ONLINE VIRTUAL TEAM COLLABORATION PLATFORM WITH 3D GRAPHICS

-RESCUE-

FINAL DESIGN REPORT

INCREDIBLES

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1. Introduction

This report is written by Ceng490 students for an overview of design of the project Rescue. A detailed explanation of the scenario description, data flows, class and state diagrams are given yet they are not final and may be changed in the final design report.

1.1. Project Description

1.1.1. Purpose

The purpose of the project is:

- To simulate real world scenarios in a virtual environment.
- To train squad leaders each specialized on its own area and improve their skills in their areas.
- To improve collaboration between different squad leaders.

1.1.2. Scope

The project will be developed for leaders of squads mentioned below:

- police squad
- fire squad
- bomb defuse squad

In addition, this simulation could be useful for anyone who wants to increase their team collaboration skills.

1.1.3. Objectives

Project will have the following features:

- The scenarios are going to be designed in a realistic manner.
- There will be a facilitator who manages the simulation from the server and can intervene anything in the scenario.
- Facilitator will be able to choose among several different scenarios.
- Users can communicate with facilitator and other users via the voice chat.
- Facilitator can observe everything in the simulation from different view angles.
- Users follow the scenario from the first person view.
- Users will have limited resources and tools. These resources will be both equipments and people.
- The squad leader's subordinates are capable of accomplishing given tasks.

The program will run in two modes: passive and active mode. The features above will be same for both modes, however there will be some differences:

Passive mode:

- Users have restricted interaction with computer.
- Users manage their teams via the facilitator.

Active mode:

- Users have active interaction with computer.
- Users manage their teams using user interfaces on their own computers and via the facilitator.

1.2. Constraints

There is not much constraint given by the company. Also there is not any restriction to project platform or development environment. The constraints are:

- The project must have been finished by June 2008.
- The project must be done by 4 Metu-Ceng senior students.
- The project schedule must be synchronous with the course schedule.
- The trainee user interface must not be complex.
- Trainees' view perspective must be first person view.
- Facilitator must not affect the flow of scenario.

1.3. Scenario

Prologue : The scenario takes place in a large public building (like a big shopping center as Armada) in present time. In the building several minor bombs have exploded and as a result fire has started in some areas. And it has been reported that several unexploded bombs may still exist.

Main goal : Take all of the civilians to a safe area before they get hurt and defuse all of the bombs.

Teams : Firefighters, police squad and bomb defuse squad

Tools & resources :

Firefighers : Water is used as both tool and resource. They have two sources of water one of which is infinite and the other one is finite. Also they have a fire engine.

Police squad : A maul will be used as a tool for breaking the doors. Also a resource will be used for taking out the civilians from the high levels of the building.

Bomb defuse squad : A trained dog will be used as a tool for finding the bombs. Also detonators will be supplied as a resource for deactivating the bombs and exploding the doors.

Subgoals :

Firefighters: Their task is to prevent the fire to spread over the building. Also they must distinguish the fire in specific areas so that police and bomb defuse squads will be able do their task on these areas.

Police squad : Their task is to find and take out the civilians from the scene. Also they must help bomb defuse squad enter the rooms by breaking the doors with their maul.

Bomb defuse squad : Their task is to find and deactivate the bombs. Also they must help police squad enter the rooms by blowing up the doors with their detonator.

Colloboration Analysis:

If a team does not exist;

Fire fighters : The fire will spread over the building. As the result police and bomb defuse squad wil not be able to operate on areas which are under fire, also civilians will be hurt by the fire.

Police squad : Not all the civilians will be found and the found ones will be taken out of the scene in an unorganized way. Also bomb defuse squad may have some problems on entering some rooms since no doors will be broken by the police squad.

Bomb defuse squad : The bombs will not be defused and will damage the building and may damage the civilians in the evidence area. Also the police squad will not be able to enter some rooms since no door will be blowed up by the bomb defuse squad.

If a team isn't collobrating with the others;

Firefighters : Police and bomb defuse squad wil not be able to operate on areas which are under fire. And they may be trapped by the fire. Also civilians will be hurt by the fire.

Police squad : There will be time loss for bomb defuse squad for waiting the door to be broken. Also firefighters may try to distinguish fires in unnecessary places.

Bomb defuse squad : Police squad or civilians under their control may be hurt by bomb defuse squad's detonator. There will be time loss for police squad for waiting the door to be exploded. Also firefighters may try to distinguish fires in unnecessary places.

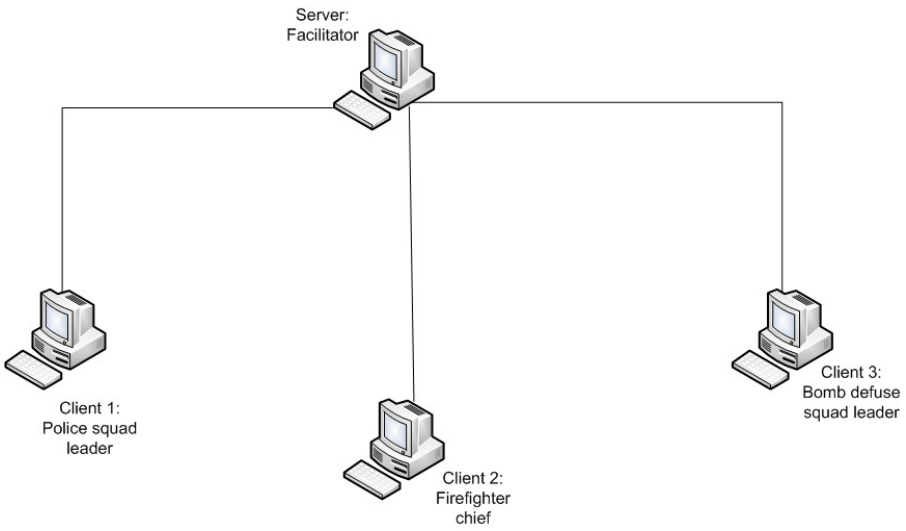
Scenario Specifications:

Bombs defuse squad is able to blow up any door with their detonators, but police squad is able to break only thin doors. Since bomb defuse squad has a limited number of detonators, they are not enough for blowing up all the doors. So they need police squad assistance for passing through the thin doors. Likewise police squad needs bomb defuse squad assistance for passing through the though doors.

2. Modules

2.1 Network Module

The project will be a real time online multi-user simulation. Users will connect to the system via network connection. This requires a good server/clients network architecture. There will be three clients and a server connected to each other. It is simply as follows:



There will be continuous data flow from server to clients and clients to server. This data will be sended and received as network packages. The network packages are converted into message objects. There will be two types of messages: voice packages for voice communication and all other messages. Every message object have tree main fields:

- message id: to determine the type of message,
- user id: to determine who send the message,
- message body: includes the message content.

Server is a user having extra privilages. He starts the session and waits for users to connect server as a client with their user id. After all connections are estaplished system is ready for bidirectional dataflow. Since the system have server-client architecture all the clients' messages are collected in server's message pool. Server processes them one-by-one and sends its own packages to related targets if necessary. Both clients and server have two main threads. First is for sending prepared messages to targets and second is for receiving and processing incoming messages. The simulation will be ended by the server.

2.1.1 Message Handling and Message Types

We are using DirectPlay in our project and its message packet class. As in other message packets our messages composed of two main parts: head and body. We are planning to use xml based messaging to handle messages easily. As an example a piece of xml based message body is given below:

```
<?xml version="1.0" encoding="UTF-8"?>
 <simulationinfos>
  <name>rescue</name>
  <creator>incredibles</creator>
  <timeperturn>120</timeperturn>
```

```
<timeleft>97</timeleft>
<gametype>active</gametype>
<description>Rescue all civilians</description>
<maxplayers>3</maxplayers>
<state>INGAME</state>
</gameinfos>
```

It was taken from internet and it can be parsed with a xml parser easily. We roughly designed message types that will be used in simulation and they are listed with their explanations below:

2.1.1.1. Messages From Server to Client

- Server Information
  This message contains personalized information about the server.
  - Name: Server name.
  - Time: Start time of simulation ('year/month/day/hour/minute/second').

- Welcome Message
  This message contains the server welcome message.
  - Welcometext: Welcome message.

- Server Userlist
  This message contains the list of all users currently connected to the server.
  - User: The user's name.
  - Class: Type of the user.

- Scenario Information
  This message provides information about a scenario.
  - Name: Name of the scenario.
  - Map: Short description about the map.
  - Description: Description about the scenario.

- A Player Connects To Server
  This message indicates to all users that a new player has connected to the server.
  - Name: Player's name.
  - Class: Type of the connected user

- Player Disconnects From Server
  This message tells users that a player has left the simulation.
  - Name: Name of the player that left the simulation.
  - Reason: Reason for leaving.

- Chat Message
  This message contains chat text. This text will be sent to every user in the scenario.
  - From : Name of the user who wrote this message.
  - Text: Chat text.

- Whisper Message
  This message contains whisper text. Only the player to which the message is specifically sent to will receive the message.
  - From: Name of user who wrote this message.
  - Text: Text.

- Start Game Indication
  This message indicates the start of the simulation.
  It does not contain any data.

- End Of Game
  This message indicates the end of the simulation.
  - Data: Statistical data about simulation.

- PauseGame
  This message sends a pause signal to all clients to pause the simulation.
  This message contains no data.

- ResumeGame
  This message sends a resume signal to all clients to resume the simulation
  This message contains no data.

- Create Object
  This message gives the required values for creating a new object in the environment.
  - id
  - name
  - type
  - isVisible
  - isPhysical
  - position
  - direction
  - scale

- Destroy Object
  This message informs that the given object is destroyed form the environment
  - id: ID of the destroyed object

- Change Object Properties
  This message indicates that an object's properties have been changed
  - id : ID of the object
  - position : New position of the object
  - direction : New direction of the object
  - scale : New scale of the object

- Change Character State
  This message indicates that the given character's state have been changed
  - id : ID of the character
  - state: New state of the character

- Change Squad Item Count
  This message indicates that a squad's item count have been changed
  - id : ID of the squad
  - item : The squad's item's type
  - count : The item's new count

- Create Trigger
  This message is invoked for informing for a new trigger
  - id : ID of the trigger
  - time : The trigger's time interval
  - action : The action will be happened when it triggers

- Dispose Trigger
  This message is invoked for informing for a destroyed trigger
  - id : ID of the trigger

2.1.1.2. Messages From Client To Server

- Player Name
  This message contains the name of the user connecting to the server.
  - Username: Name of the user.

- Chatting
  This message contains chat text written by the user.
  - Chattext: Chat text.

- Whispering
  This message contains a whisper text and the user to whom this text is to be sent to.
  - Text: Whisper text.

- Disconnecting From Server
  This message indicates that the user is disconnecting from the simulation.
  - Reason: Text indicating the reason for which the user is disconnecting from simulation.

- Change Position
  This message provides the user's new position if he/she moves
  - position : Last position of the user
  - direction : Last direction of the user

- Change State
  This message is sent for indication if the user changes his/her state
  - state : New state of the user

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- Give Order
  This message is sent when a user gives his/her squad an order
  - order : The given order's type
  - target : The given order's target object

- Pause
  This messages sends a pause signal to the server.
  This message contains no data.

