A Peer Auditing Scheme for Cheat Elimination in MMOGs

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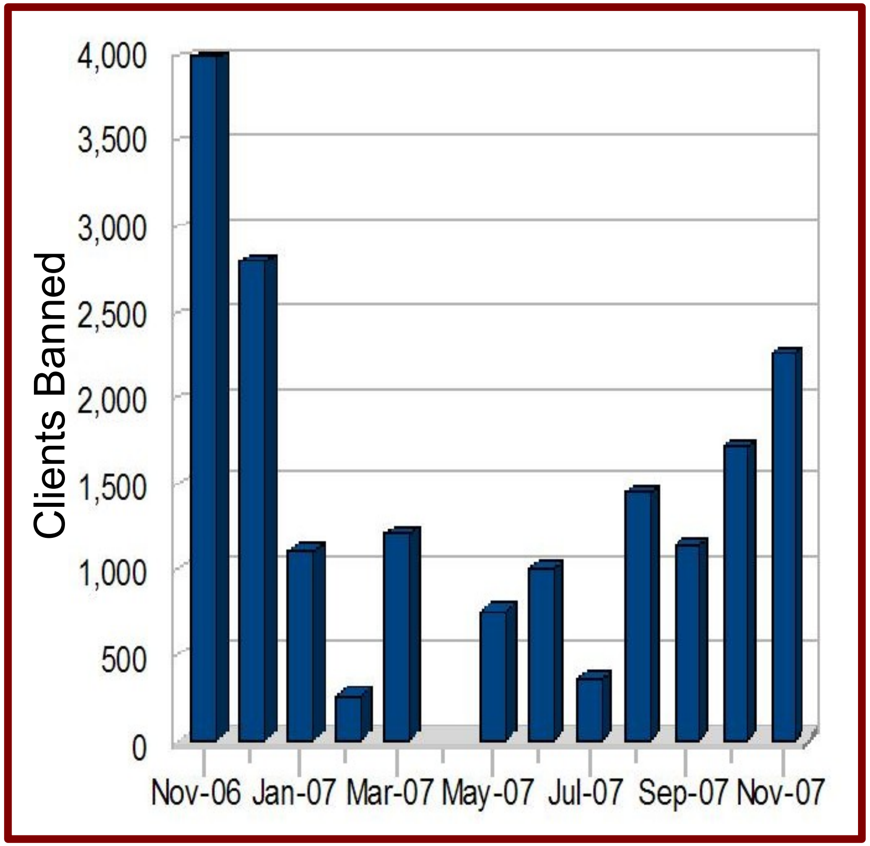
Introduction: *Cheating Impact*

- Cheating in MMOGs can have an **important** impact
- Example: cheaters **banned** for using the "Movement Enhancing Hack" in Final Fantasy XI
- There is a FFXI cheating task force



Introduction: *Current Solutions*

- Current Cheat Elimination Solutions are:
  - Manual:
    - Log reviewing
    - Complaint based
  - Methods that focus on a specific cheat
  - Using to Client Server (C/S) models
- **But:** harder to implement and limit scalability (C/S over P2P)

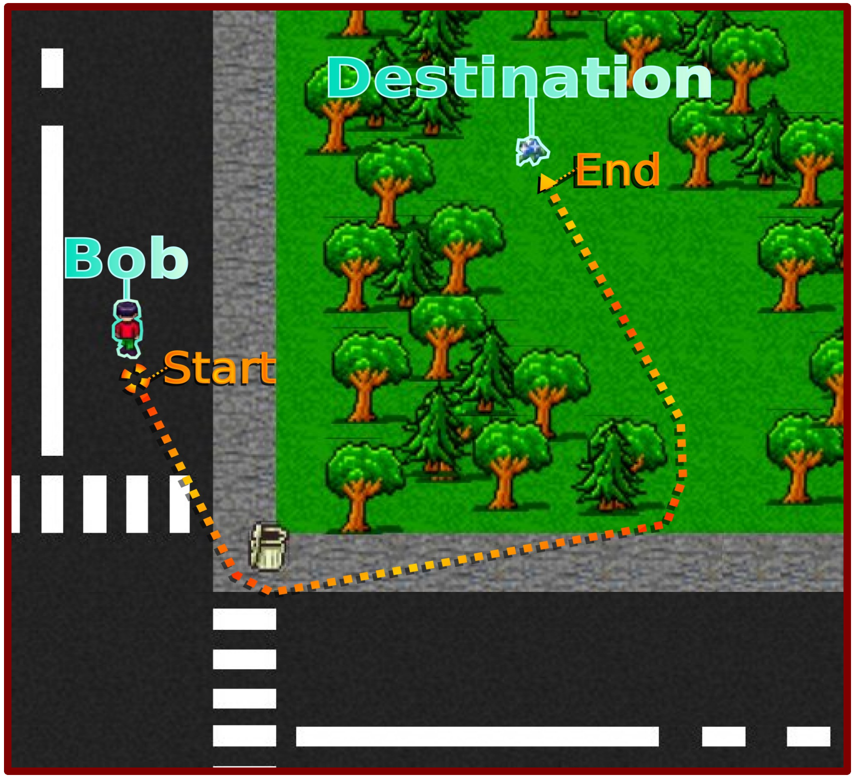
Introduction: *Other Solutions*

- Automatic, scalable cheat resistance is very desirable, however:
  - Cheating domain: it is hard to define exactly what *"cheating"* is
  - Performance: a solution must be scalable, having low overhead
  - Accuracy: a solution should punish **only** cheaters
    - Should avoid mistaking a trustworthy client as a cheater

      False positives

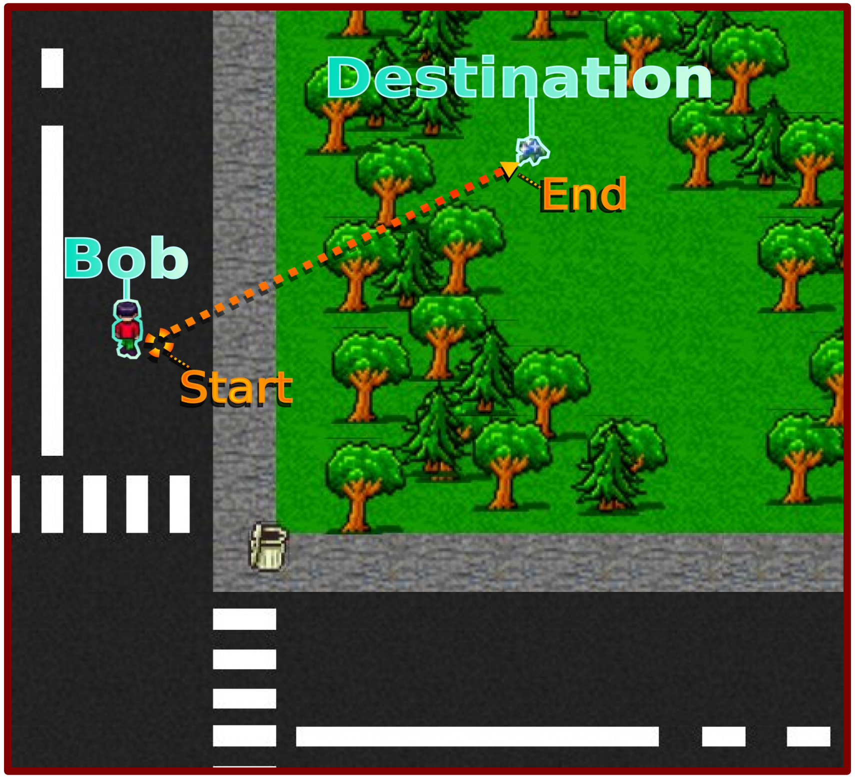
Introduction: *Motivating Example*

- McGill MMOG Testbed: ***Mammoth***
- Problem:
  - Path-finding done **client side**
  - Allows for **abuse** / **cheating**
- Example:
  - Normally, **Bob** finds the path leading to the **destination**



