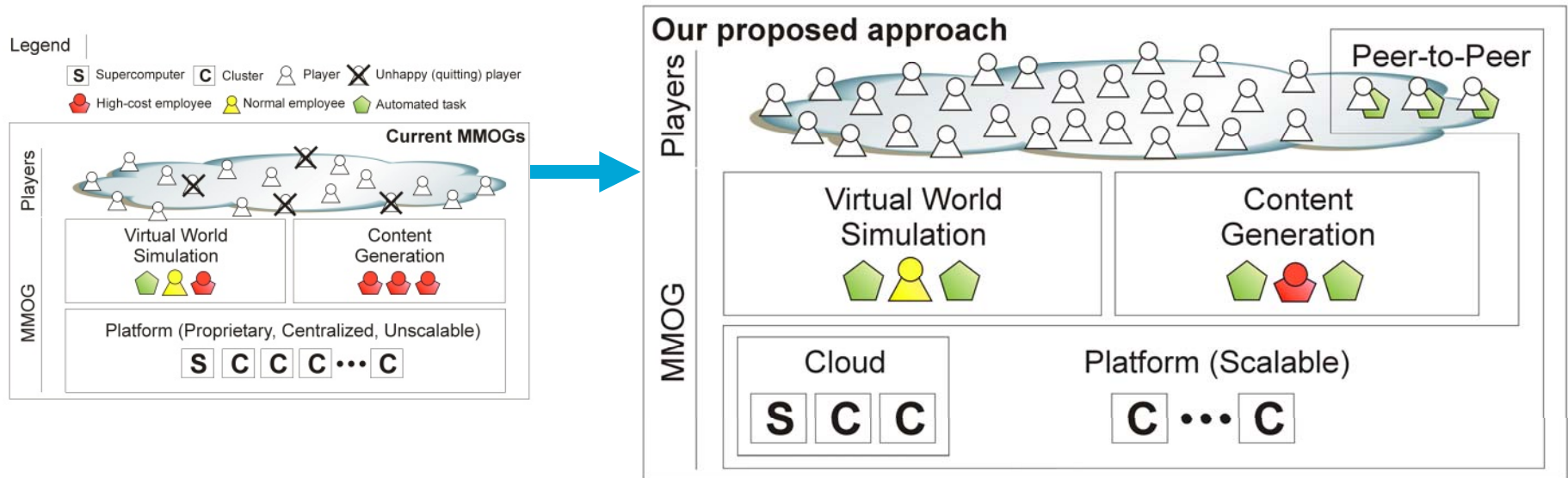
Today's Technology

The Content Problem

- Human content designers
- 2-3 years of development before release
- **Not player-customized**
- **Updates are rare**
- **Upfront payment**
- **Not scalable**