- Resume
  This message sends a resume signal to the server.
  This message contains no data.

2.2 Sound module

Voice chat is essential part of simulation. Users will be able to communicate with other user including facilitator via voice chat. When user wants to talk with someone he presses the button and then microphone start to record the speech. Actually recorded data agglomerates in the buffer, and when buffer becomes full data will be encoded into package before being sent to server. Data packages, received by server, are transferred to appropriate user. When client gets message it decodes the package and speaker will play the speech. There will also be two main threads running one for recording speech and second for decode and playing the received data packages.

2.3 Graphics Module

Graphics has always been one of the most important aspect of a program for the end-user. Since computer users usually don't have a detailed knowledge (and they don't need to actually) about the infrastructure and the architecture of a program, a well designed project may be thought as a useless one because of its hardly managable and complex user interface. Especially in a simulation program, making the user feel as if he is in the simulated environment is a hard task to achieve without decreasing the usability. The more the reality is achieved, the more successful and credible the results of the simulation are. Considering those facts, we try to present an environment with satisfying details level to the user. But this requirement should not overcome the usability of the system since the users are predicted to be trainees which are not so professional in managing complex GUIs.

Such goals bring the requirement of a well design of the graphics module. The general methodology is to define the module as seperate as possible from the main program to make debugging and testing easier. Thus we designed a module, which consists of a single class, SceneManager. Our approach is basically as follows:

- Load all objects to the scene at the beginning of the simulation.

- As the simulation commences, if there is a change in the object's properties which will affect how it will be rendered, that change is reported to SceneManager.
- SceneManager receives the changes, recalculates, and draws to the screen.

Our GUI will consist of irrLicht's own GUI elements. The library already has any elements we can possibly need in the simulation, like textboxes, buttons, slidebars, comboboxes, etc. The resulting events will be either processed inside the graphics module or sent to the main engine, depending on the event.

For the environment, we thought .bsp maps are the best choice for us the reasons of which will be explained below. Thanks to irrLicht's nice map loading capabilities and bsp maps' optimized design, well designed and realistic maps will not decrease the system performance too much.

In terms of objects data, graphics module will be very similar to the main engine. To prevent extra data traffic between modules, actual object data will be kept in the graphics engine. irrLicht's integrated physics functions like collision detector will help a lot in modifying object positions. All we have to do is to tell the module to move an object, and look at the resulting data for final position of the object. Whenever neccessary, engine will request an object's data and send it to appropriate modules.

2.4 Engine Module

The engine is the core of the simulation. It basically is the boss which manages all other modules, establishes the connection and controls the dataflow between other parts of the system. The engine also applies game logic rules, such as spreading of fire, exhaustion of resources, etc. Starting and terminating the triggers is another task done by the engine module. All map, character and environment object data is stored and their related properties are transferred to related modules by the engine. The engine is composed of several classes.

2.5 AI Module

AI is the brain of a system. The better the AI of a program, the better it can simulate human actions and present a more realistic system. In our project, since we are not advanced in aspects of developing a complex AI, simple tasks like pathfinding and decision making will be done by this module. For these two subtasks, two classes will be implemented as described in the following sections. This module contains three classes which are PathFinder, BehaviourDecider and a ScriptEngine powered by Python.

2.6 Physics Module

With just stunning graphics, fast network protocols and a genious AI, a simulation may be complete but the objects will fall when placed in the air! This is just one task the physics module

should overcome. The system we are planning to develop will be able to calculate basic physical properties of enviromental objects and characters.

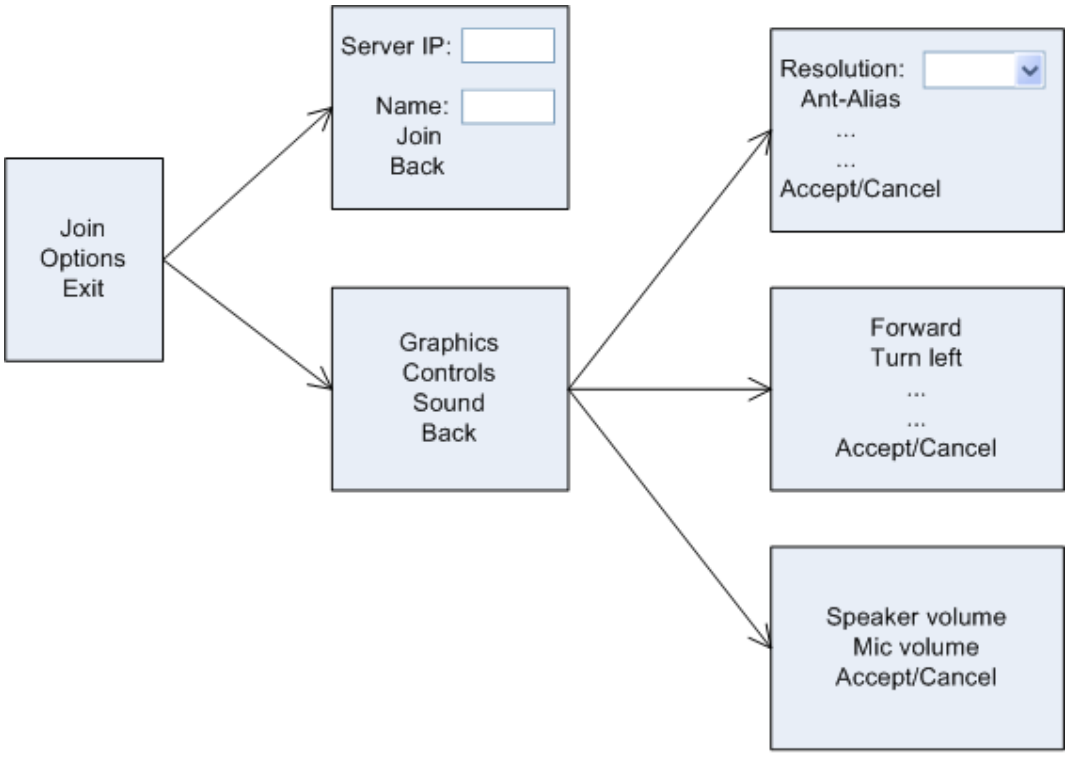
Yet after seeing irrLicht's capabilities on collision detection , idea of entegrating a complex physics engine to the server independent from the other modules became more unnecessary. In the beginnings an environment with fully interactive objects which affects each other objects physically (like pushing each other) was being thought. But such an environment does not provide any functionality to the current scenario (It can only increase reality of the environment which is not the project's primary goal). Entegrating such a physics engine will make the development last longer, will consume a noticeable CPU power of the facilitator's PC and will produce extra network packages over the network. Currently client's simplified physics module is being planned to applied to the server as well.

3 User Interface

The user interface, an mentioned above, is designed to be simple and useful for the trainees to navigate easily. Two seperate menus are designed for client and server.

3.1 Client Menu

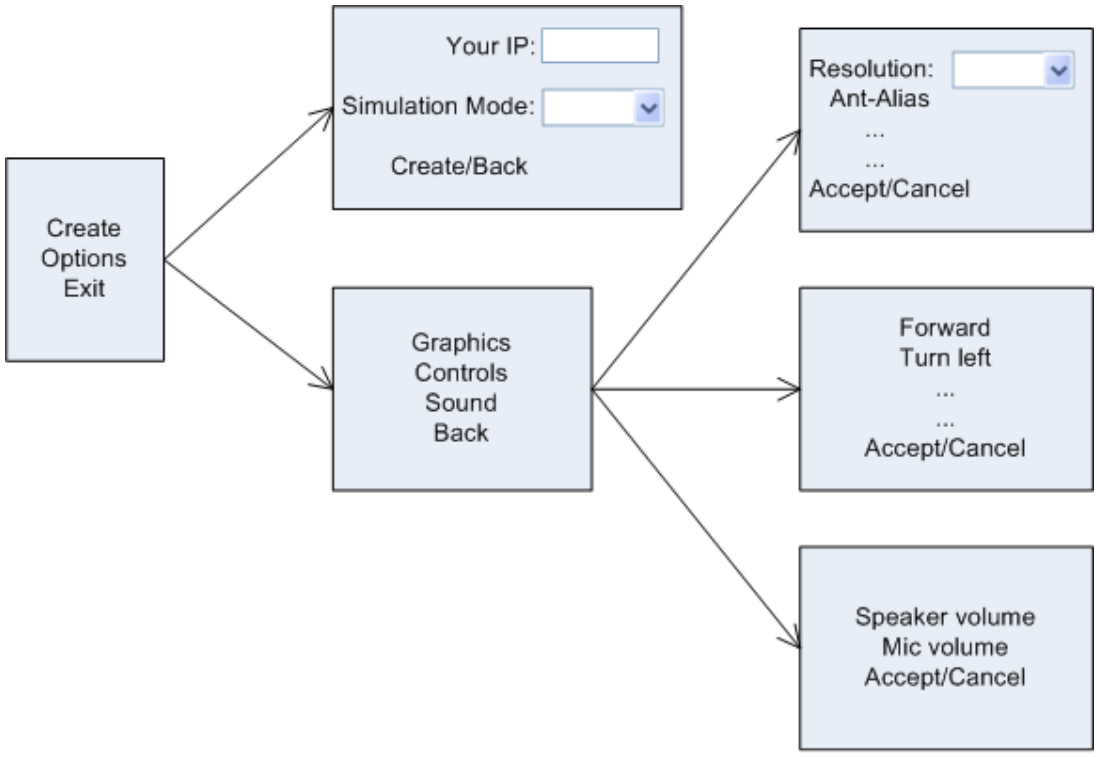
- From the main menu, user can connect to a server, adjust simulation settings or exit the system.
- In the join menu, after typing the server's IP address and specifying a name for the user, the simulation begins.
- From the options menu, user can change graphics settings (e.g. resolution, texture details..), control settings (e.g redefine movement keys, camera control keys,..), or adjust volume settings.



Client Menu

3.2 Server Menu

- In the main menu, facilitator can host a new session, adjust game settings or exit the system.
- From the create menu, IP address will be shown for the clients to join and the facilitator will choose whether the simulation will run on active or passive mode.
- From the options menu, user can change graphics settings (e.g. resolution, texture details..), control settings (e.g redefine movement keys, camera control keys,..), or adjust volume settings.