Introduction: *Motivating Example*

- McGill MMOG Testbed: ***Mammoth***
- Problem:
  - Path-finding done **client side**
  - Allows for **abuse** / **cheating**
- Example:
  - **Bob** can also cheat sending a path that ignores obstacles



Introduction: *Motivating Example*

- Alternate approach
  - Path-finding done **server** side
  - Lowers chances for **abuse** / **cheating**
  - Path-finding is expensive
  - Can cause a bottleneck
- Idea: Marry both approaches
  - Use **P2P** for <u>load management</u>
    - Use **Peers** to resolve path requests
  - Use **C/S** for <u>cheat resistance</u>
    - Use **server** as an arbiter

Hybrid Solution: *The IRS Model*

- Approach MMOGs with a Hybrid Model
  - Try and create a network model that is the best of both worlds
- The *IRS* hybrid model:
  - Uses a centralized server for verification / persistence
  - Uses P2P communication for message handling
- Goal:
  - Reduce the occurrence / accessibility of **Cheating**
  - Reduce the computational requirements of the Server

Hybrid Solution: *Cheat Detection*

- Detection of suspicious behaviour
  - Use *peer auditing*
    - Send copies of requests to an extra client
    - Compare both answers
  - If both answers are the same
    - Assume they are both correct
  - If both answers differ
    - Assume either is cheating
    - Compute the **true** result and compare both answers

Hybrid Solution: *Cheater Identification*

- There are many causes for suspicious behaviour
  - Hardware differences
  - Communication failure
  - Cheating
- Differentiating between errors and cheating:
  - Use a ***Trust Metric:***
    - Group the failures by severity
    - Count the number of failures against successes
    - Since random hardware or communication errors are rare
    - Use this to determine if a client is likely cheating

Hybrid Solution: *Summary*

- We propose the IRS model as a cheat reduction solution that is:
  - *Scalable with Low overhead:* allows P2P communication and reduces server **CPU load**
  - *Automatic*: peer auditing allows for the identification of suspicious behaviour
  - *Accurate:* Trust based scoring differentiates between random *errors* and *cheating behaviour*

Design: *Overview*

- The IRS Model incorporates the following:
  - Communication Model
  - Message Verification Scheme
    - Auditing
    - Monitoring
    - Quick Testing
  - Trust method for identifying cheaters
  - Disciplinary system that removes malicious clients

Design: *Components*

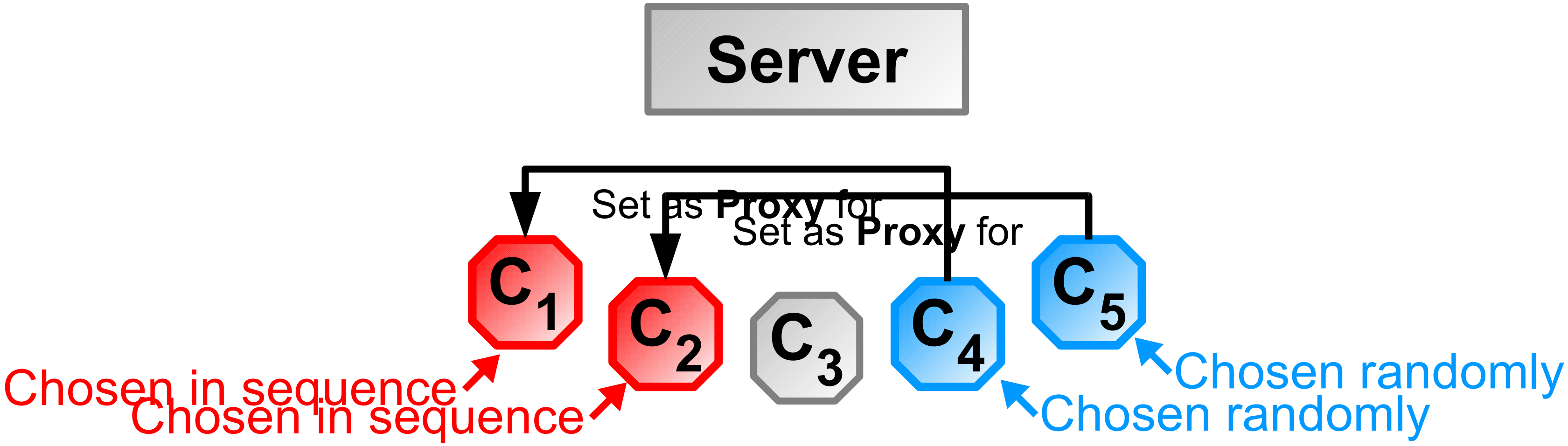
- Components of the IRS Model:
  - **Server**
    - Acts as arbiter for clients
    - Manages gamestate
    - Handles Login
  - Monitors **M_1**
    - Owned by the game providers
    - Monitor and verify audits
  - Clients **C_1**
    - The game players
    - Acts as a **proxies**
    - Has a client **proxy**

Design: *Load Distribution Protocol*

- The IRS model's *load distribution protocol* is:
  - P2P oriented:
    - *<u>Proxies</u>* are clients that compute message results for others
    - Each client has a proxy and acts as a proxy for others
  - C/S oriented:
    - Server handles login
    - Result monitoring
    - Gamestate maintenance
    - Message relaying
    - Matching clients and proxies

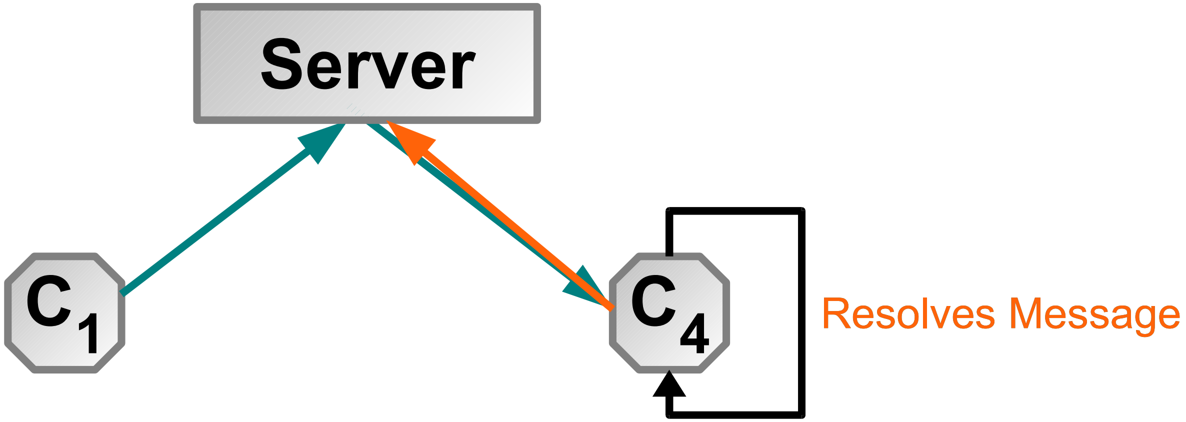
Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 1. Proxy Assignment
    - Randomly matches clients to proxies
    - Proxies are assigned by server at regular intervals



