

The Lost Vaults: Uneasy Alliance

An online multi-user Dungeon Client and Server.

Project Proposal for group 4

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Abstract

A proposal for implementing a concurrent server model as the basis for an online, multi-user dungeon role playing game in Scala.

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1 Introduction

Concurrency is becoming a more and more important facet of software development as computers rely more heavily on parallel processing and because of this the way we write programs has to change. This new kind of architecture brings with it a new type of problems, and without adapting we will not be able to make use of the increase in processing power. As a way for us to explore these challenges and their solutions, we opted to work on a server-client system over a TCP/IP network connection. The problem we attempt to solve is maintaining a responsive environment for multiple, simultaneous connections as well as multiple active and independent sections of program logic. We represent this problem through a multi-user dungeon or MUD, a form of online multiplayer game, where we aim to make sure that the server maintains stable performance regardless of the number of connected users.

We decided to call the game Lost Vaults and it is a semi-traditional MUD where users interact with other players and take on quests in parties of multiple players working towards a common goal while still looking out first and foremost for themselves. It is possible to adventure as a group of one person, but the focus of the game will be the group dynamic offered by interaction with other players. The game takes place in one of two locations, the city and the dungeon; the city being where the players may recoup from previous adventures, restock on supplies and form parties to delve back into the dungeon. The second location is the dungeon, a procedurally generated set of rooms populated with monsters, traps and treasures. The dungeon is procedurally generated and instanced in such a way that each party of players has its own dungeon, uniquely generated when the party delves down into the magical caves underneath the city. Once inside, the party is given one or several quests they should take on while exploring.

A quest can be finding an object and bringing it back to the surface, killing a number of monsters or collecting a set amount of gold. The party works together to accomplish the goals, but at the same time only one of the party members reaps the rewards, making the party a tense and fragile alliance of rogues. Gold earned in the dungeon can be spent in the city on equipment and consumables to increase the player's chance of surviving in the dungeon and taking on more difficult and threatening monsters.

The final product of this project will be a fully functional and interactive multiplayer online role playing game called The Lost Vaults.

The relation between the concept of concurrency and our project is the ability to have more than one player active in the game at the same time and their interaction with each other.

Part I

Design

2 System Architecture

The system architecture is in this document divided into Client-side architecture and Server-side architecture. Being written in Scala, the application runs in the Java Virtual Machine and as such, both client and server should be able to run on any platform supporting Java VM 1.7.

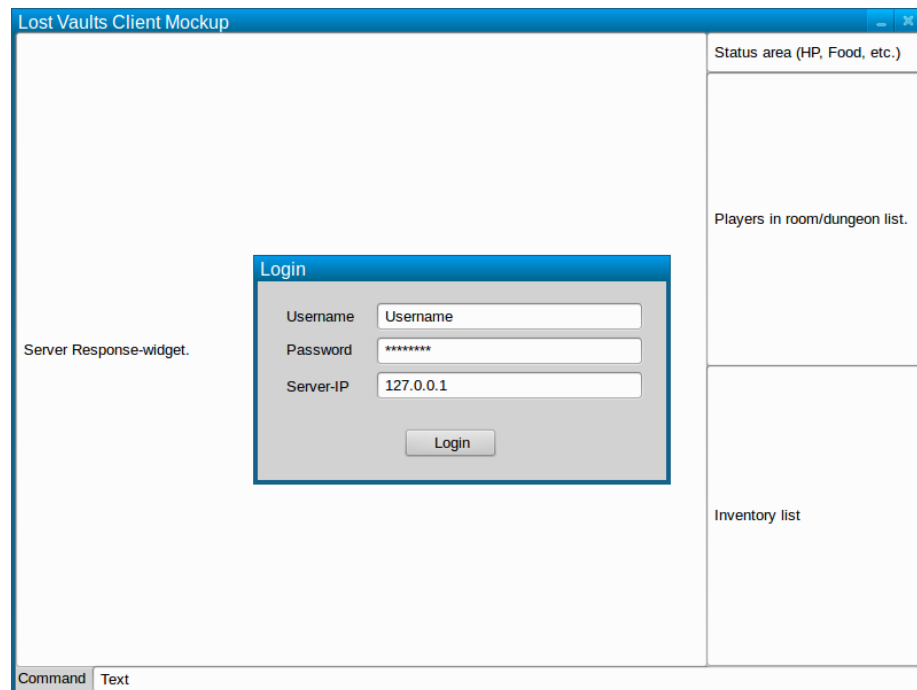


Figure 1: User Interface mockup of the Lost Vaults Client.