Our Vision: Automate Content Generation



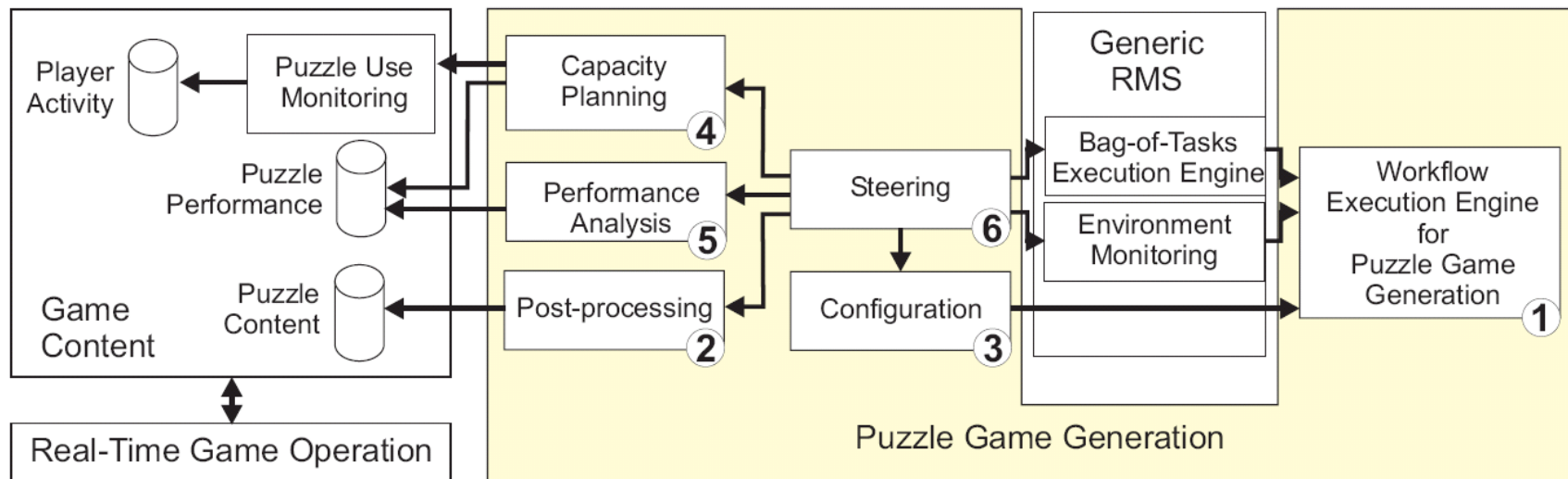
The Content Problem

- Auto content generation on grids
- Player customization (Balanced and Diverse)
- Frequent updates (Fresh)
- Low response time, Scalable

Outline

1. Introduction, Research Goal, and Motivating Scenario
- 2. The POGGI Architecture**
3. Experimental Results
4. Research Directions
5. Conclusion

The POGGI Architecture



Focus on game content generation on grids

- Use existing middleware
- Control MMOG-specific workload demands and variability (soft guarantees for low response time by pre-generating content)

... but do not forget lessons on system design

- Add components for capacity planning and process monitoring

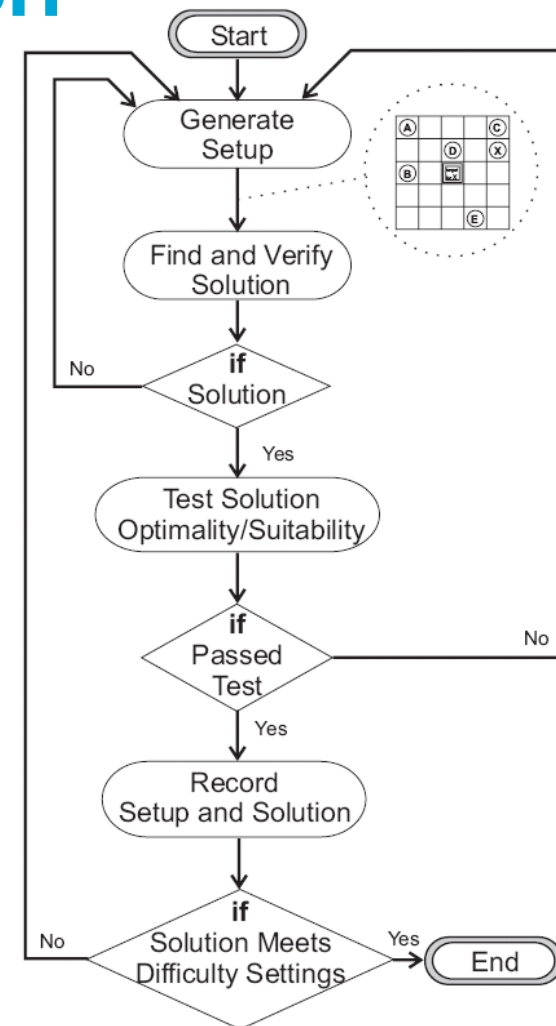
Workflow Execution Engine for Puzzle Instance Generation

Generic engine for puzzle generation

- Can plug-in different puzzles
- Can plug-in different solvers
- Can plug-in different policies for instance generation

Reduce execution overheads

- By-pass RMS (similar to Condor glide-ins, Falcon/Swift, etc., but for WFs instead of tasks)
- Execute on single resource (current implementation, simplicity)