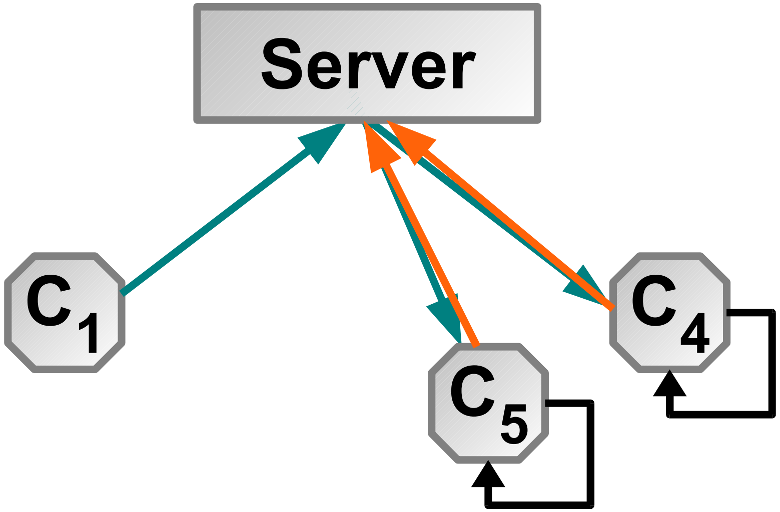
Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 2. Message Relaying
    - Server relays path finding requests from a client to its proxy
    - The proxy is responsible for resolving said request



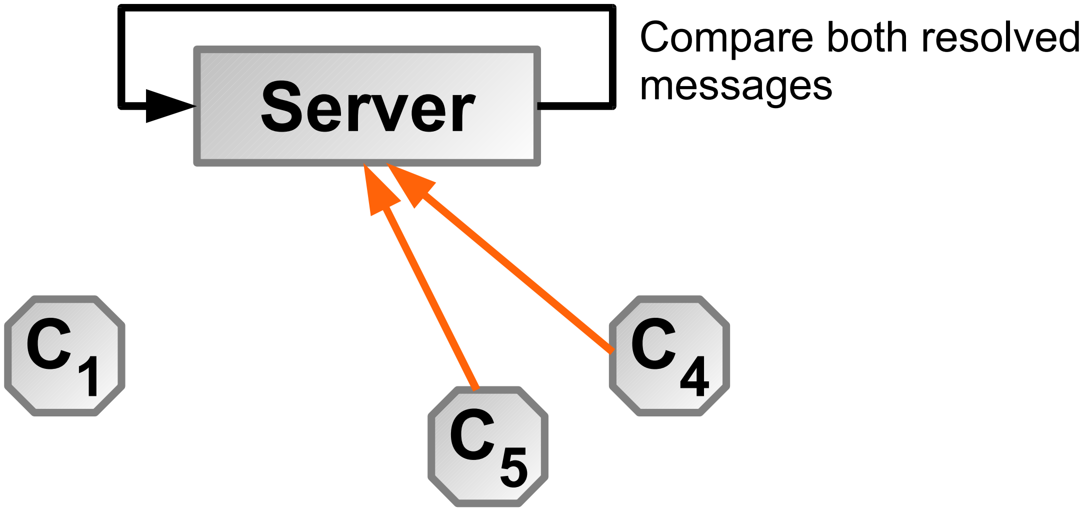
Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 3. Peer Auditing
    - The server randomly audits clients by simultaneously sending the request message to an extra client (co-auditor)



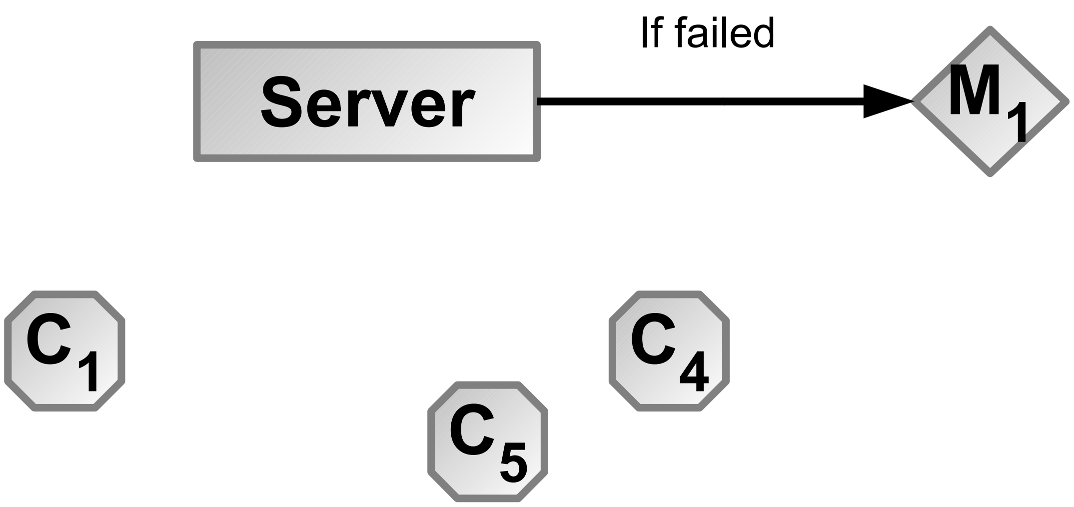
Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 3. Peer Auditing
    - The proxy's message is quick-tested and forwarded
    - The server then compares both resolved messages



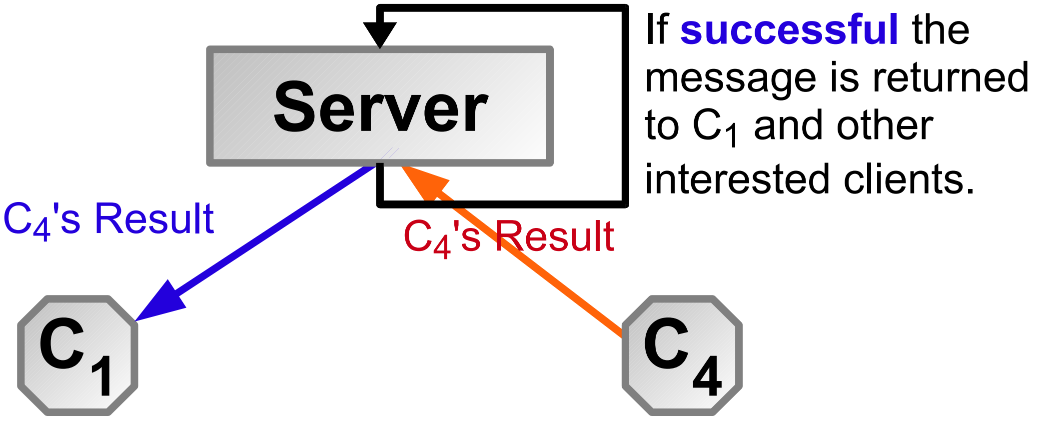
Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 3. Peer Auditing
    - If the comparison fails, the audit is sent to the monitor



Design: *Load Distribution Protocol*

- 4 Protocol Phases (Server)
  - 4. Message Handling
    - Quick Testing of resolved messages
    - Relaying the resolved message to appropriate clients