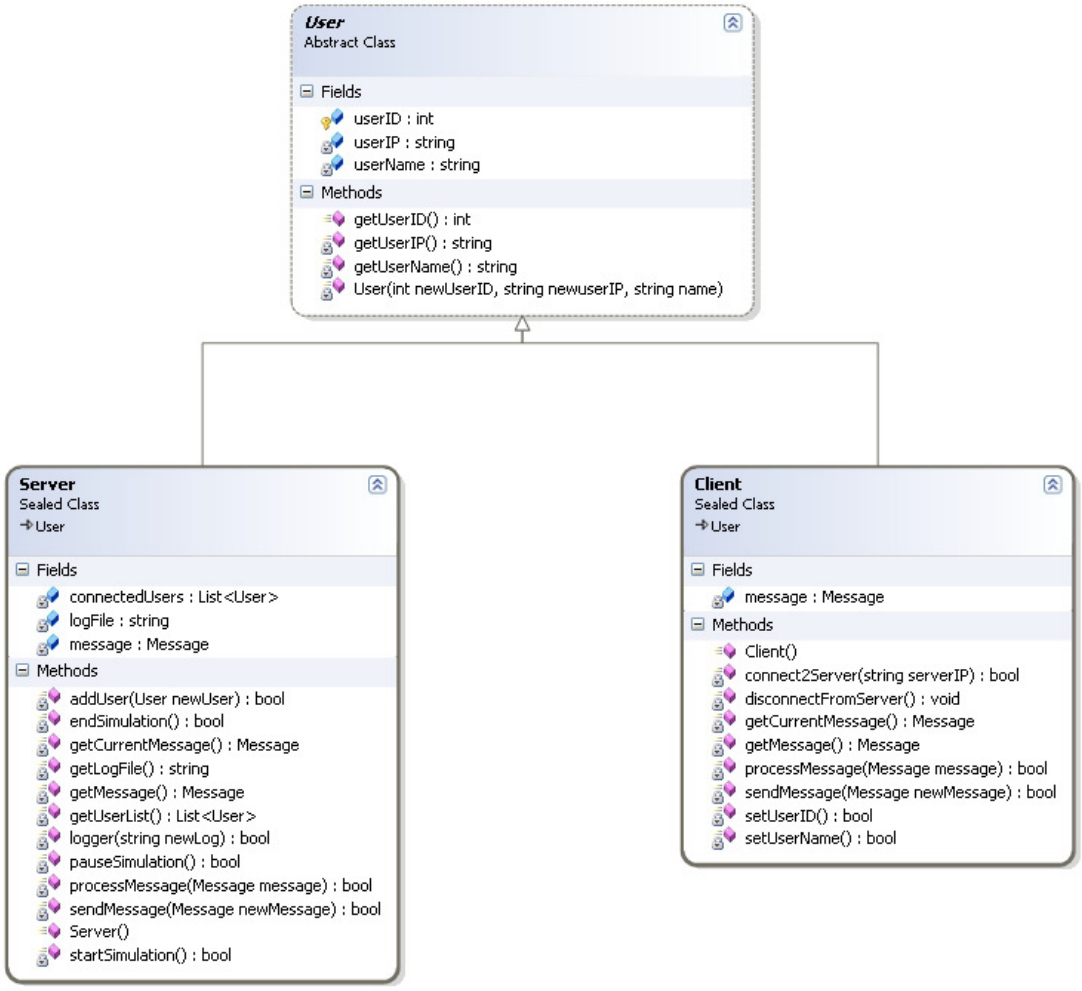


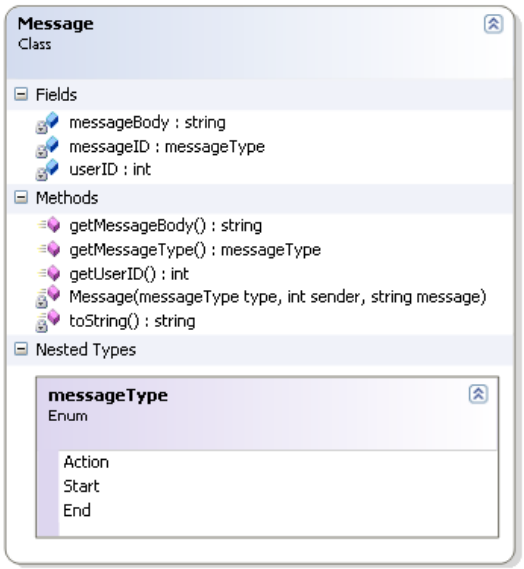
Server Menu

4 Class Definitions

4.1 Network

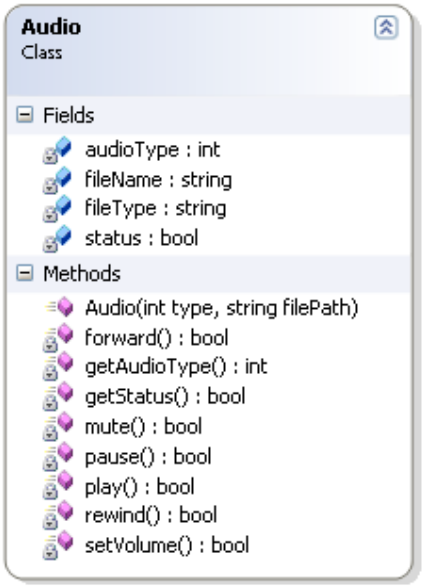
Network module consists of three classes. Two classes for client and server network modules which inherit the user class and one common Message class. Message types are to be defined in detail in the final report. We will use XML for message bodies which will make handling messages across the network.


User
Abstract Class
Fields
userID : int
userIP : string
userName : string
Methods
getUserID() : int
getUserIP() : string
getUserName() : string
User(int newUserID, string newuserIP, string name)
Server
Sealed Class
User
Fields
connectedUsers : List<User>
logFile : string
message : Message
Methods
addUser(User newUser) : bool
endSimulation() : bool
getCurrentMessage() : Message
getLogFile() : string
getMessage() : Message
getUserList() : List<User>
logger(string newLog) : bool
pauseSimulation() : bool
processMessage(Message message) : bool
sendMessage(Message newMessage) : bool
Server()
startSimulation() : bool
Client
Sealed Class
User
Fields
message : Message
Methods
Client()
connect2Server(string serverIP) : bool
disconnectFromServer() : void
getCurrentMessage() : Message
getMessage() : Message
processMessage(Message message) : bool
sendMessage(Message newMessage) : bool
setUserID() : bool
setUserName() : bool


Message
Class
Fields
messageBody : string
messageID : messageType
userID : int
Methods
getMessageBody() : string
getMessageType() : messageType
getUserID() : int
Message(messageType type, int sender, string message)
toString() : string
Nested Types
messageType
Enum
Action
Start
End

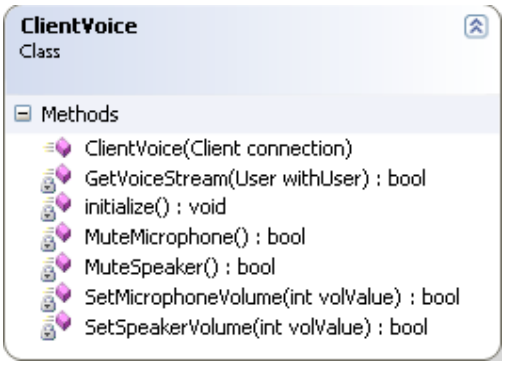
4.2 Sound

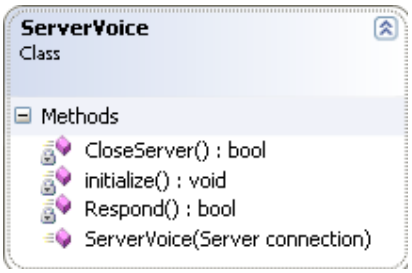
This class is used for playing environment sound, menu music and any audio files throughout the simulation.



4.3 Voice

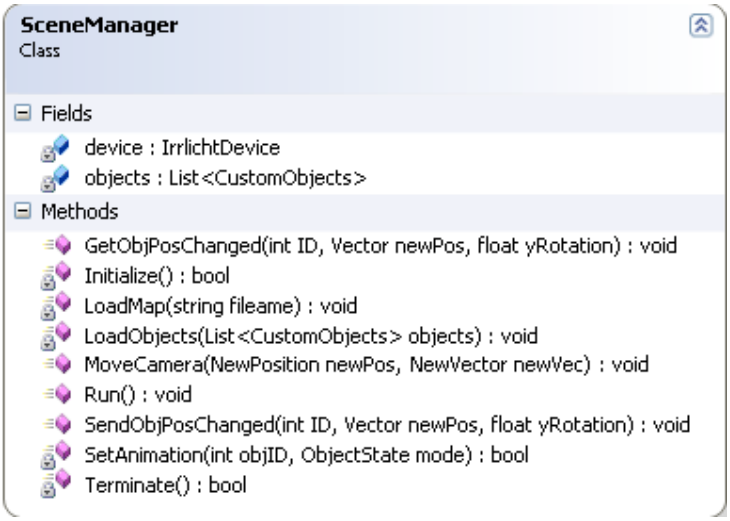
VoiceMessage is separated from normal Message class since it has a different structure. Speaker and Microphone classes are used for encoding and decoding audio streams.





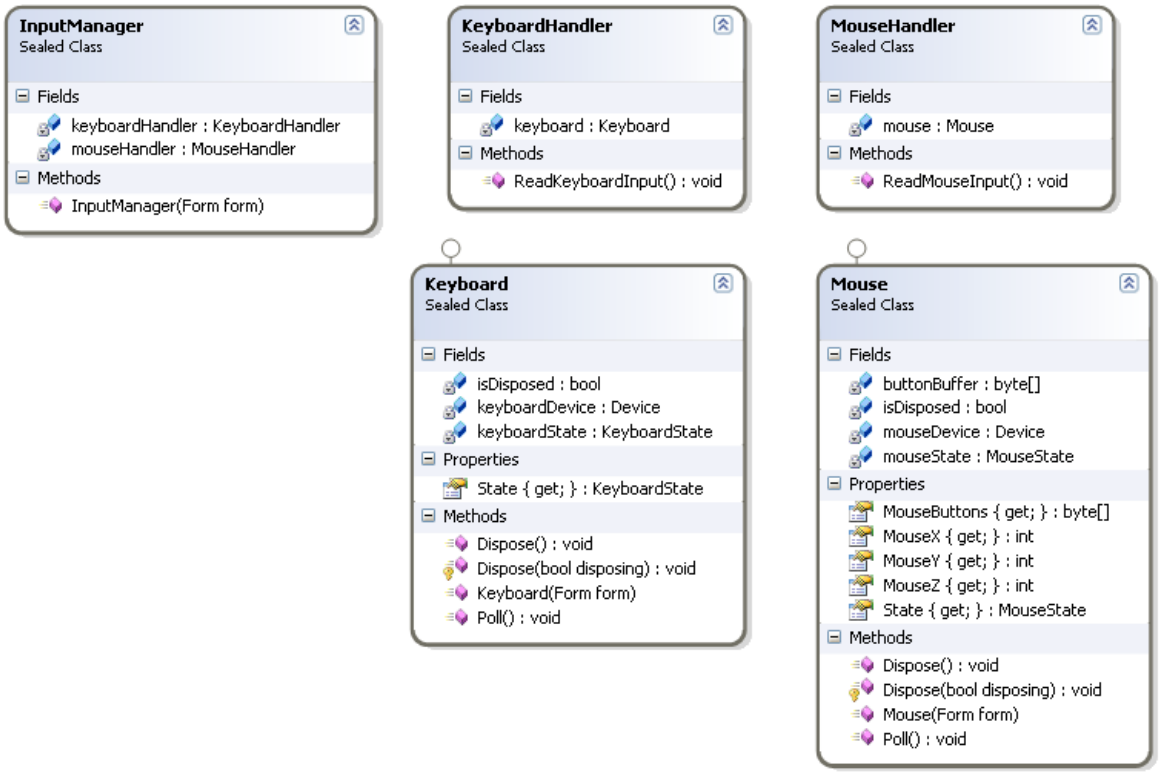
4.4 Graphics

This module consists of a single SceneManager class. Objects are loaded into the class and changes are reported in as they occur. Rendering details are handled inside the class.