2.1 Client-side

The design goal for the Lost Vaults client is to create something akin to a remote terminal, where no logic is performed beyond sending requests, and receiving and interpreting request responses. Ultimately, we aim to accomplish a client-side implementation that is easily extensible when the server's implementation of game logic increases, i.e. a system we can add to by simply adding new requests and responses.

As seen in Figure 1 the client window is divided into several text areas displaying relevant information to the player. The main area is for regular server responses and will contain room descriptions, player chat messages, system information messages and similar. The right side of the client is reserved

for persistent information that the player may need to quickly reference. The top division contains information about the player’s own character, listing the player’s health and combat stats as well as the group’s remaining food.

The bottom of the window contains the command input field, where the player types in commands in accordance to a strict syntax listed under the server architecture below. Upon starting the client, the player is faced with the login window shown in the center of the mockup, where the player can enter their username and password as well as the server IP address to connect to.

The client GUI will be implemented using Java’s Swing UI library and integrated into Scala to utilize Akka’s TCP capabilities.

2.1.1 Class Model

The client is structured up into four distinct classes as described by figure 2. The classes `PlayGame` and `PlayGameCommunication` work together to create a bridge between the TCP layer and the GUI, with `PlayGame` accepting messages from `TCPClient` and passing it along to the GUI through `PlayGameCommunication`. Likewise, the GUI sends data over the network using method calls in `PlayGameCommunication` which passes it along to `PlayGame` and then `TCPClient`.

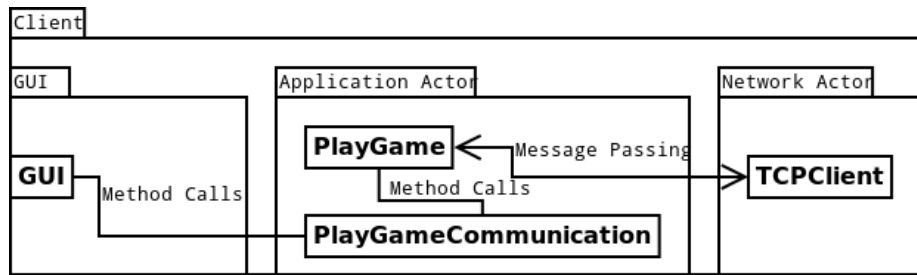


Figure 2: Client class relationship model.

2.2 Server-side

The server-side system architecture is further divided into the sections Concurrency model, Actor Model and Class Model. The first describes our choice of concurrency model and the reasoning behind it, the second describes the function of the five major actor types of the Lost Vaults server and the final gives a more in-depth description of the class relationships used by the server.

2.2.1 Concurrency Model

We are opting to use the Actor Model for the project as we during our initial design discussion managed to isolate behaviour into several smaller and largely independent sections, which could with ease be made to share data only through message passing and thus avoiding the problem of deadlocks by removing shared data from the equation.

In order to implement this kind of system with the greatest efficiency, we have chosen Scala as the language for the server as scalability is one of the

fundamental design goals of the language. Per recommendation by the Scala language creators themselves and because of the library's strengths and ease of use, we decided to use Akka as our actor library and to make use of Akka's TCP library for network communication. Its simple integration also guided our decision towards choosing Scala and Akka as the language and library of choice even for the client, as mentioned in the previous section.