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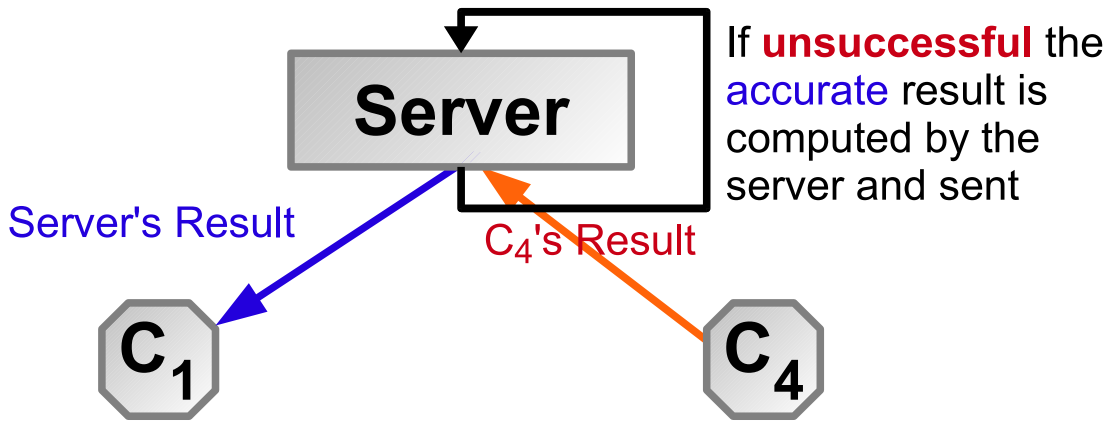
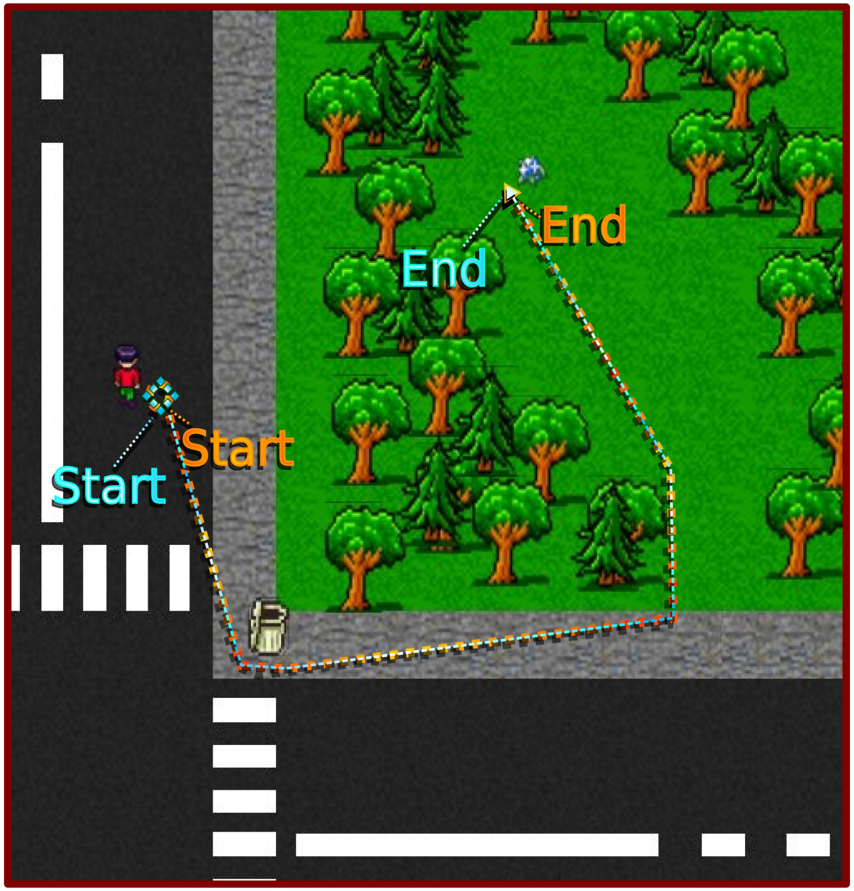


Design: *Auditing Scheme*

- Peer Audits
  - Examine resolved messages returned by proxies
  - Started randomly
  - Opened during the message relaying phase
  - Compared at a **later** time
- Audits yield the following:
  - Identical
  - Equivalent
  - Inequivalent
  - Infeasible

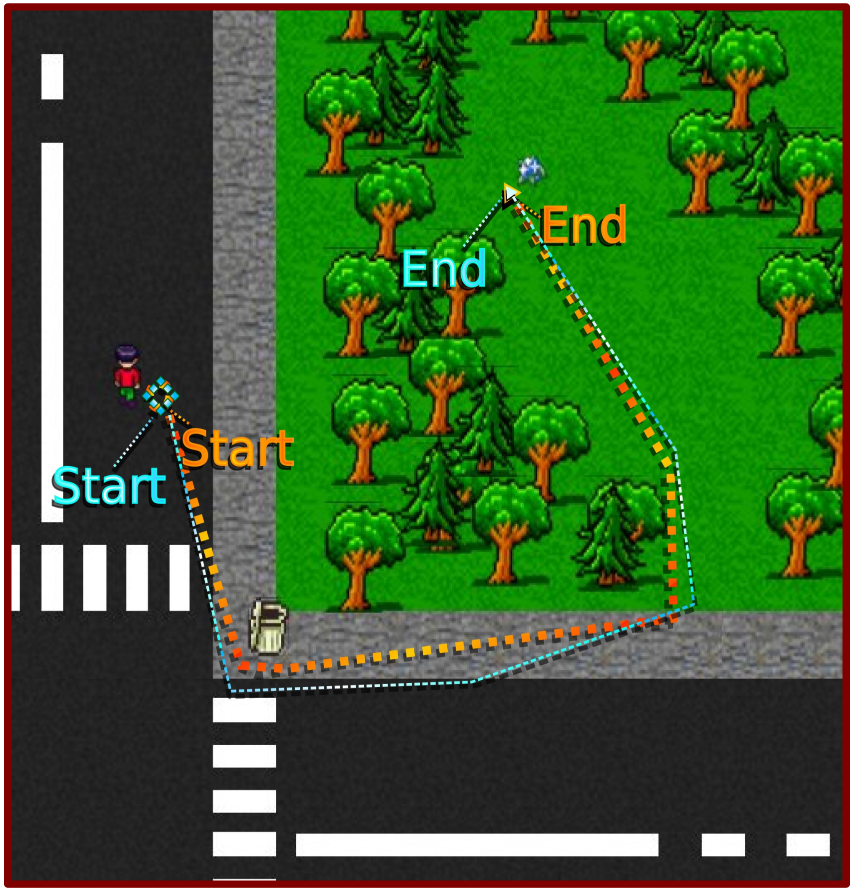
Design: *Comparison Types*

- **Identical:**
  - All points are coincidental
  - This is the **best** possible comparison result.



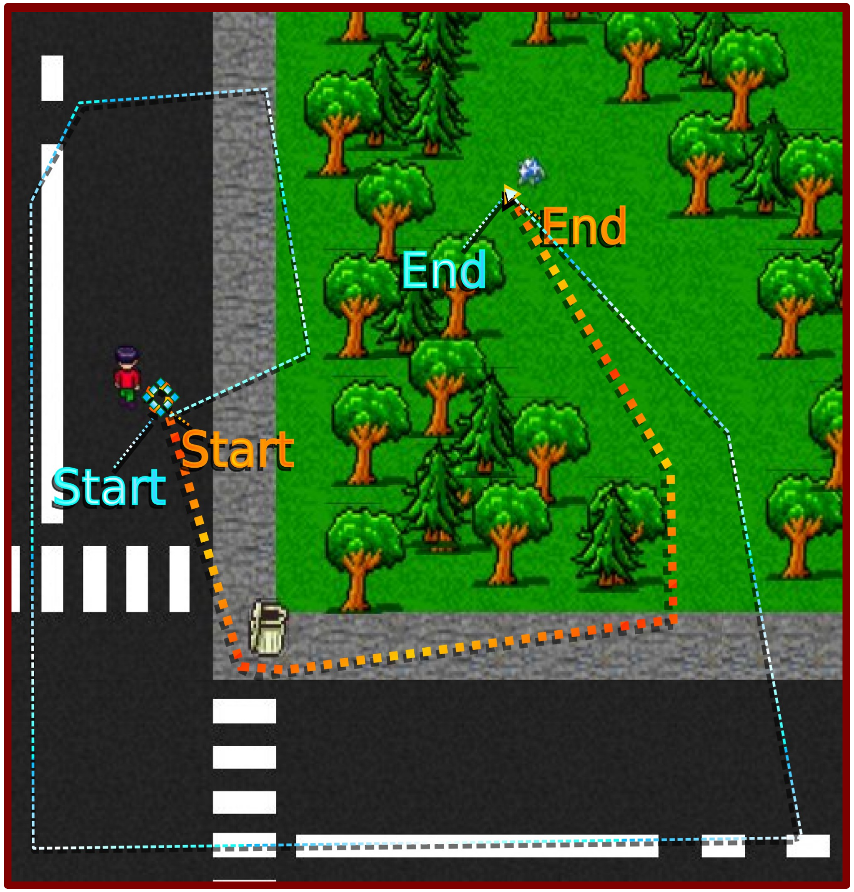
Design: *Comparison Types*

- **Equivalent:**
  - Same **starts** point
  - Same **ends** point
  - Similar **lengths**
  - Regarded as a **positive** result