4.5 Input

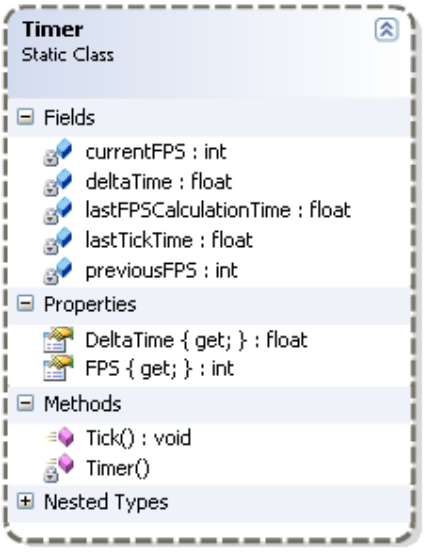
InputManager class handles keyboard and mouse events with its KeyboardHandler and MouseHandler members. These handlers access Keyboard and Mouse classes which have event polls and translate events to InputManager.



4.6 Engine

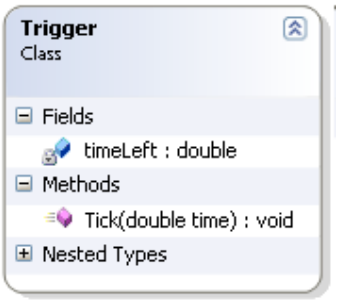
4.6.1 Timer

This class helps control game speed of the simulation.



4.6.2 Trigger

This is the class for triggering events during the simulation.



4.6.3 BaseSquad

This is the main squad class. All other squads inherit this class.

4.6.4 PoliceSquad

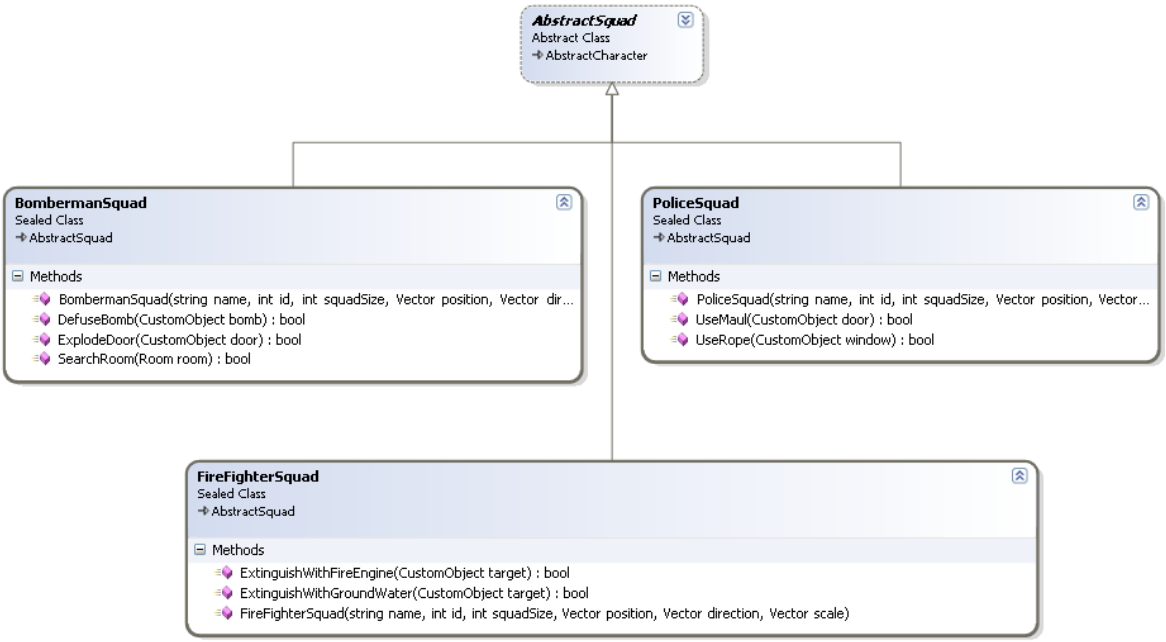
This is the police team class. It composes of many PoliceOfficer classes and controls them according to the orders given by PoliceLeader

4.6.5 BombermanSquad

This is the bomb defuse team. It composes of many Bomberman classes and controls them according to the orders given by BombermanLeader

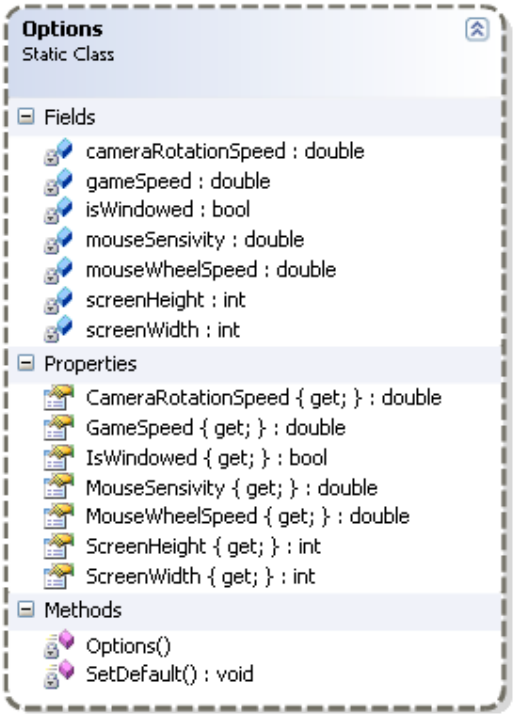
4.6.6 FirefighterSquad

This is the firefighter team. It composes of many Firefighter classes and controls them according to the orders given by FirefighterLeader



4.6.7 Options

This is the class that hold the settings about the simulation.



4.6.8 Officer

This is the main NPC class. All other NPCs inherit this class.

4.6.9 PoliceOfficer

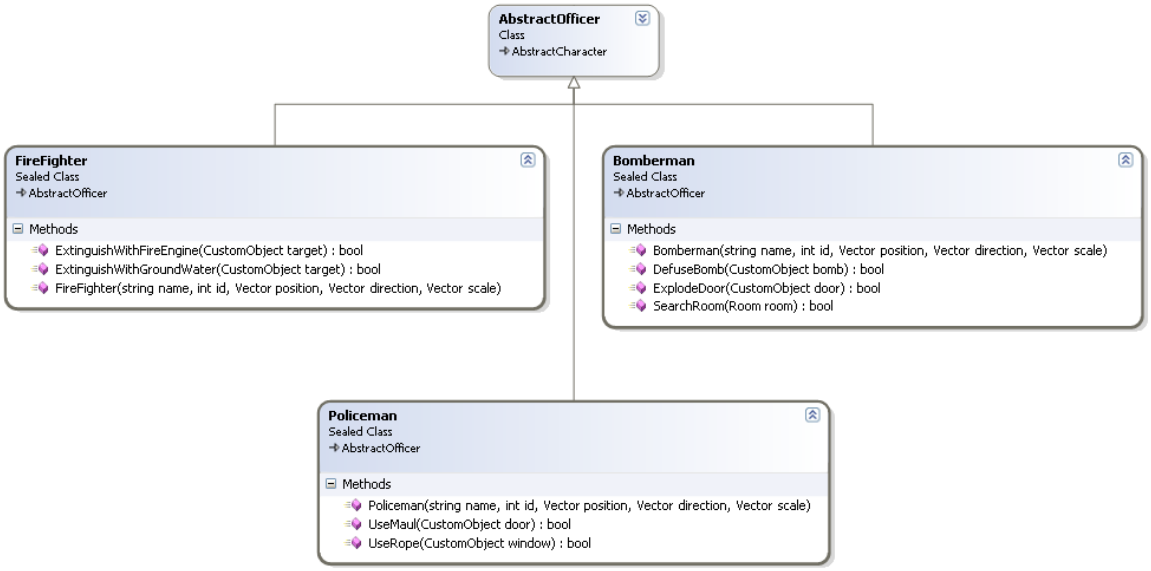
This is the NPC police class. These follow the orders given by the squad.

4.6.10 Bomberman

This is the bomb defuse NPC class. These follow the orders given by the squad.

4.6.11 Firefighter

This is the firefighter NPC class. These follow the orders given by the squad.



4.6.12 CustomObject

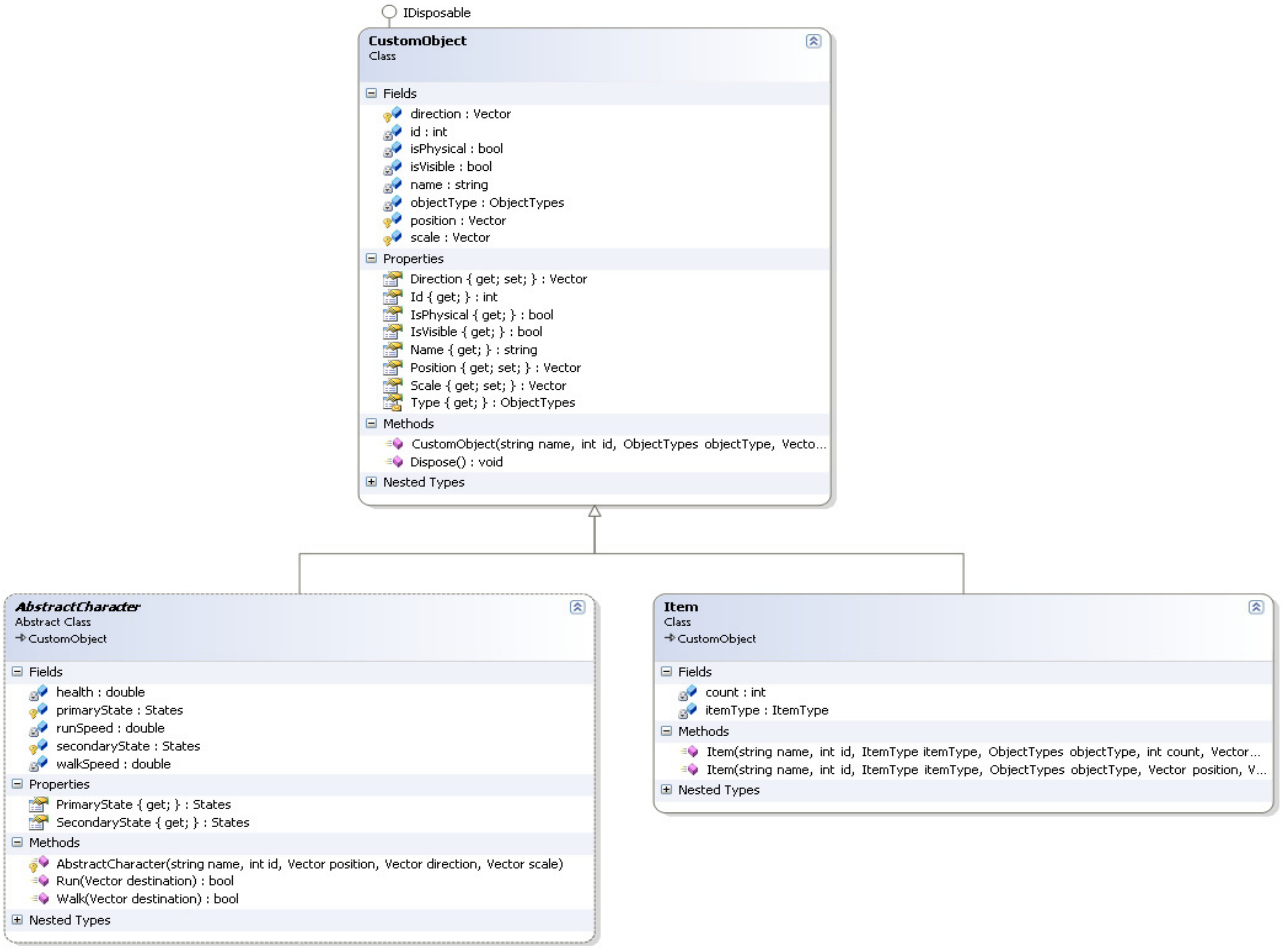
This is the main object class. All other objects inherit this class.