2.2.2 Actor Model

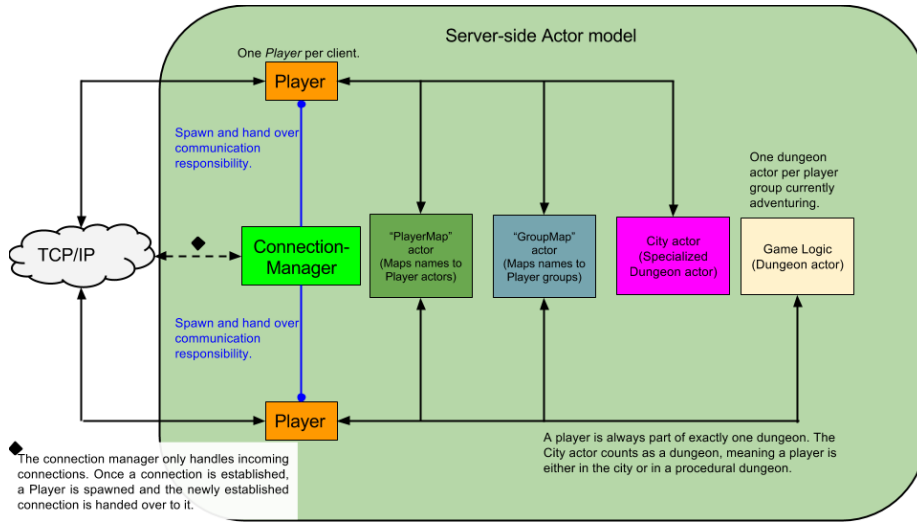


Figure 3: Diagram of the server actors' interactions.

The server side is divided up into several processes using Akka's actor library to enforce the actor concurrency model in accordance with figure 3. Only two types of actors communicate directly with the network through TCP/IP, the Connection Manager actor and the Player actors. The Connection Manager actor serves as the entry point for incoming connections, and is in charge of spawning Player actors as new top-level actors before registering them as the newly established connection's listener. As the listener, the Player actor will receive and send data over the network through the established connection. The Player actor is in charge of all things related to the clients, such as the specific player's attributes, as well as verifying login attempts through communication with the PlayerMap and it is through the Player actors that the other actors can send messages over the network when necessary.

The PlayerMap actor and GroupMap actor serves two specific utility functions, the first of which is to map a string, the names of all connected players, to the actors controlling the player with that name. Through this actor, another actor can quickly and easily send messages to a specific actor based on its name - an important feature for commands acting on other players, such as *WHISPER*. It also allows a quick and simple way for the Player actor to ensure no more than one player of a given name exists on the server at any given time.

The GroupMap actor performs a similar function as PlayerMap, however it links player names with player groups instead of player actors. A player group,

as described in the game design section of this document, is a collection of one or more players who together can enter a dungeon that is procedurally generated for them. The purpose of this actor is to facilitate forming and joining other groups of players. Using the GroupMap, it is enough to join a player by name to be included into that player's group, or have a new group formed for them.

The fourth type of actor used by the Lost Vaults server is the Dungeon actor, the actor performing all game logic. There is a special case of Dungeon actor which is called the City actor. The City actor is a Dungeon actor that is persistent over the lifetime of the server and has special behaviour to handle the socializing aspect of chatting and forming groups as well as trading with NPC ¹ merchants. The ordinary case of the Dungeon Actor is in charge of generating and handling a procedural dungeon of multiple, interconnected rooms layed out in a two-dimensional grid. It is in these dungeon rooms that players will have the ability to complete quests, find treasure, etc. The Dungeon actor is in charge of coordinating all the players that are currently present in the dungeon, and make sure that commands such as *SAY* are relayed to the relevant players. With the exception of the City actor, the Dungeon actors are in charge of their own lifespan after having been spawned by the City actor, and a Dungeon actor will stop itself once there are no more players within it.

2.2.3 Class Model

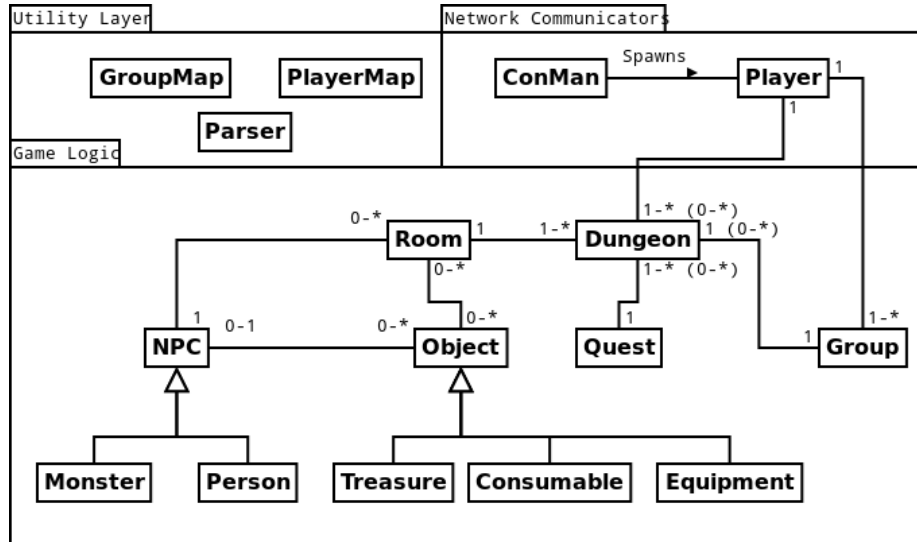


Figure 4: The server's class relationship model.