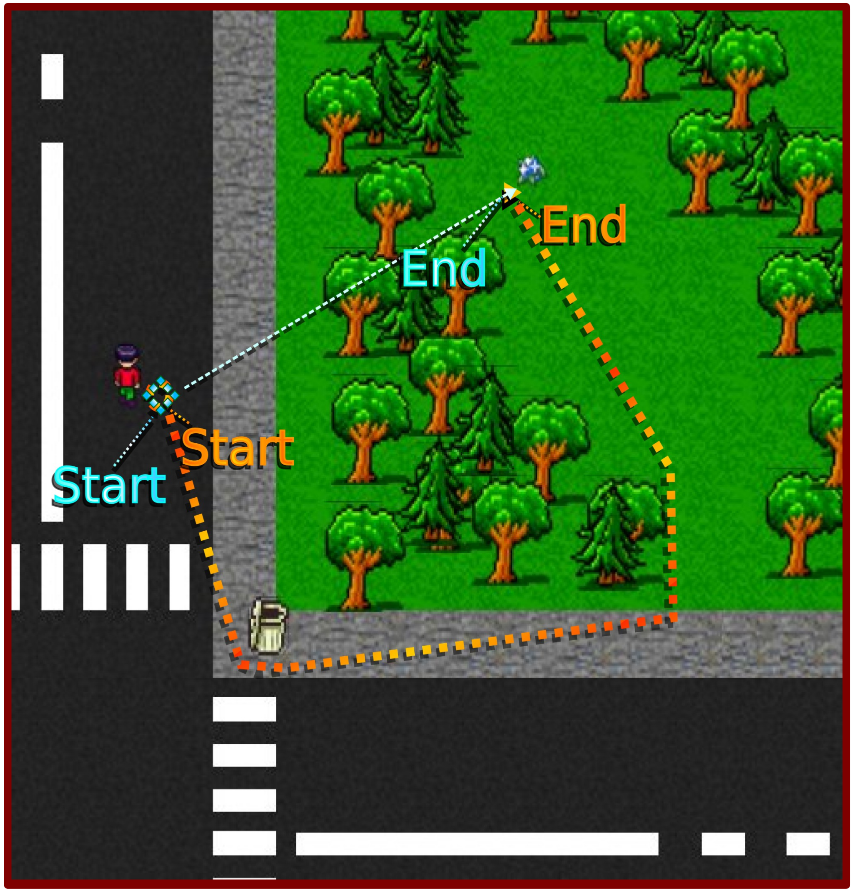
Design: *Comparison Types*

- **Inequivalent:**
  - Different **start** points <u>or</u>
  - Different **end** points <u>or</u>
  - Dissimilar **lengths**
  - Regarded as a **negative** result



Design: *Comparison Types*

- **Infeasible:**
  - *Violates game rules*
  - Passes through obstacles or
  - Leads to inaccessible areas
  - This is the **worst** possible comparison result



Design: *Monitoring*

- Failed audits are subjected to *Monitoring*
  - *Monitors* are controlled by game company
  - Monitors resolve the original request message
  - Compares its result to the two results contained in the audit
  - Determines which clients are responsible for the audit failure

Design: *Trust*

- *Trust*
  - Designed to distinguish cheats and error
  - History based
  - Identical and equivalent messages cause an increase
  - Inequivalent and infeasible messages causes a drop
  - Can require a discount factor in order to forget older infractions

Design: *Quick Testing*

- *Quick Testing* eliminates worst-case inaccuracies
  - Computed cheaply
  - Can only determine if a message is infeasible or not
  - Is used **before** relaying messages back to clients
  - If failed, the server will compute its own resolved message

Design: *Disciplinary Action*

- Disciplinary Action
  - Booting: when an inaccuracy is caught
    - Temporary
    - Early warning
    - Breaks up consecutive cheating
  - Banning: when trust falls below the *ban threshold*
    - Permanent
    - Ultimate deterrent
    - Lowers the number of cheaters in the system

Results

- Cheat reduction tests in 2 environments
  - Static client base
  - Dynamic client base
- Load analysis
  - Determine CPU load reduction
  - Bandwidth increases
  - Costs of cheat reduction

Results: *Parametrization*

- Client Simulation:
  - Legit Clients:
    - Trustworthy clients
    - Never attempt to cheat
    - Have a small chance to fail
  - Are 99% accurate

Results: *Parametrization*

- Client Simulation:
  - Griefers:
    - Want to disturb others
    - Cheat in order to ruin other's game play
    - Example: sending clients in the wrong direction
  - Will “grief” 50% of the time, returning inequivalent results

Results: *Parametrization*

- Client Simulation:
  - Hackers:
    - Malicious clients
    - Attempt to destabilize the game
    - Example: returning a result with a different start point in order to “teleport”
  - Will cheat 50% of the time
    - 50% of said cheats will be infeasible
    - The other 50% will be inequivalent

Results: *Parametrization*

- Client Simulation:
  - Monitors:
    - Owned by the game providers
    - Used to monitor audits after the fact
  - Assumed to resolve messages 100% accurately
  - Compares its result to audit
  - Determines whch client is responsible

Results: *Parametrization*

- Client Overview:
  - Legit Clients: 99% accurate, 1% error
  - Hackers: 50% accurate, 25% inequivalent, 25% infeasible
  - Griefers: 50% accurate, 50% inequivalent
  - Monitors: 100% accurate
  - Clients make requests every ~{0,3] seconds
    - Based on practical game data

Results: *Parametrization*

- Cheat Reduction:
  - Audit: 10% of requests, Monitor: 5% of positive audits.
  - Boot time: 30 secs
  - Ban threshold: -15
    - Determined as best candidate experimentally
  - Trust metric:
    - Also Determined as best candidate