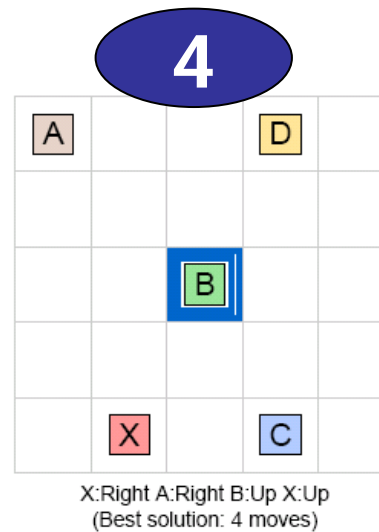


Puzzle-Specific Considerations

Generating Player-Customized Content

Puzzle difficulty

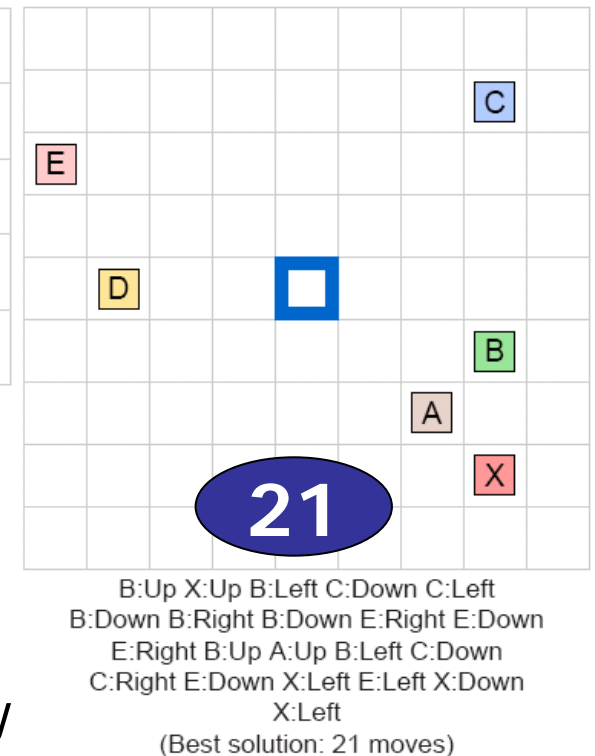
- Solution size
- Solution alternatives
- Variation of moves
- Skill moves



Player ability

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

Target: Pins:



Capacity Planning using MMOG Analytics*

Skill Level Distribution in RuneScape

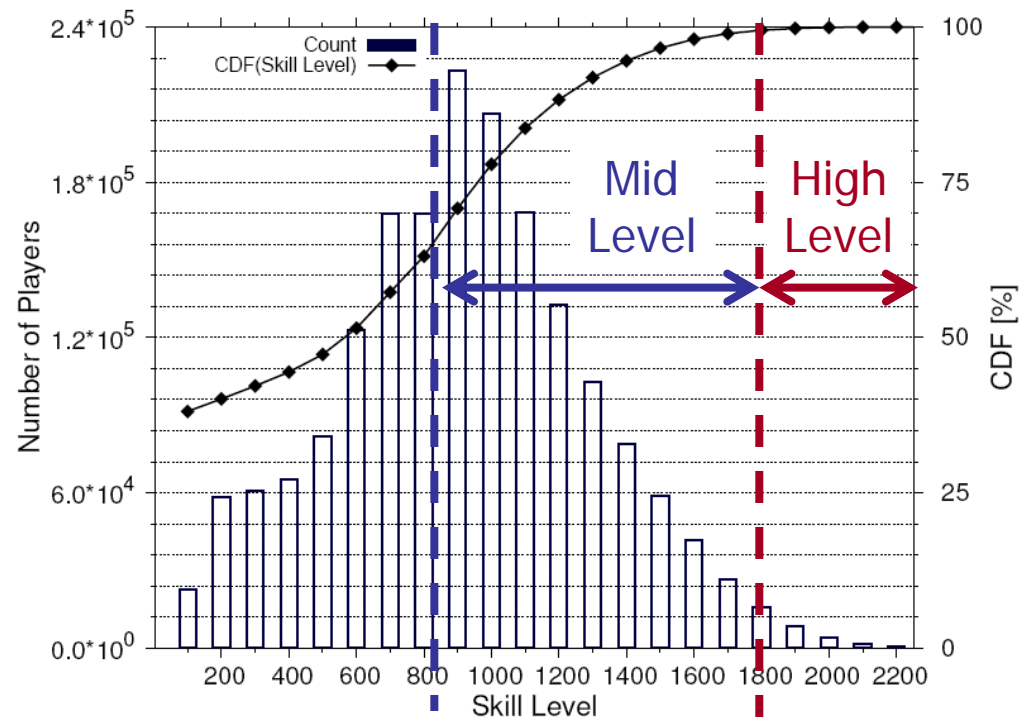
Dataset: **2,899,407 players** (largest MMOG msmt.)