Figure 4 show the relationship between the different classes of the Lost Vaults server implementation and the multiplicity of relevant relationships. They are divided into three categories; the Utility Layer, the Network Communicators and the Game Logic. The Utility Layer provide supporting functionality to the other classes and exactly one of each class should exist at any given time. The Network Communicators are the ones that relate back to the network through

¹Non-Playable Character

Akka's TCP library. Of the two, ConMan, the connection manager class, is to be considered a singleton and only one instance should exist at any given time. The Player class however has one instance for each open connection.

The Game Logic section contains all the internal classes as well as the Dungeon class. The Dungeon class is the bridge between the Network Communicators and the Game Logic and it is only through a Dungeon class that a Player can perform any actions apart from the server-wide *WHISPER* command. The Dungeon class keeps track of explored and unexplored rooms, quests, groups, objects and NPCs. The Dungeon also keeps track of all Players currently connected and associated with the given dungeon.

3 Game Design

3.1 Dungeon

The meat of the game takes place in procedurally generated dungeons, each unique to the group of players who enter that dungeon. Once a dungeon has been created and a group has been assigned to it, no new players may enter that dungeon. A player who dies in the dungeon will be forced to leave the dungeon, as described below, and a player who has left the dungeon may not reenter it.

The dungeon's room are created procedurally on demand. That is to say, a new room is only created when a player tries to enter a room that does not yet exist. There are exceptions to this, as will be described in the quest section of this document.

3.1.1 Rooms

The dungeon is made up of interconnected rooms, which may have one or more exits, each representing a door on one of the room's four walls. A room may contain any number of players, monsters and items. A room may also contain a "trap" which can be harmful as well as beneficial, performing an action on the first player to enter that room. Players may attack any other player or NPC occupying the same room. Combat is described in more detail below. When the combat is between players, neither player currently fighting may escape the room until one of them has fallen. Escaping from a battle with an NPC will cost the escaping player one extra food.

3.1.2 Food

Food is the main type of resource to be managed in the game as food is needed to explore the dungeon. Each player has their own supply of food, starting at a minimum of five pieces of food and additional food can be bought from the city merchant or be found in the dungeon. When a player enters a room that player has not yet explored, one piece of food is subtracted from their personal supply. Entering a room previously explored by that player does not consume food. The players' progress is therefore limited by how much food they bring with them into the dungeon.

3.1.3 Leaving The Dungeon

Upon leaving the dungeon, all the consumables found or brought down will be lost to the player (food and potions rot), and all treasure items that are found are sold off for gold. Furthermore, every player leaving a dungeon is awarded gold for the quests they have completed both as a group or individually. Dead players do not gain gold for completed quests.

If a player dies, they are forced to leave the dungeon, and gain no gold from either treasures found or quests completed.

3.2 Player

The player has four distinct attributes to aid her in her adventure. Life signifies the current health of the player, when life reaches zero the player dies and she will face the penalty described below. Defense represents her ability to withstand damage and is in direct opposite to the Attack attribute of an opposing entity. Attack then is the ability to inflict damage, and the damage calculation is a simple calculation of subtracting the defender's defense score from the attacker's attack score. The result, if greater than zero, is then subtracted from the defender's current life. If the defender's life reaches zero, she dies. The final attribute is food, and as described above it represents the player's ability to explore the dungeon as well as her ability to flee from combat against foes that are too dangerous.

3.3 Combat

Lost Vaults uses a turn-based combat system, where each participant get their chance to attack any of the other occupants in the room. Attacking another player forces them to join in the combat, denying them the ability to escape the room. During player versus player combat, neither player may send a private message or perform a dungeon wide yell command, limiting their ability to communicate to only the room they're occupying. Combat against an NPC does not have this limitation, and players may both escape at the cost of one additional food, and they may use yells to call in aid from their allies.

3.3.1 Death

Dying in Lost Vaults carries a penalty in the form of losing all consumable items and treasures the dying player carries, as well as being forced back into the city without the possibility to rejoin their comrades still exploring the dungeon. This means all progress made inside the dungeon is lost upon death, as well as all gold spent preparing for the adventure. All treasure and consumables held by the dying player will be left on the floor of the room in which she died.

