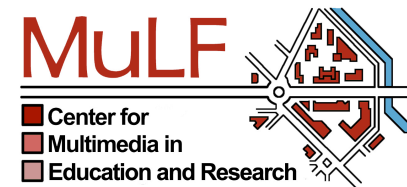
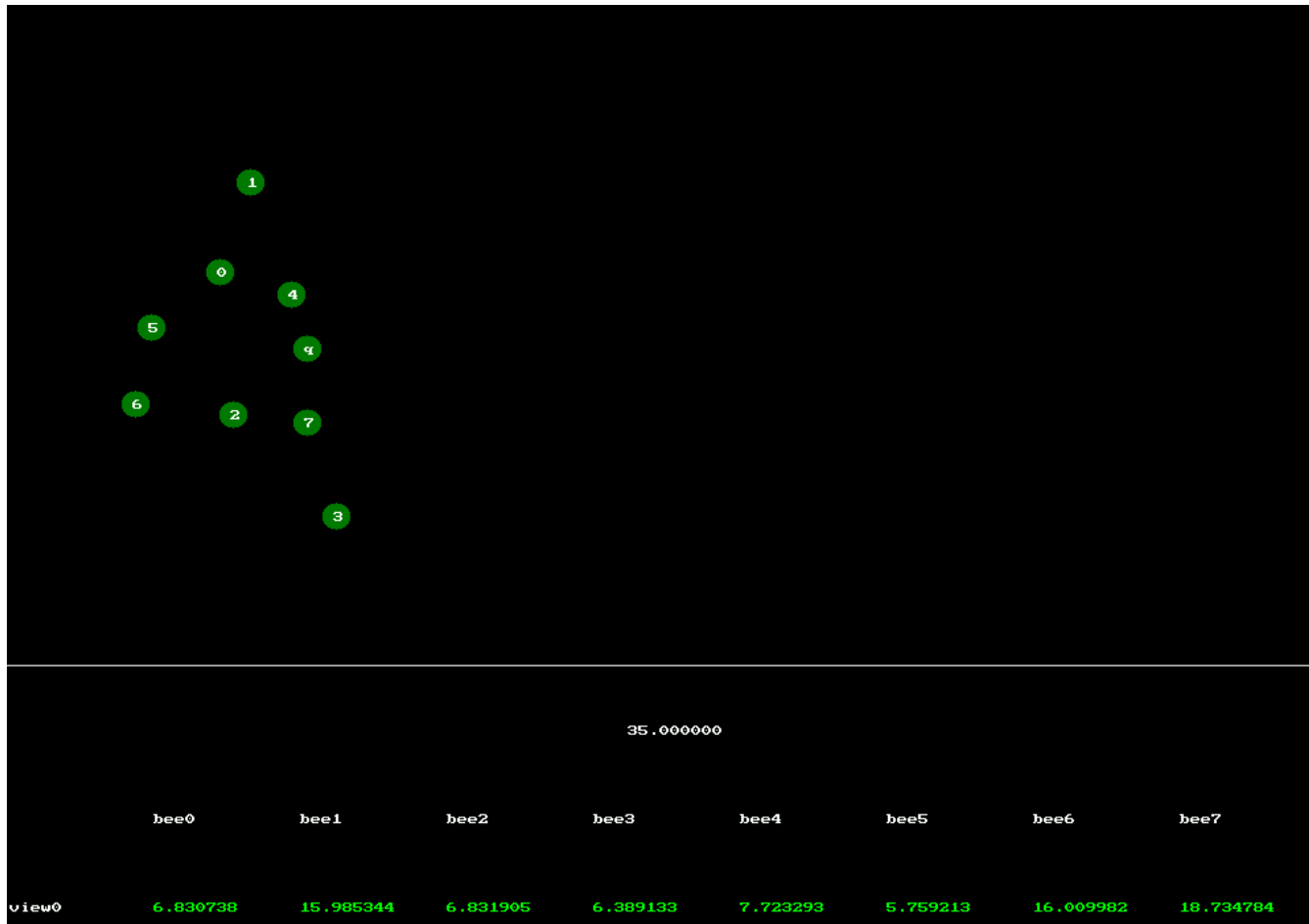