4.6.13 Item

This class is used for environment objects and items carried by players and NPCs like maul, door, etc.

4.6.14 BaseCharacter

This is the main character class. All other characters inherit this class.



4.6.15 Map

This is the class holds other environment data. It is divided into sub regions.

4.6.16 Region

This is the class for a specific area of the map. Regions may be buildings, open areas, etc.

4.6.17 Building

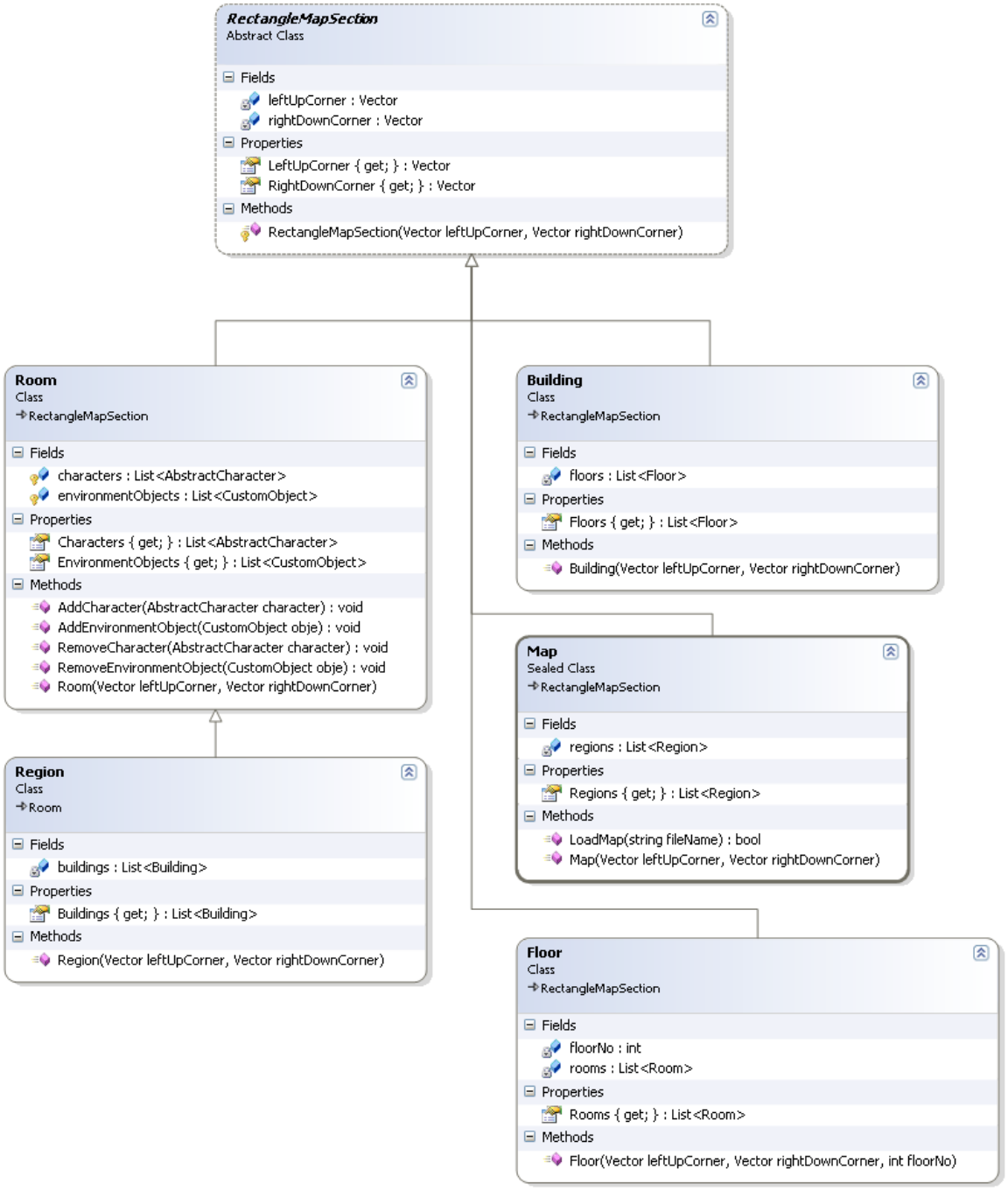
This is the class for buildings in a region. It is divided into floors.

4.6.18 Floor

This is the class for a floor in a building. It is divided into rooms

4.6.19 Room

This is the class for rooms in a floor of a buildings.



4.6.20 Leader

This is the main player class. All leaders inherit this class.

4.6.21 PoliceLeader

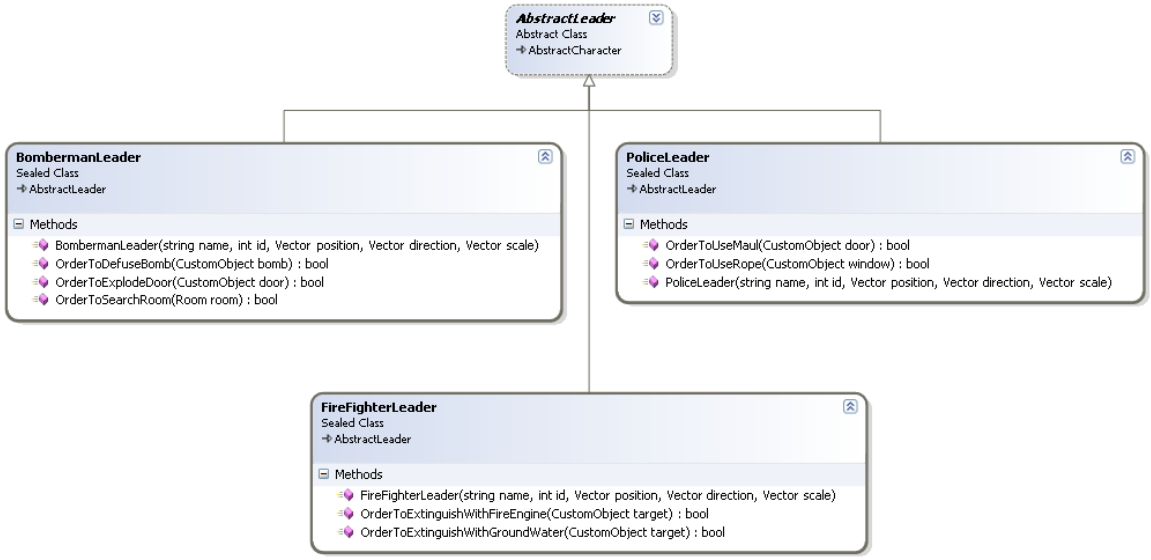
This is the police player's class. It has a squad member and can give orders through this squad class to PoliceOfficers

4.6.22 BombermanLeader

This is the bomb defuse player's class. It has a squad member and can give oerders through this squad class to Bombermans.

4.6.23 FirefighterLeader

This is the firefighter player's class. It has a squad member and can give orders through this squad class to Firefighters.