3.4 Quests

When entering a dungeon, the group is given one or more quests to complete which will net them extra gold upon leaving. However, individual players may also be given an additional quest, which they alone stand to gain from and which is in direct opposition to the group's best interest.

3.4.1 Group Quests

Group quests are quests that all players of the group benefit from, and completing the quest is in everyone's best interest. The reward for a completed quest is given to each player who is alive to leave the dungeon after completion. The group quests are as follows.

Kill a specified monster. The group is tasked to kill a specific monster, appropriate to the strength of the group. The monster is placed in a random location and a path is guaranteed from the start to the monster's room.

Find an item. A specific piece of treasure is to be located and taken out of the dungeon. Similarly to the previous quest, a room is created containing the item and a path is guaranteed to it from the start.

Kill X monsters. A specified number of monsters are to be slain. The types of monsters do not matter, and every killed monster works towards this goal.

Every ally must leave. This quest works against traitorous players. Whenever a player gains the Kill a specified player or Kill all other players quests, the group gains this quest. In order for this quest to be completed, not only does everyone not tasked with a kill quest leave the dungeon but the player who does have that quest must not. That is to say, the traitor has to be rooted out of the group and killed in order for the group to accomplish this quest. This quest does not require a traitor be present, but if a traitor is present this quest will always accompany it.

3.4.2 Player Quests

Player quests are quests given to individual players and they alone stand to gain from it. It's in opposition to the best interest of the rest of the group and their rewards are greater than the others, providing an incentive to complete them. The player quests are as follows.

Kill a specified player. The player is tasked with killing one of the other players in his or her group and then manage to leave the dungeon alive. There is no requirement to leave the dungeon immediately, however, but an enterprising player may continue to play as part of the group if possible, reaping the rewards from the group quests as well. However, the group knows that someone has been tasked to kill someone else through the *Every ally must leave* quest. The player does not have to be the one killing the target, as long as the target does not exit the dungeon alive.

Earn the most money. Be the player who has earned the most gold during the adventure, either by making sure other players do not leave or by taking all treasure that they come across.

Kill all other players. The player is tasked with being the only one to leave the dungeon alive. Not only do they stand to gain the reward of all items found in the dungeon, they also gain a substantial reward for completing this quest, greater than any other quest available. Completion of this quest will be difficult and require more than brute strength on the part of the player. Similarly to the *Kill a specified player* quest, this will force a *Every ally must leave* quest on the group.

3.5 Items

Lost Vaults have three subsets of items, as described below.

3.5.1 Equipment

Equipment provide the player a bonus to their attack or defense score, making them stronger or more resilient. Equipment is the only way to increase the player characters' powers and equipment is upgraded either by purchasing them from the city merchant or finding them in the dungeon. The player may only hold one offensive and one defensive equipment item at a time and finding or buying new equipment means the old equipment is dropped or lost respectively.

3.5.2 Consumables

Consumables come in two further flavours, food and potions. Food allow players to progress deeper into the dungeon and potions recover Life when used. Consumables are good for exactly one round of adventuring and both potions and food can be found in dungeons or bought from the city merchant. Consumables may also be given from player to player. Consumables are lost either when the player dies or when the player leaves the dungeon they are in.

3.5.3 Treasure

Treasure is a type of item which has no practical use but instead has a monetary value. When a player exits a dungeon, the treasures she holds are converted into gold which is rewarded to the player carrying the item. It is a personal reward and only the player carrying a treasure item gains its value upon exit.

Part II

Development Process

4 Development Tools

For this project we intend to use a number of tools to facilitate development. Since we will be working in Scala we will be writing our code in Eclipse. We decided to use Eclipse because we consider it far the easiest way to develop code when writing in Java or Scala. Despite writing our code in Eclipse, however, we make use of the Ant build system to automate compilation and building of our client and server, ready to be run in a Java virtual machine.

To handle version control we intend to use the reliable and well known tool Git. We setup a fresh git repository on GitHub.com specifically for this project and we chose Git because it is a powerful tool we are all familiar with.

Testing of our code will be done through the JUnit and ScalaTest frameworks and the Ant Build script will allow automatic building and running of the test suites.

For assembling our documentation we will use Scaladoc since it is similar to JavaDoc, a tool we are all familiar with and Ant has been amended to automatically build our documentations.

5 Process evaluation

We applied the Osborn principles for brainstorming with a small addition to the process. In the brainstorming process we went around the table and each group member had to add at least a couple of ideas before we let anyone who had an idea add them to the list of possible ideas. This led to many ideas which might lead to other group members coming up with new ideas from the proposed idea.