- 1,817,211 level 100+
- Max skill 2,280

Number of mid- and high-level players is significant



Scale too big for human designers



* A. Iosup, CAMEO: Continuous Analytics for Massively Multiplayer Online Games, ROIA Workshop @ EuroPar 2009

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Experimental Results: Goals and Setup

Goals

- **Automatically generate commercial quality content on grid resources**
- **Meet content generation challenges**

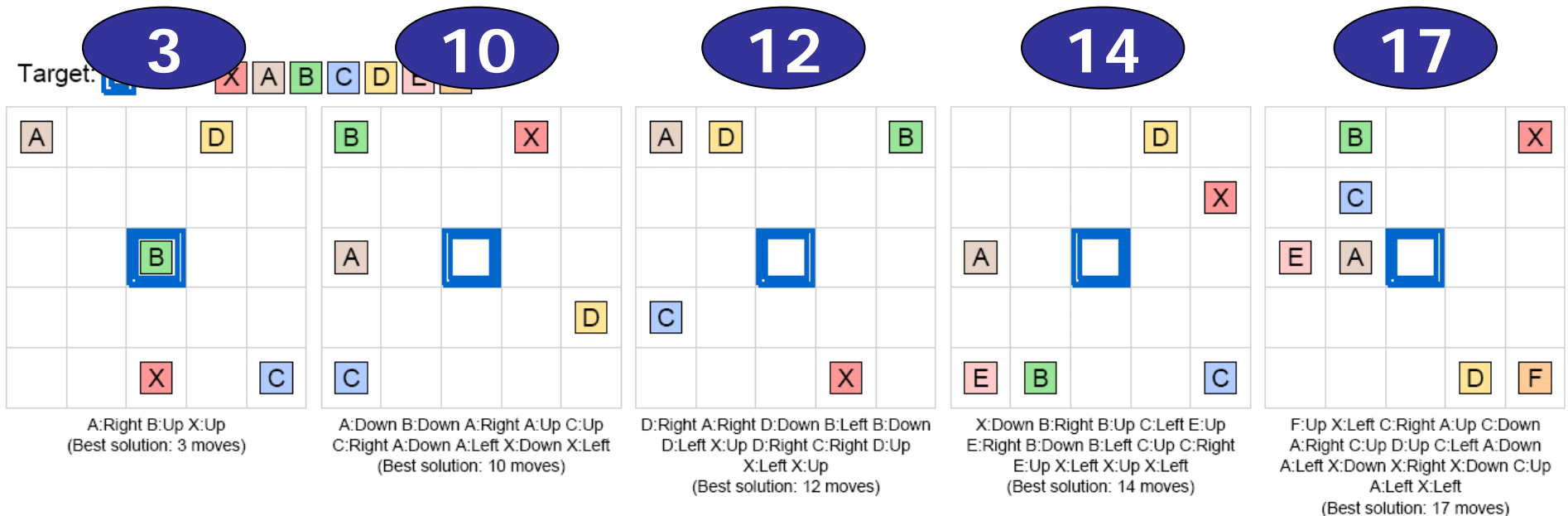
Experimental Setup

- RMS: Condor, 1,600 nodes in resource pool
- Regular user, normal priority
- GrenchMark grid testing tool augmented to become a proto-POGGI implementation