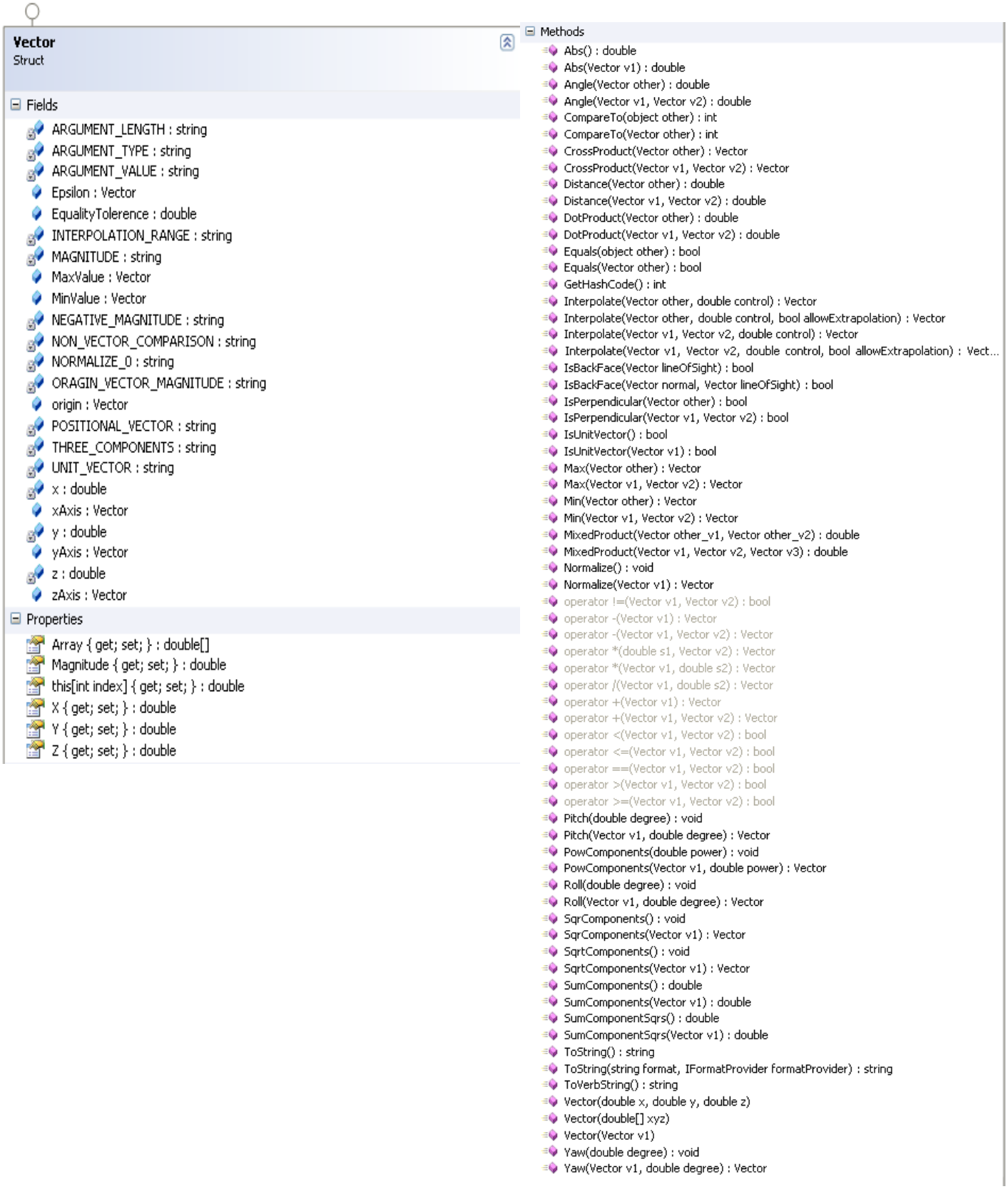


4.6.24 Civilian

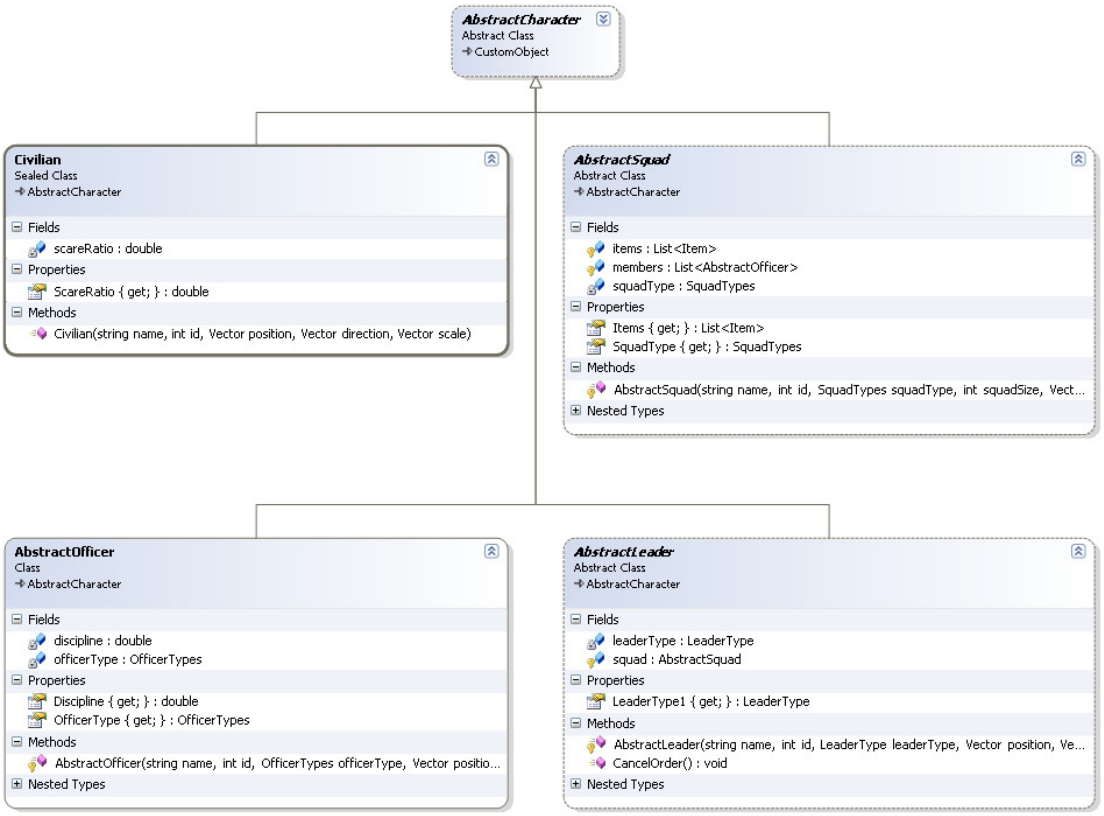
This class is used for civilians to be rescued in the building.

4.6.25 Vector

This is the main class for defining a position, direction and size on the map. It also has methods to calculate mathematical operations.


Vector
Struct
Fields
ARGUMENT_LENGTH : string
ARGUMENT_TYPE : string
ARGUMENT_VALUE : string
Epsilon : Vector
EqualityTolerence : double
INTERPOLATION_RANGE : string
MAGNITUDE : string
MaxValue : Vector
MinValue : Vector
NEGATIVE_MAGNITUDE : string
NON_VECTOR_COMPARISON : string
NORMALIZE_0 : string
ORAGIN_VECTOR_MAGNITUDE : string
origin : Vector
POSITIONAL_VECTOR : string
THREE_COMPONENTS : string
UNIT_VECTOR : string
x : double
xAxis : Vector
y : double
yAxis : Vector
z : double
zAxis : Vector
Properties
Array { get; set; } : double[]
Magnitude { get; set; } : double
this[int index] { get; set; } : double
X { get; set; } : double
Y { get; set; } : double
Z { get; set; } : double
Methods
Abs() : double
Abs(Vector v1) : double
Angle(Vector other) : double
Angle(Vector v1, Vector v2) : double
CompareTo(object other) : int
CompareTo(Vector other) : int
CrossProduct(Vector other) : Vector
CrossProduct(Vector v1, Vector v2) : Vector
Distance(Vector other) : double
Distance(Vector v1, Vector v2) : double
DotProduct(Vector other) : double
DotProduct(Vector v1, Vector v2) : double
Equals(object other) : bool
Equals(Vector other) : bool
GetHashCode() : int
Interpolate(Vector other, double control) : Vector
Interpolate(Vector other, double control, bool allowExtrapolation) : Vector
Interpolate(Vector v1, Vector v2, double control) : Vector
Interpolate(Vector v1, Vector v2, double control, bool allowExtrapolation) : Vect...
IsBackFace(Vector lineOfSight) : bool
IsBackFace(Vector normal, Vector lineOfSight) : bool
IsPerpendicular(Vector other) : bool
IsPerpendicular(Vector v1, Vector v2) : bool
IsUnitVector() : bool
IsUnitVector(Vector v1) : bool
Max(Vector other) : Vector
Max(Vector v1, Vector v2) : Vector
Min(Vector other) : Vector
Min(Vector v1, Vector v2) : Vector
MixedProduct(Vector other_v1, Vector other_v2) : double
MixedProduct(Vector v1, Vector v2, Vector v3) : double
Normalize() : void
Normalize(Vector v1) : Vector
operator !=(Vector v1, Vector v2) : bool
operator -(Vector v1) : Vector
operator -(Vector v1, Vector v2) : Vector
operator *(double s1, Vector v2) : Vector
operator *(Vector v1, double s2) : Vector
operator /(Vector v1, double s2) : Vector
operator +(Vector v1) : Vector
operator +(Vector v1, Vector v2) : Vector
operator <(Vector v1, Vector v2) : bool
operator <=(Vector v1, Vector v2) : bool
operator ==(Vector v1, Vector v2) : bool
operator >(Vector v1, Vector v2) : bool
operator >=(Vector v1, Vector v2) : bool
Pitch(double degree) : void
Pitch(Vector v1, double degree) : Vector
PowComponents(double power) : void
PowComponents(Vector v1, double power) : Vector
Roll(double degree) : void
Roll(Vector v1, double degree) : Vector
SqrComponents() : void
SqrComponents(Vector v1) : Vector
SqrtComponents() : void
SqrtComponents(Vector v1) : Vector
SumComponents() : double
SumComponents(Vector v1) : double
SumComponentSqrs() : double
SumComponentSqrs(Vector v1) : double
ToString() : string
ToString(string format, IFormatProvider formatProvider) : string
ToVerbString() : string
Vector(double x, double y, double z)
Vector(double[] xyz)
Vector(Vector v1)
Yaw(double degree) : void
Yaw(Vector v1, double degree) : Vector

Below is shown an inheritance map among the abstract classes in the Engine module.



4.7 AI

4.7.1 Path Finder

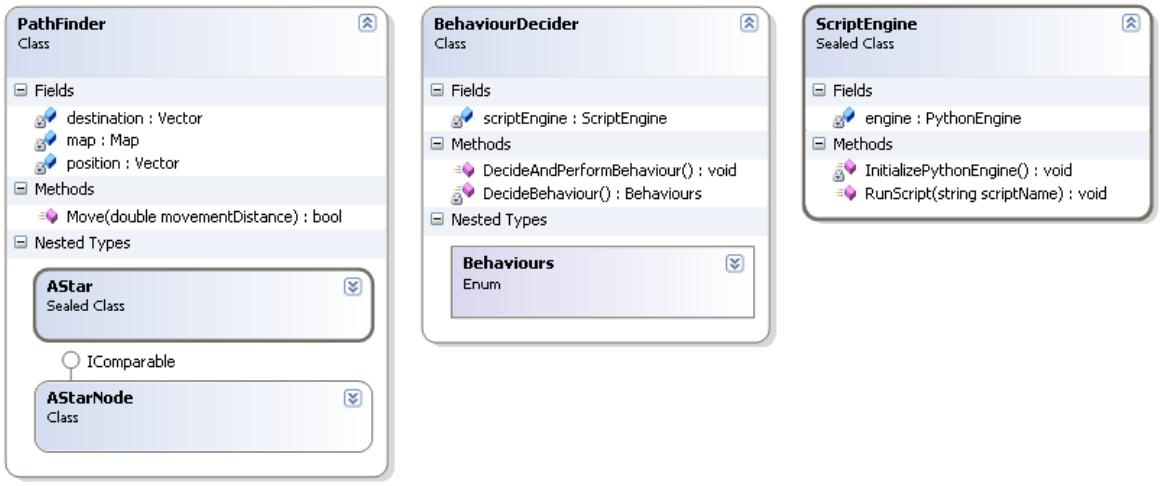
Given the start and end points, this class makes the necessary calculations to find a path between two poins on the map.