The initial brainstorming went as expected with a long list of possible project ideas as the result. No ideas were criticised during the brainstorming and all the group members' ideas were shared. Nothing specific could be improved about our brainstorming session.

During the brainstorming session three main project ideas were presented. The first idea was to make an online multiplayer game and the two others were simulation programs, one to simulate the traffic situation in a city and one to simulate an ecosystem. We divided the group into three focus groups that looked deeper into these three options. After this, each group were given time to present their respective fields, and after discussing pros and cons for the potential of each idea, we decided to choose the online multiplayer game. The reasons for this was that the complexity was intriguing, and that there was potential to develop the game further in case of extra time. Some of the interesting parts of the online game, besides being the most fun, was to learn about networking and our chosen programming language, Scala.

Focusing on quantity in the first stage of brainstorming led to a good brainstorming process with plenty of ideas and doing so we found that it was easier to decide on a high quality idea when ideas could be put on the table and refined by the group as a whole, rather than feeling that any idea had to be fully formed before being suggested.

The main challenges that we expect to face during the development of both client and server are writing network code as well as learning a new programming language.

Part III

Appendices

A Network Messages

Message	Direction	Description
<i>SAY</i> [msg]	Client → Server	Chat message sent from client to server.
<i>SAY</i> [name] [msg]	Client ← Server	The Chat message sent by [name] and relayed to the relevant clients.
<i>WHISPER</i> [to] [msg]	Client → Server	A private message sent from a player to another player named [to].
<i>WHISPER</i> [from] [to] [msg]	Client ← Server	A private message sent from a player named [from], to another player named [to].
<i>LOGIN</i> [name]	Client → Server	A request to sign onto the server using [name] as the player's username.
<i>LOGOUT</i>	Client → Server	A Request to sign out of the server.
<i>LOGINOK</i>	Client ← Server	Response from server that a login request has been accepted.
<i>LOGINFAIL</i>	Client ← Server	Response from server that a login request has been denied.
<i>BYE</i>	Client ← Server	Connection Closed message sent from server to client.
<i>SYSTEM</i>	Client ← Server	System message sent from the server to the client.
<i>INVENTORY</i>	Client → Server	Request from a client to list a player's current inventory.
<i>INVENTORY</i> [list]	Client ← Server	Response to a client's inventory request. [list] is a comma delimited list of item names.
<i>ROOMENTER</i> [name]	Client ← Server	Notification that a player named [name] has entered the room which the client receiving the message is in.
<i>ROOMLEAVE</i> [name]	Client ← Server	Notification that a player named [name] has left the room which the client receiving the message is in.
<i>ROOMLIST</i> [list]	Client ← Server	Notification that the list of players in the client's current room should be repopulated. [list] is a newline-delimited list of names.
<i>NPCLIST</i> [list]	Client ← Server	Notification that the list of NPCs should be updated. [list] is a newline-delimited list of NPC names.
<i>ROOMITEMS</i> [list]	Client ← Server	Notification of all the items in the current room. [list] is a newline- delimited list of all the items in the room.
<i>ROOMDESC</i> [description]	Client ← Server	Notification of the client's current room's description.
<i>ROOMEXITS</i> [list]	Client ← Server	Notification of all possible exits from the client's current room.
<i>ROOMPLAYERS</i>	Client → Server	Request for a list of players in the client's current room.

Message	Direction	Description
<i>DUNGEONPLAYERS</i>	Client → Server	Request for a list of players in the client's current dungeon.
<i>ROOMNPCS</i>	Client → Server	Request for a list of NPCs in the client's current room.
<i>DESCRIBE</i>	Client → Server	Request for a room description of the client's current room.
<i>ITEMS</i>	Client → Server	Request for a list of items in the client's current room.
<i>EXITS</i>	Client → Server	Request for a list of exits in the client's current room.
<i>HELP</i>	Client → Server	Request for a list of available commands and their descriptions.
<i>DUNGEONENTER [name]</i>	Client ← Server	Notification that a player named [name] has entered the same dungeon the client is currently in.
<i>DUNGEONLEAVE [name]</i>	Client ← Server	Notification that a player named [name] has left the room which the client receiving the message is in.
<i>DUNGEONLIST [list]</i>	Client ← Server	Notification that the list of players in the client's current room should be repopulated. [list] is a newline-delimited list of names.