Many thanks U. Wisconsin-Madison

Experimental Results [1/3]

Lunar Lockout: Solved and Extended

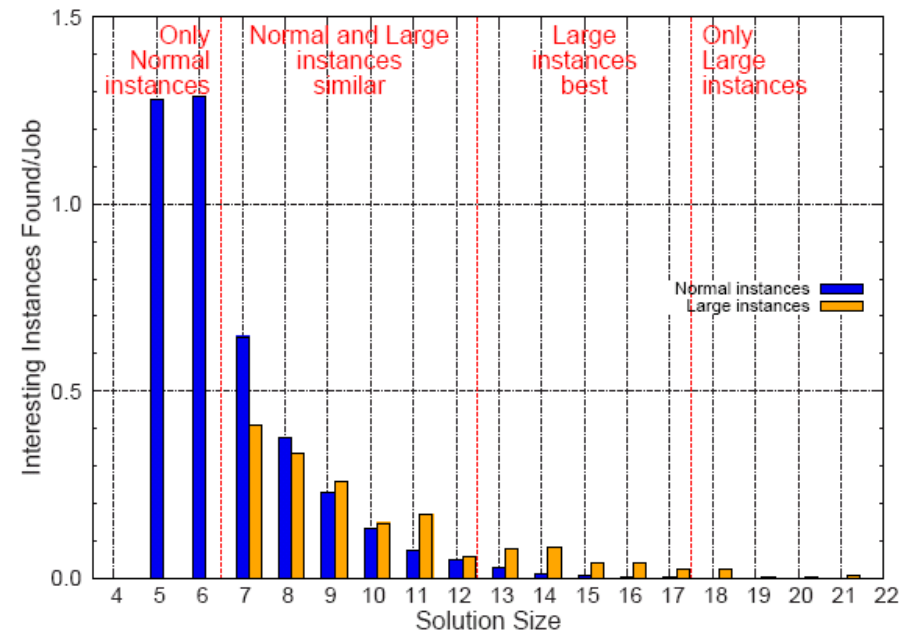
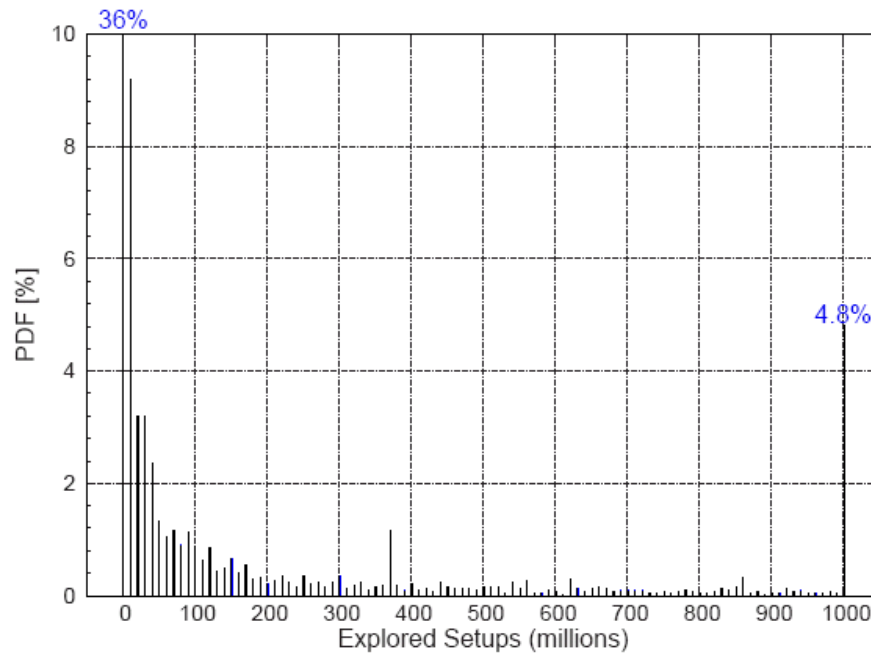