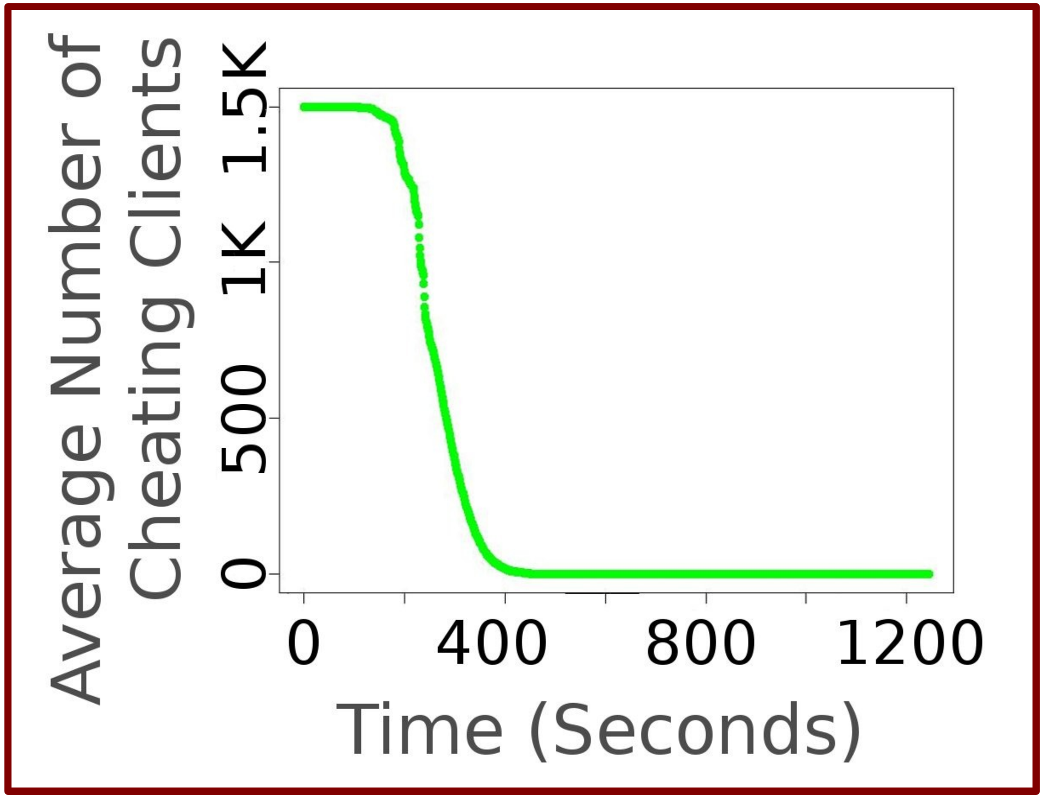
$$\boxed{T = [\text{identical}] + [\text{equivalent}] - [\text{inequivalent}]^{1.5} - [\text{infeasible}]^{2}}$$

An exponent of 1.5 causes less serious cheats to ramp up quickly, but not too quickly as to effect legit cleints

An exponent of 2 causes more serious cheats to ramp up exceedingly quickly removing malicious clients effectively

Results: *Experiment 1*

- Experiment in a **static** setting
- Initial clients:
  - 8,500 legit
  - 750 hackers
  - 750 griefers
- 20 minute experiments
- Very few false positives ~ 0.4 clients per experiment



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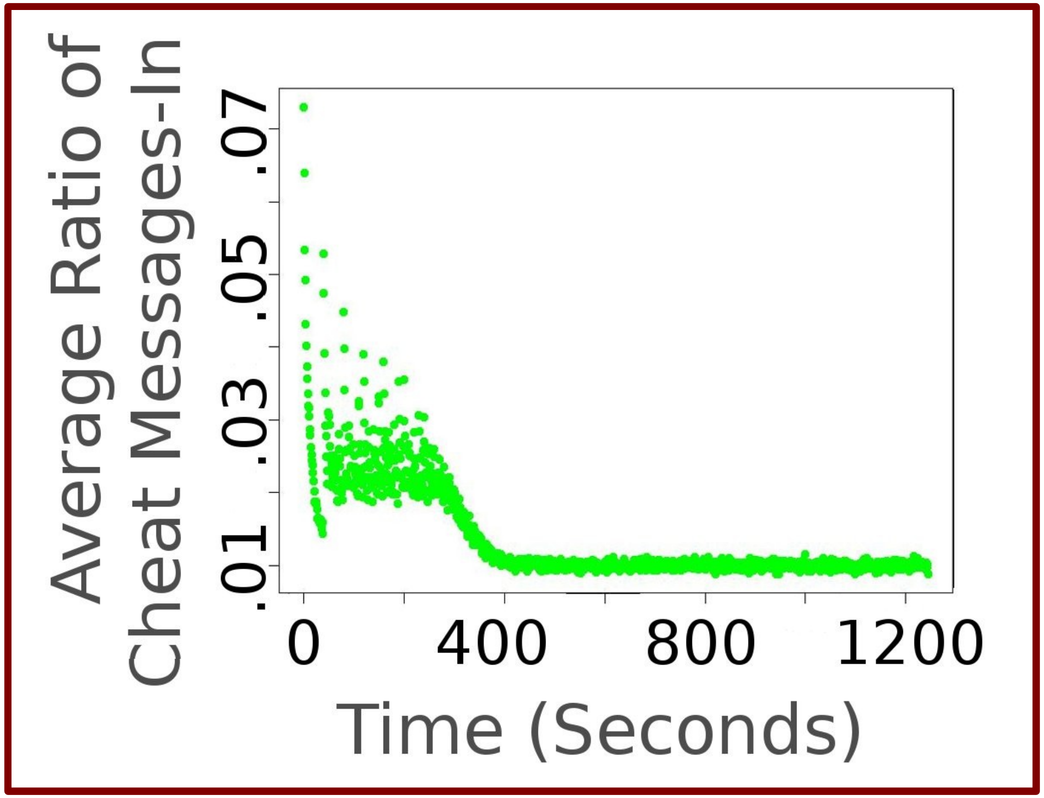
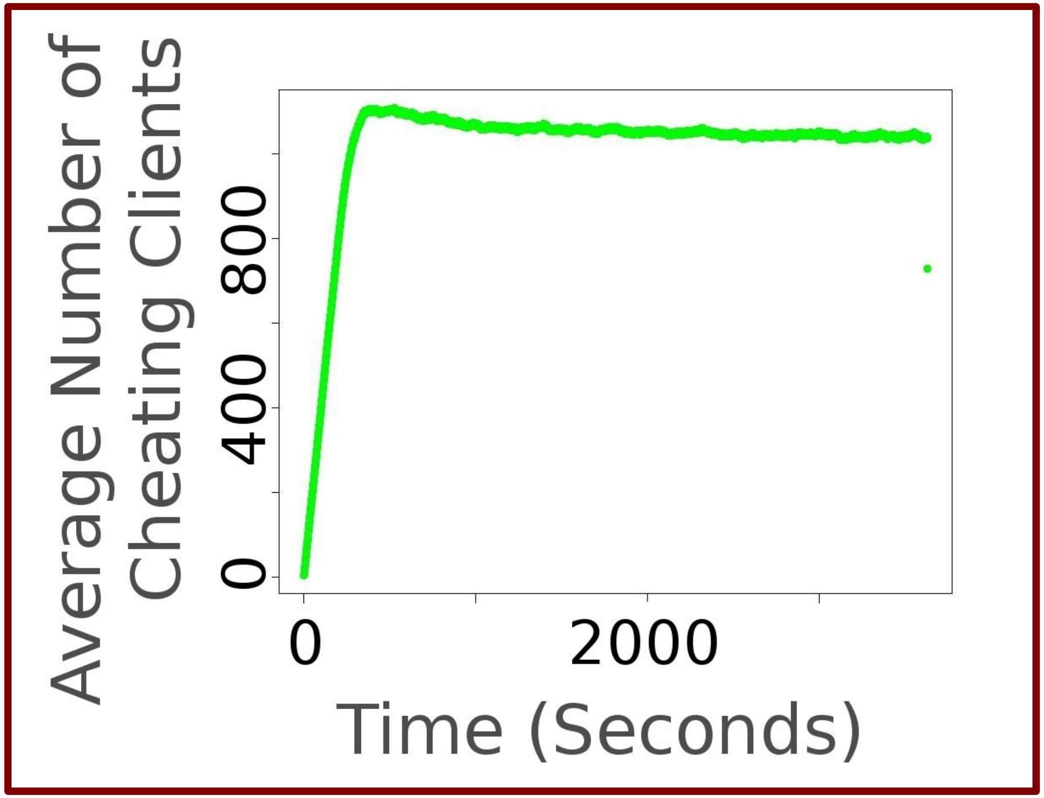


Results: *Experiment 2*

- Experiment in a **Dynamic** setting
- Initial clients: 0
- Per second:
  - 6 legit
  - 2 hackers
  - 2 griefers
- 60 minute experiments
- More false positives ~ 8 per experiment