4.7.2 Behaviours Decider

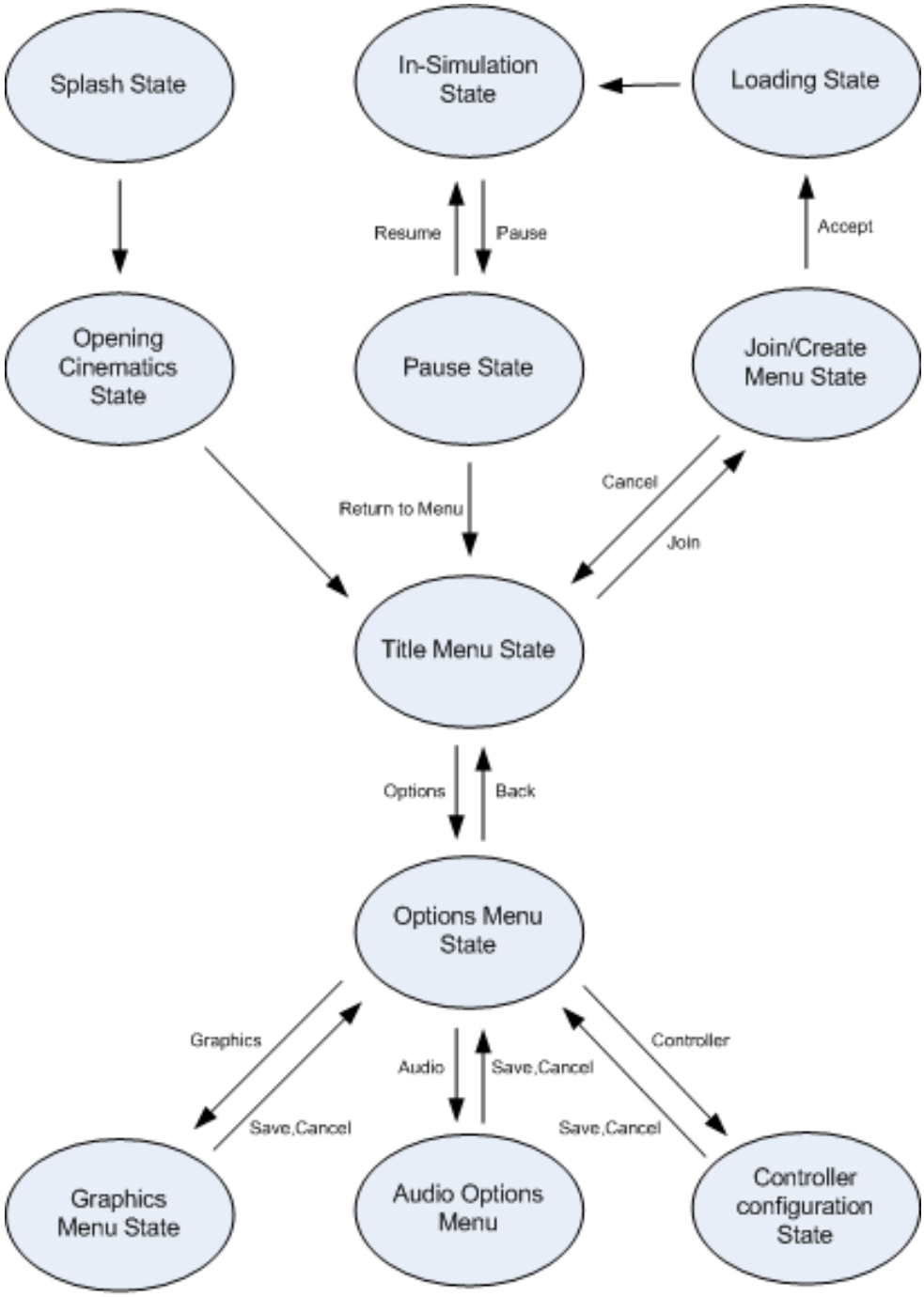
Using a script engine and looking at the objects' behavior, this class determines how the object should act in the simulation

4.7.3 Script Engine

This class is used by the behavior decider.



5 State Transition Diagram



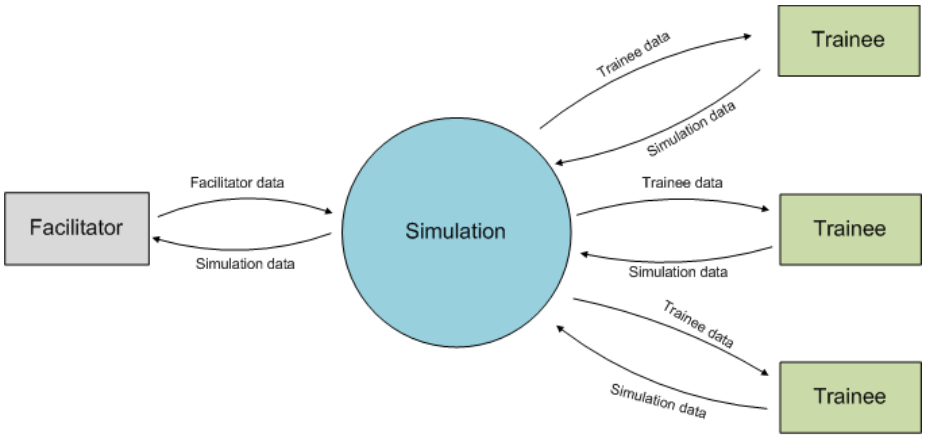
State Transition Diagram

6 System Analysis

6.1 Data Flow Diagram

6.1.1 DFD Level-0

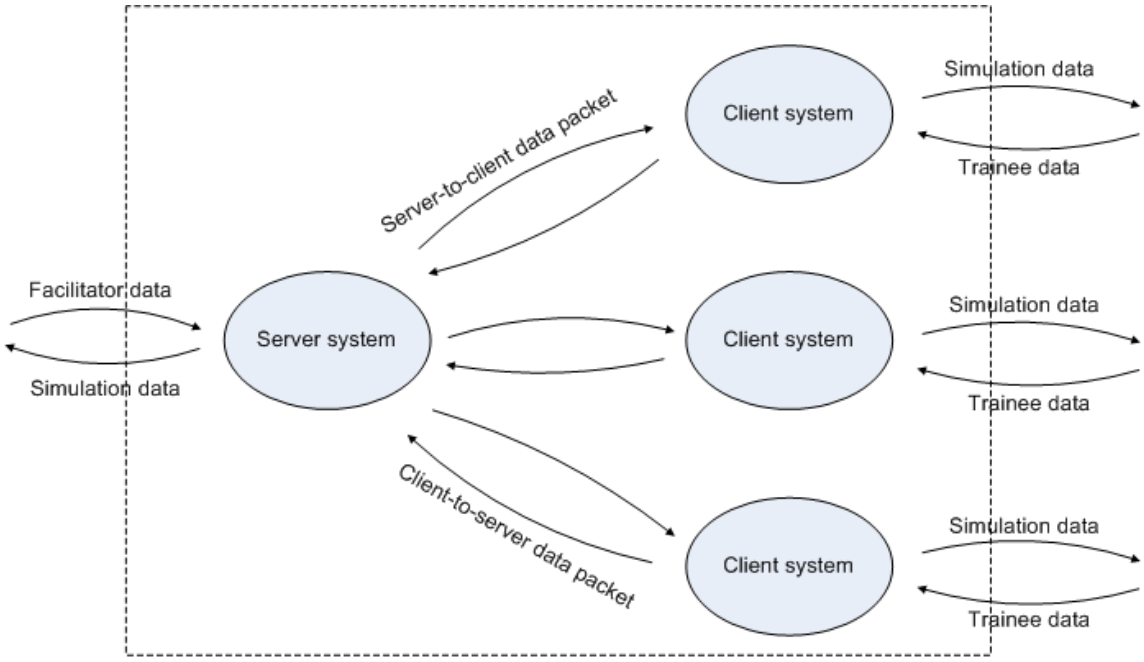
This diagram explains Data Flow Level-0 of the simulation. Facilitator and trainees sends commands via mouse, keyboard and microphone. They receive graphical representations of the simulation environment and listen to other users from their speaker.



DFD: Level 0

6.1.2 DFD Level-1

This diagram explains Data Flow Level-1 of the simulation. Client-to-server data packets include information such as user's outgoing voice and user commands. Server-to-client data packets include information such as other users' incoming voice, environment objects' modified properties.



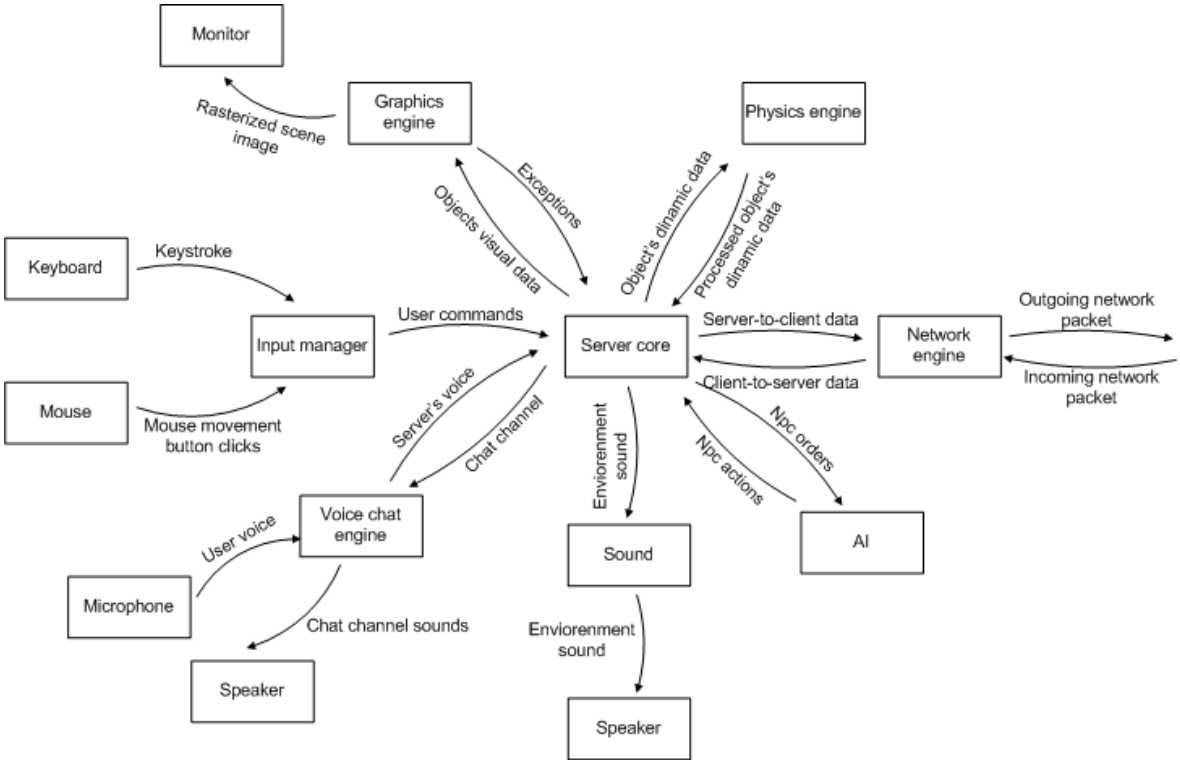
DFD: Level 1

6.1.3 DFD Level-2

These diagrams explain Data Flow Level-1 of the simulation.