Generated and solved all 40 puzzle instances included in the commercial version of the game

Generated puzzles of **increasing difficulty**, from similar to much more difficult than the original puzzles

Experimental Results [2/3]

Workflow Characterization



- Job = 10,000 WFs → 1,364 billion puzzle setups
- Can tune the generation process: Normal vs. Large

Experimental Results [3/3]

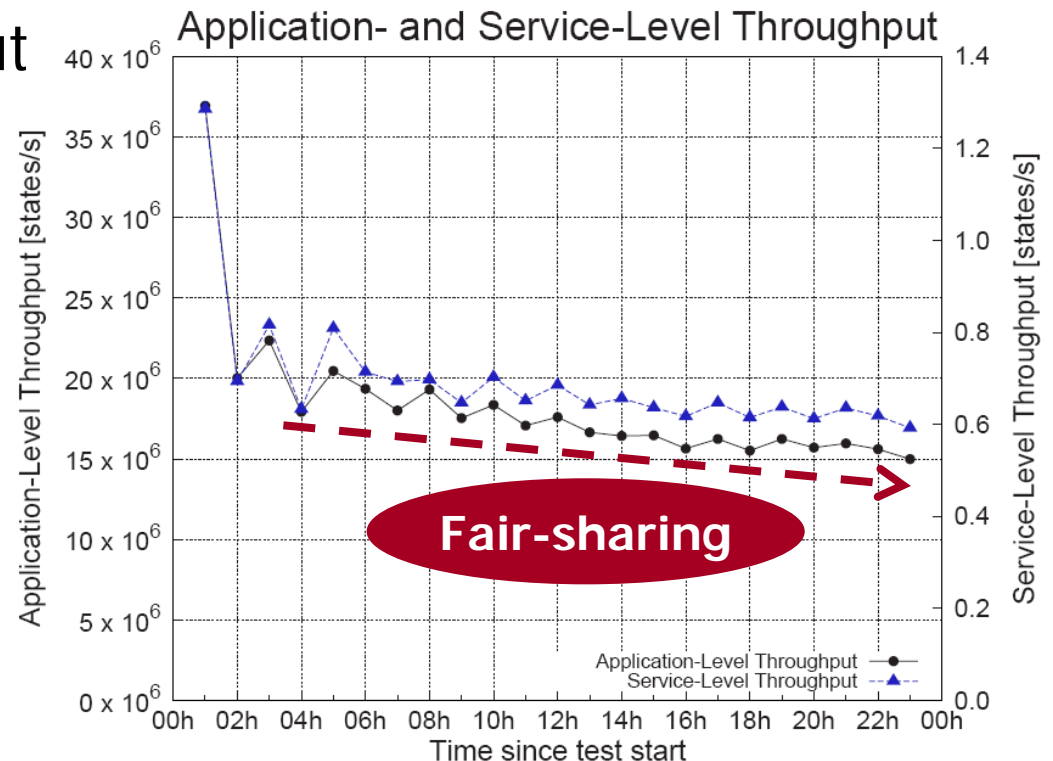
Steady (Linearly Scalable) Process

Application-Level Throughput

- Number of puzzle setups explored over time unit
- Average = >15M/second

Service-Level Throughput

- Number of interesting puzzle setups found over time unit
- Average = >0.5/second



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Three Research Directions

1. Generate more intricate puzzles and inter-related puzzles (quests)

- Orders of magnitude more difficult to generate
- Framework for evaluating “content interestingness”

2. Share state between workflow engines that generate content

- Find good synchronization granularity (auto-adapt)
- Co-execution (yes, co-allocation with a different name)

3. Guarantee service levels

- Workload modeling, process monitoring
- Clouds

Conclusion

MMOGs and Content Gen.