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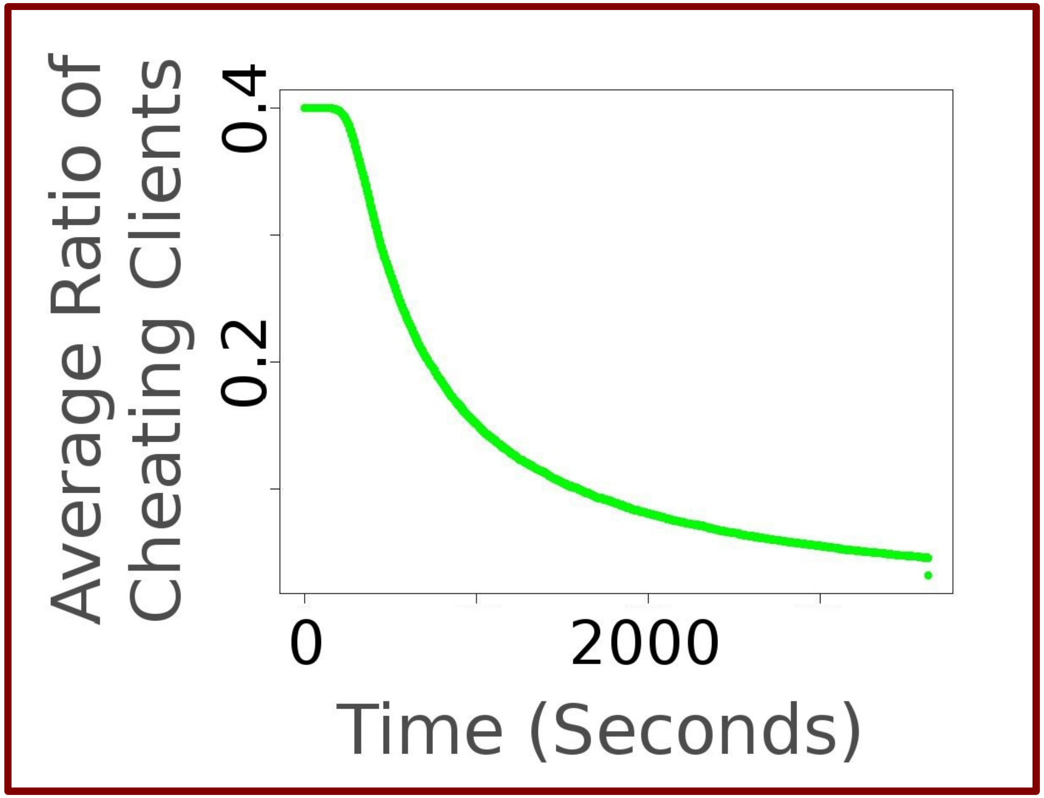
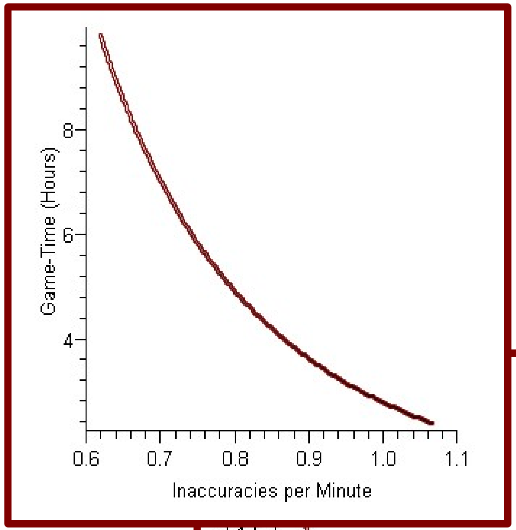
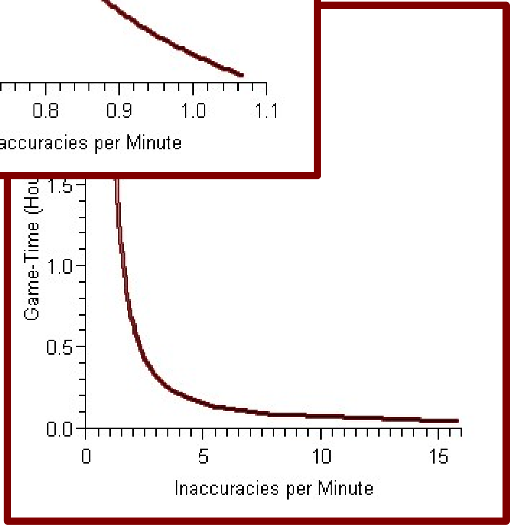


Results: *Rate of Cheating Analysis*

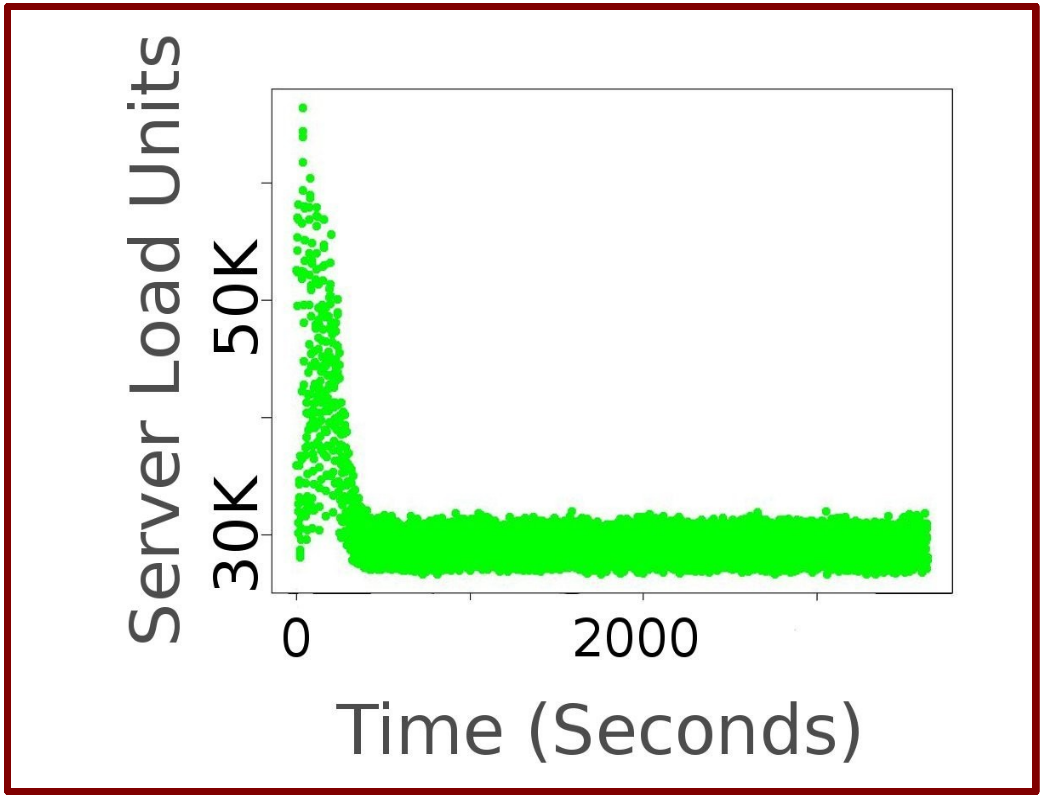
- Formal analysis
  - Relates rate of cheating to expected ban time
  - Shows:
    - A cheater must reduce its rate of cheating to last
    - A lower rate of error extends game time drastically
    - A client with a 0.1% error rate is expected to last will last ~7.5 months of continual gameplay