# Protection of Virtual Property

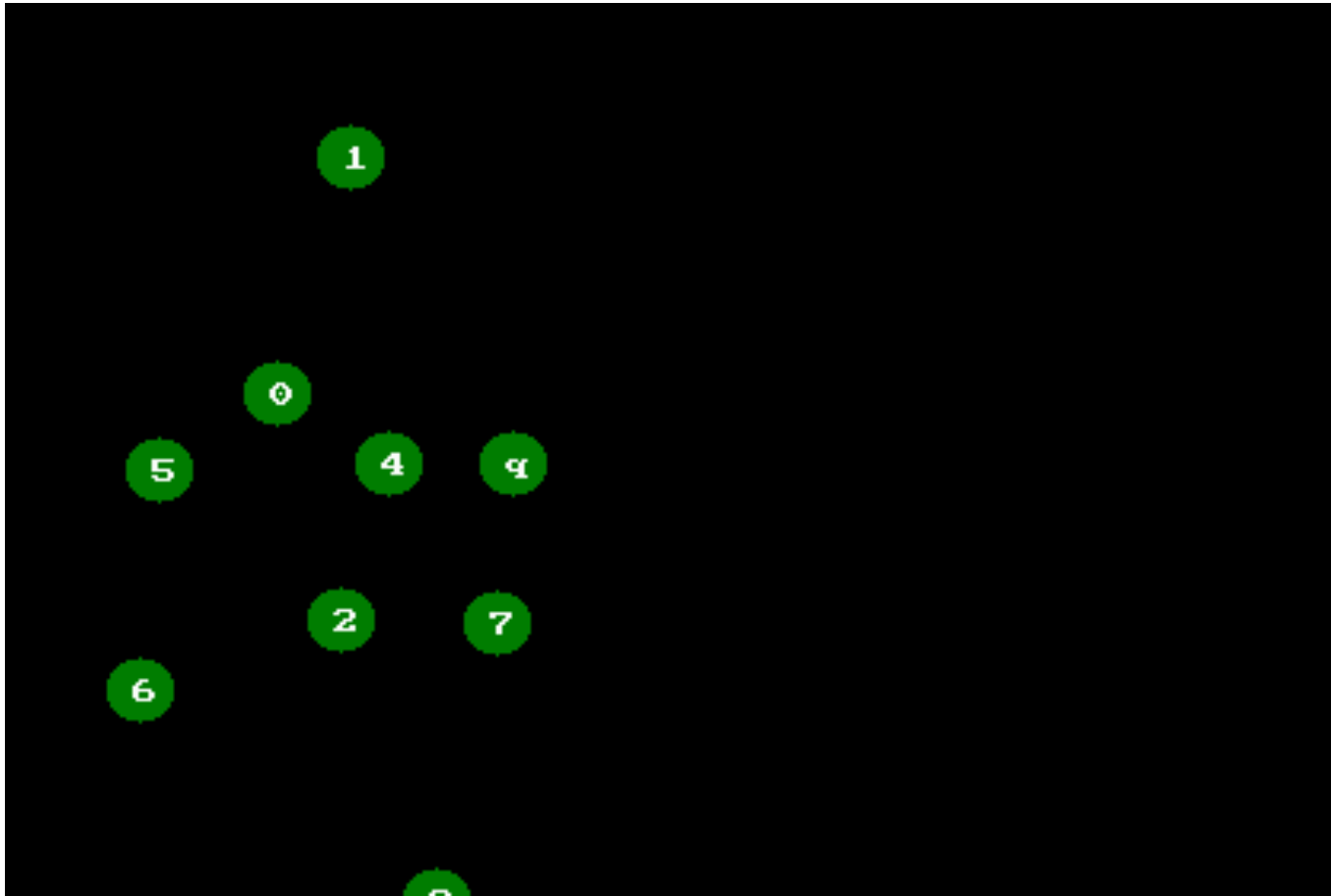
## The Future of Online Worlds



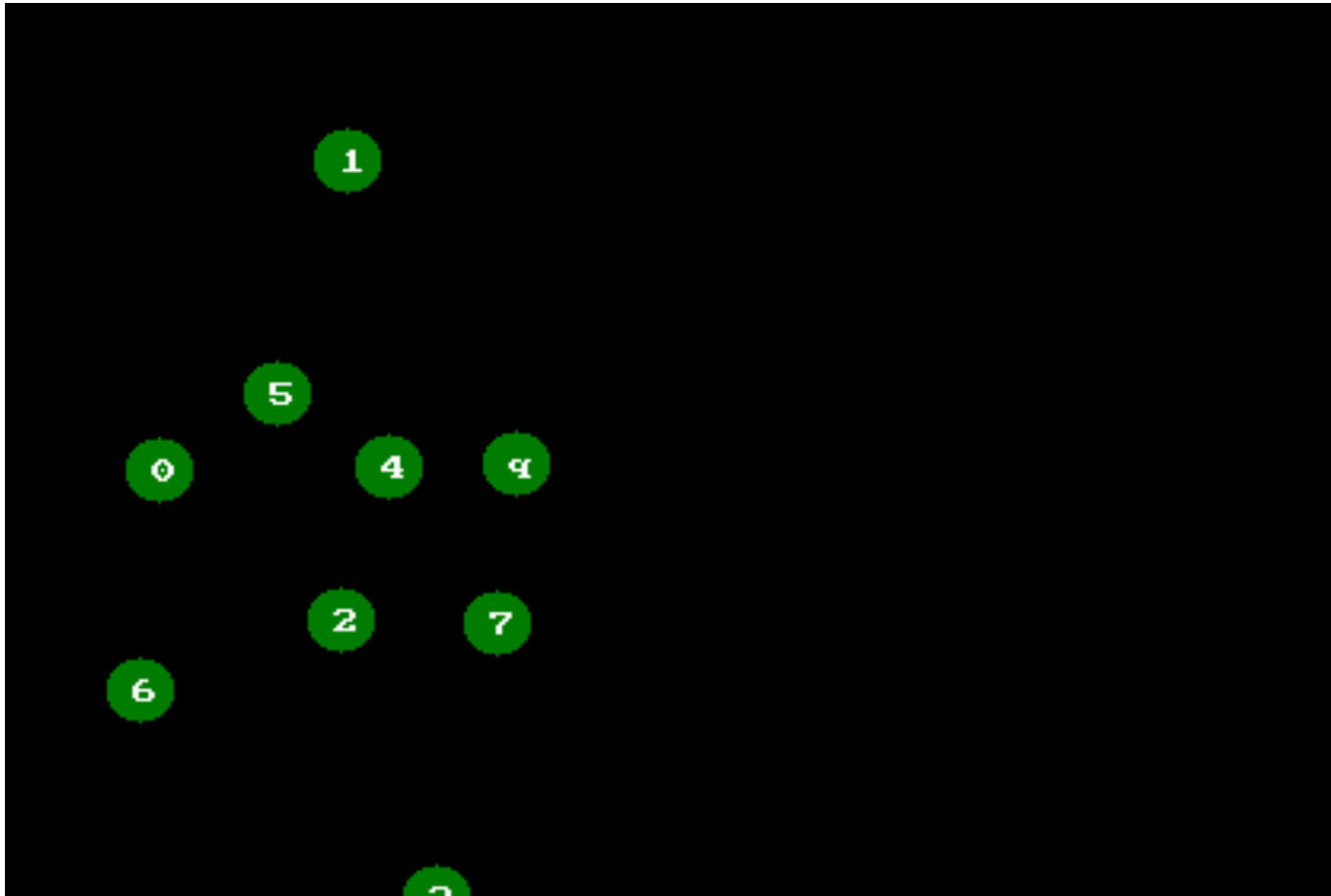
# The Problem



# The Problem



# The Problem



# Overview

- **The importance of virtual property**
- **The future of virtual worlds**
- **Consistency in DVEs (distributed virtual worlds)**
- **Outlook**

# The Value of Virtual Property

## ***What it is:***

- **Object/construct in a virtual environment**
- **Especially if production controlled, tradable**
- **Sword, umbrella, plot of virtual land, L  
\$**

# The Value of Virtual Property

## ***What it is not:***

- **A placeholder for a real object**
- **A work of art, intellectual property**
- **Bank account, music, design/  
textures/script for umbrella**

# The Value of Virtual Property

- **Accruing of virtual property often the main point (especially games)**
- **Usually generated according to specific rules**
- **Traded for real \$, thus real value**
- **\$2 Billion/yr market**

# The Value of Virtual Property

## *They all want it:*

- **Big money -> lots of criminals**
- **Cheat: Gain an advantage by breaking the in-world rules**
- **Attain, clone, destroy items**