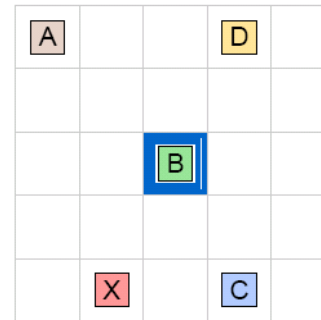
- Million-users, multi-bn. market
- Need content generation

Current Technology

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

Our Vision

- Automated content generation
- Economy of scale



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



The POGGI Architecture

- Focuses on puzzles
- Uses common cluster/grid middleware
- Can generate commercial quality content: Lunar Lockout

The Future of POGGI

- More puzzles
- More platforms
- **Three research directions**

Thank you for your attention!
Questions? Suggestions? Observations?

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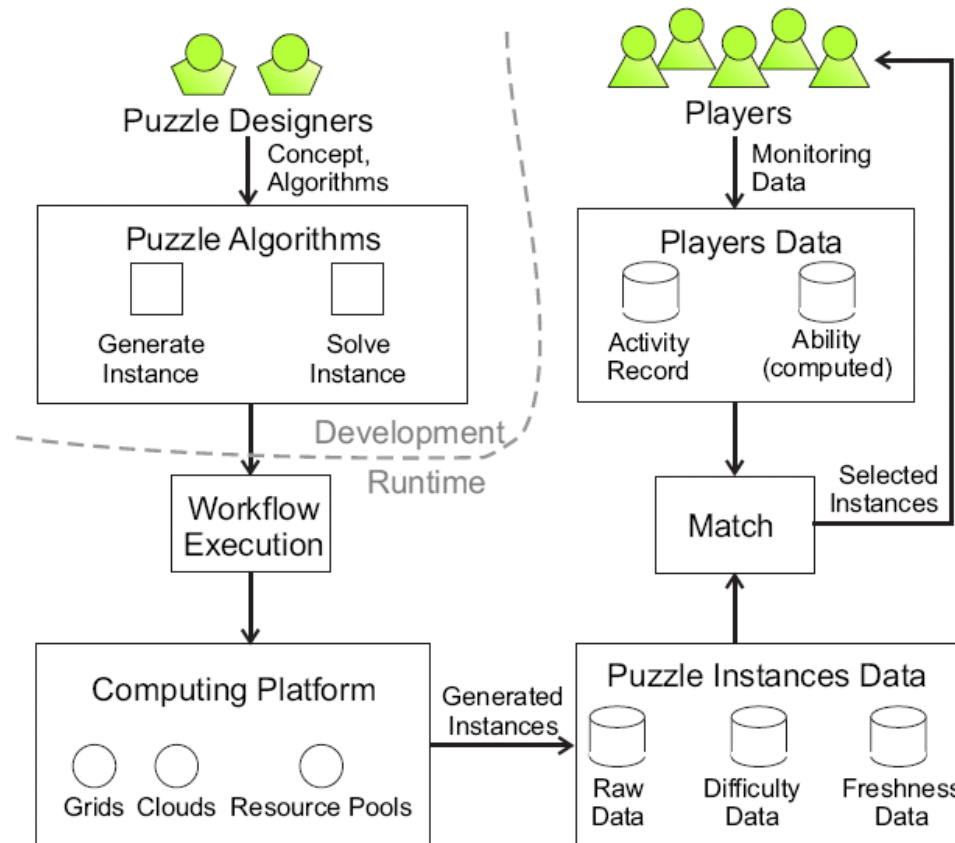
<http://www.pds.ewi.tudelft.nl/~iosup/> (or google "iosup")

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Additional Slides

The New Content Generation Process



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

Why Not Let Players Generate Puzzles?

How to control production pipeline?

After all, game developers sell content not technology.

How to select content?

Ranking problems, diversity problems.

How to avoid game exploits?

Virtual currency = Real currency

server	faction	100 Gold	Amount	Price	Quick link	Shop profile	Shop rating
Aegwynn	Alliance	\$0.57	5mn Gold	\$15.90	Buy now!	OgPal	<input type="text" value="3.0/10"/>
	Horde	\$0.45					

Source: mmobux.com, Aug 2009

User-generated content is clearly an interesting research area, but that's another story.