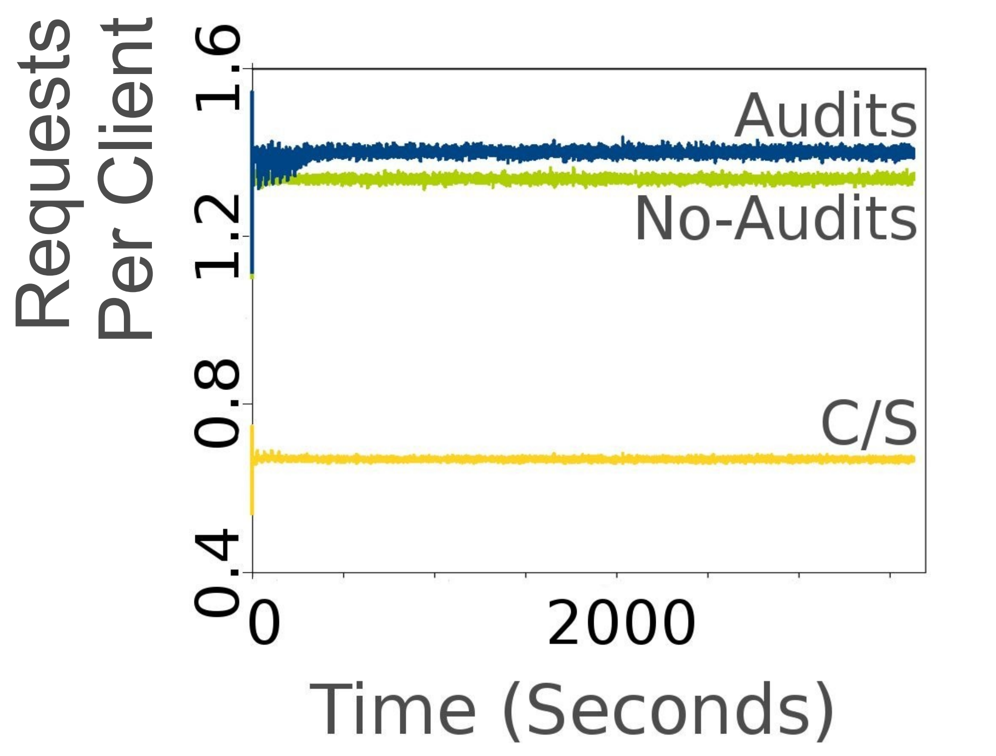
Results: *Experiment 3a*

- Experiment on Load/Overhead
- From static experiment data
- 60 minute experiments
- C/S results depict a load of around 250,000-275,000 units.



Results: *Experiment 3b*

- Experiment on Load/Overhead
- From static experiment data
- 60 minute experiments
- Compares
  - C/S
  - IRS w/ audits
  - IRS w/o audits



Conclusion: *Summary*

- Trade-off between **scalability** and **Cheat Resistance**
- IRS model shows
  - Good CPU load reduction ~ 10%
  - Ability to eliminate cheaters quickly
    - In approximately 400 seconds (due to booting)
  - Higher bandwidth > 200%
  - Higher Number of Hops > 200%

Conclusion: *Future Work*

- The examination of models which:
  - Ensure the IRS cheat reduction guarantees
  - Lower bandwidth cost
  - Lower latency
- The examination of auditing systems which:
  - Use adaptive auditing based on trust
- Integration of the IRS model into Mammoth
  - Alleviate cost of server side path-finding
  - Investigate IRS properties in a concrete setting

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Design: *Communication Model*

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  - 1. Proxy Assignment
    - Done by server at certain intervals
  - 2. Message Relaying
    - Server relays messages from a client to its proxy
    - The proxy is responsible for resolving said message
  - 3. Peer Auditing
    - Resolved messages computed by different clients on identical requests are compared
  - 4. Message Handling
    - Quick Testing of resolved messages
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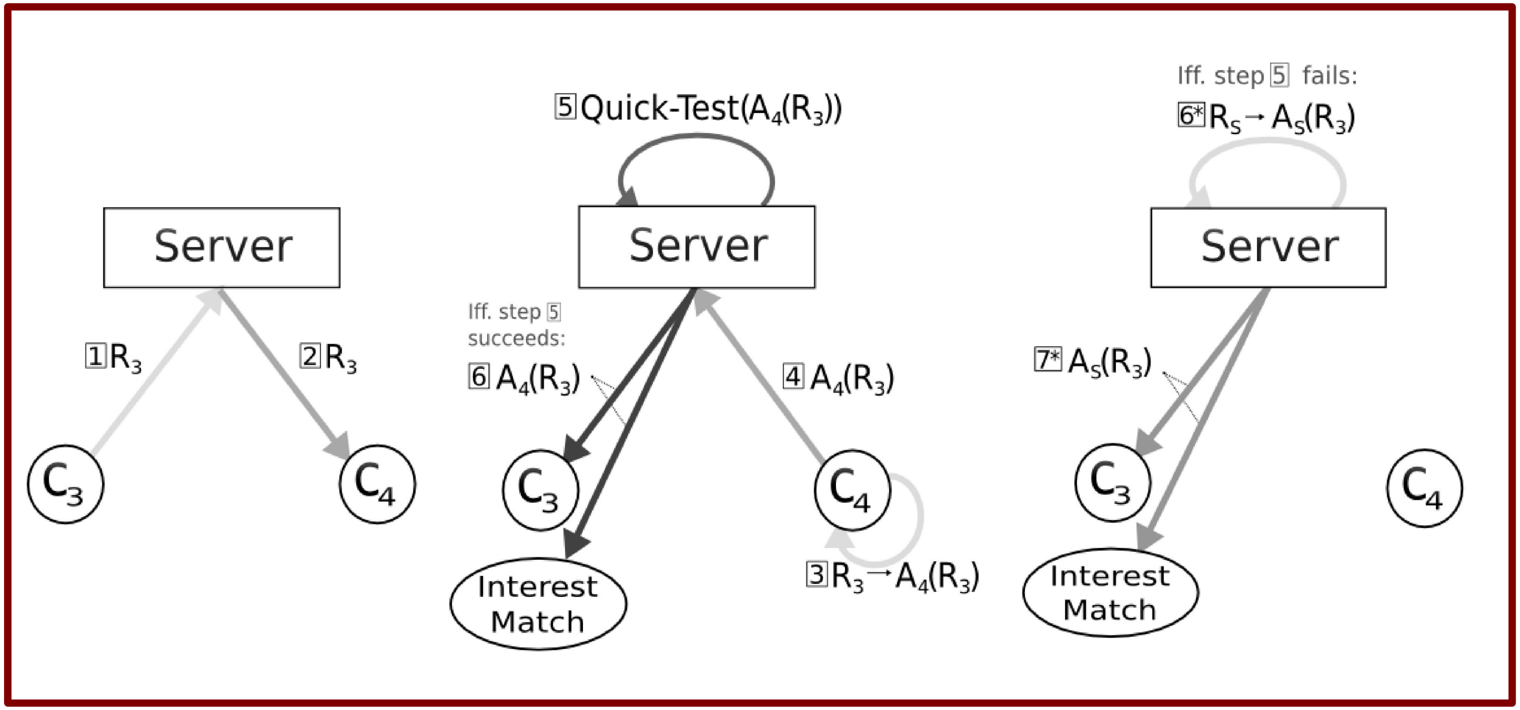
Design: *Communication Model*

- Diagram of phases 2-4:



Introduction: *Current Solutions*

Introduction: *Cheating Focus*

- In MMOG's there are a vast variety of cheating behaviours
- It is also difficult to formulate a precise definition of cheating
- Many ad hoc cheat elimination systems exist
- However, with P2P communication avoiding **abuse of authority** is imperative
- Therefore: we *focus* on reducing/eliminating **abuse of authority** cheats