- **Fraud: Scamming other people**
- **Often relies on obfuscation**

# The Value of Virtual Property

## ***Why security?***

- **Virtual economy**
- **Attractiveness of the virtual world**
- **Lawsuits**

# The Value of Virtual Property

## ***Cost of security?***

- **Seamless exploit protection**
- **Withstand concerted attack**
- **Logging, preferably replay**
- **Decidable + provable**
- **Customer service (~50% fraud-related)**

# The Future of Online Worlds

## ***External:***

- **More computational power**
- **More bandwidth**
- ***Not* significantly lower ping**

# The Future of Online Worlds

## ***Many many more users:***

- **Now:**
  - Average 2k CU, max 60k CU
  - However, WoW has 10M TU
- **Then:**
  - China: VE's with 7M CU, 150M TU.
  - SL: 50M CU, 2G TU

# The Future of Online Worlds

## ***Scalability:***

- **Currently: Some component  $O(N)$**
- **Must have  $O(1)$  -> Distributed**
- **P2P**
- **Vast server parks**

# Consistency of DVEs

## ***Traditional consistency:***

- **DB, concurrent programming, multiprocessors**
- **Problem is solved**
- **Sequential, causal, FIFO, weak, etc.**
- **Trade-off between speed and strictness**

# Consistency of DVEs

## ***Interactive consistency:***

- **Immersion requires fast local reactions (<150ms)**
- **Can not wait for synchronization**
- **Typically act inconsistently**
- **Conflicts arise**
- **Conflict resolution**

# Consistency of DVEs

## ***Loose consistency:***

- Regular updates to other hosts
- Overwrite with incoming data
- Prevent oscillation

## ***Advantages:***

- Simple
- Robust
- Scalable

# Consistency of DVEs

## ***Loose consistency:***

### ***Problems:***

- **Simulation errors**
- **Differing logs**
- **Undecidable cases**
- **Dependance on network timing**

# Consistency of DVEs

## ***Optimistic consistency:***

- **Speculative consistency (DB, multiprocessors)**
- **Build global history on each host**
- **Enqueue late events**
- **backtracking**

## ***Advantages:***

- **One true, error-free global history**
- **All hosts reach global log in hindsight**

# Consistency of DVEs

## ***Optimistic consistency:***

### ***Problems:***

- **More computation**
- ***Currently not scalable***

# Outlook

- **Theoretical problem unsolved**
- **SL, OpenSim**
- **Carefully scripted protection (e.g. L\$)**
- **Scalable optimistic consistency**