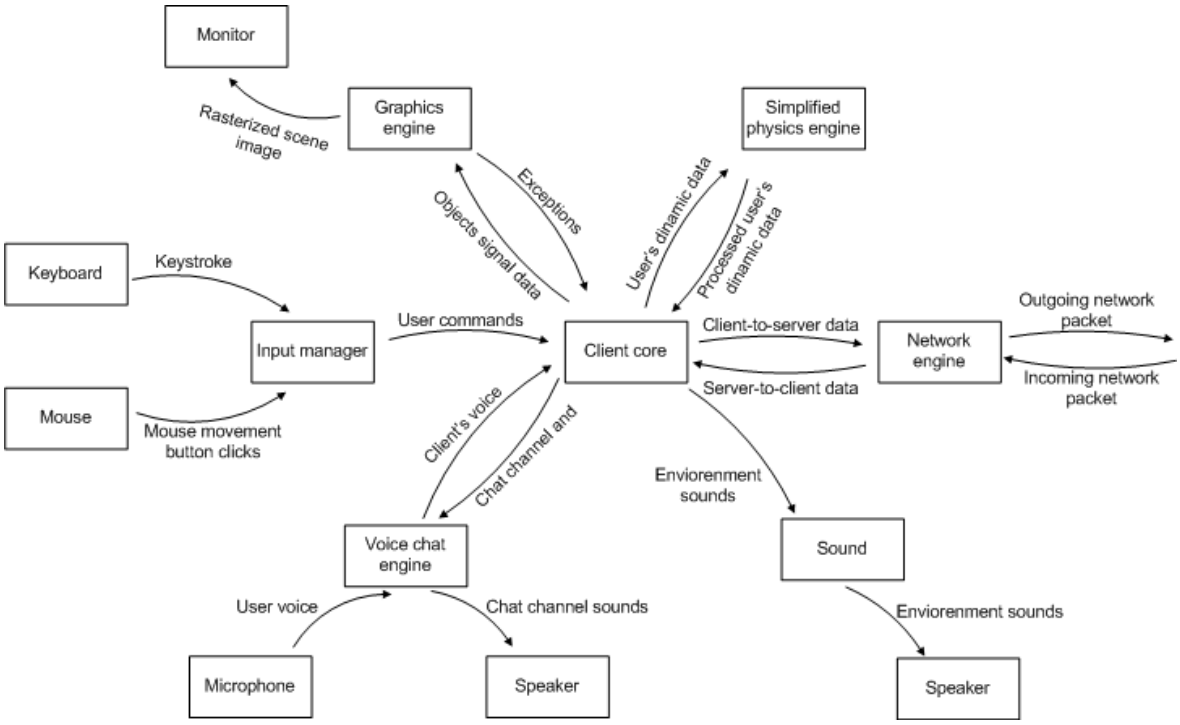
6.1.3.1 Server Core

- Object's visual data contains visible objects information.
- Graphics engine returns only exceptions to server core.
- Object's dynamic data contains physical object information.
- Processed object's dynamic data consists of physical object's modified information.
- NPC orders consist of given to non-playing characters.
- NPC actions consist of non-playing characters' reaction to given orders.
- User commands are commands generated by the user inputs.



6.1.3.2 Client Core

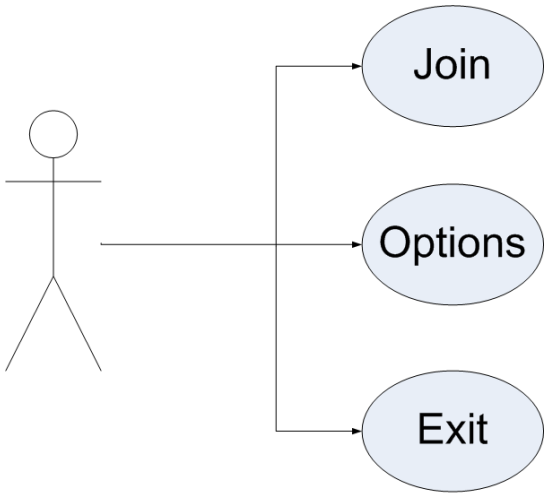
- Object's signal data contains visible objects information.
- Graphics engine returns only exceptions to server core.
- User's dynamic data contains user's character's physical information.
- Processed user's dynamic data consists of physical object's modified information
- User commands are commands generated by the user inputs.



6.2 Use Case Diagrams

6.2.1 Client: Menu State Use Case

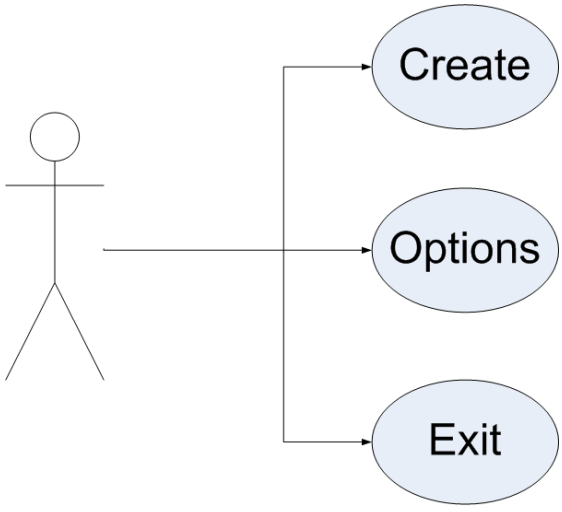
This is the main screen the client will face when starting the program. The screen has 3 buttons.
Join: Connect to the server at the given IP address.
Options: Set program options such as graphics, audio and controller configurations.
Exit: Terminates the program.



Client: Menu state

6.2.2 Server: Menu State Use Case

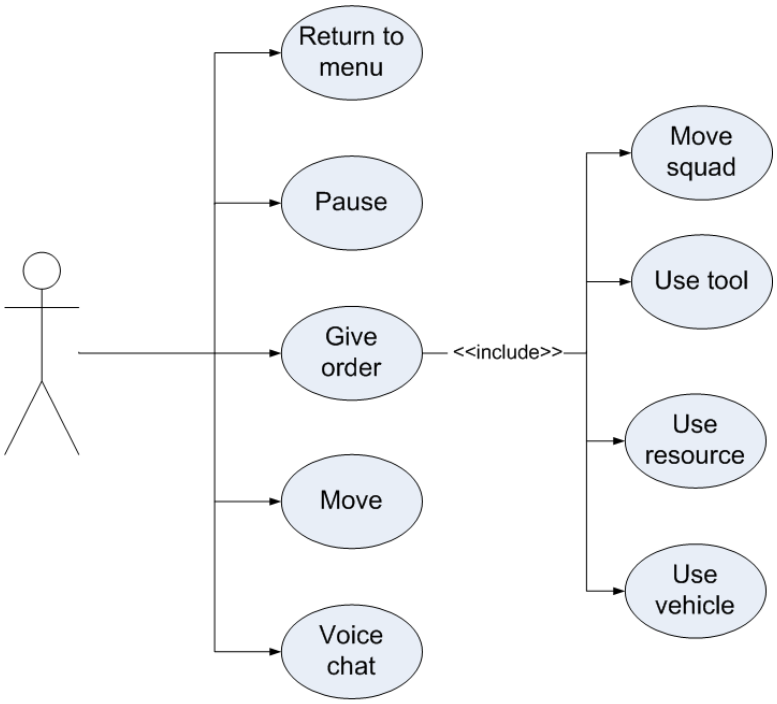
This is the main screen the server will face when starting the program. The screen has 3 buttons.
Create: After clicking this button and choosing the simulation mode, the simulation will initialize. The clients will then be able to connect the server by entering the server's IP.
Options: Set program options such as graphics, audio and controller options.
Exit: Terminates the program.



Server: Menu state

6.2.3 Client In-Simulation State Use Case

This diagram explains what the client can do while the simulation is running.
Return to Menu: Selecting this will switch the current state to the user menu state.
Pause: Selecting this will send a pause request to server and the simulation's current state will be switched to pause state.
Give Order: The client will be able to give commands such as: Move squad, use tools, use resources and use vehicle. If the simulation is at "Passive Mode", these commands shall be given to the facilitator via voice chat and are executed by the facilitator. If the simulation is at "Active Mode", these commands can be given by either voice chat or user interface.
Move: Moves the user on the map using the keyboard and the mouse.
Voice chat: Users will be able to communicate with the facilitator and other users by voice chat.

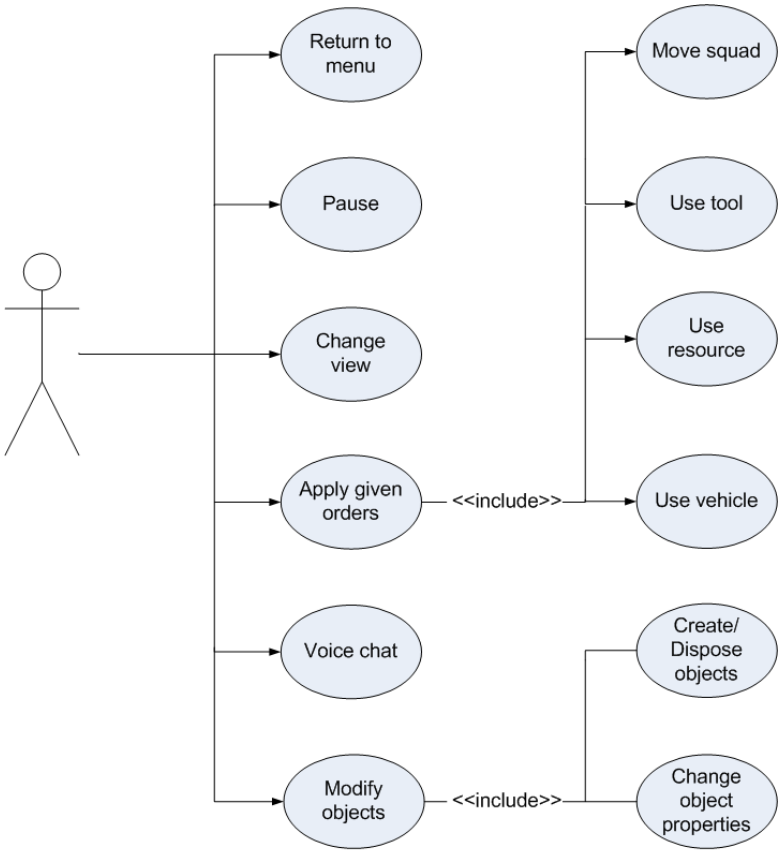


Client: In-simulation state

6.2.4 Server: In-Simulation State Use Case

This diagram explains what the server can do while the simulation is running.
Return to Menu: Selecting this will switch the current state to the server menu state.
Pause: The simulation's current state will be switched to pause state.
Change View: By default, facilitator will begin at "Free View", in which he can move in any direction without any constraint. He also can view the scene directly from any client's view at "User View". Another view mode is the "Map View", in which the facilitator sees the clients as little symbols on a full screen map.

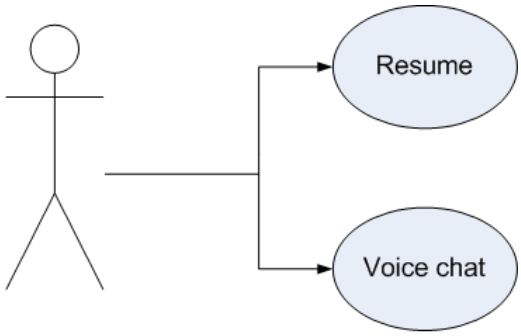
Apply given orders: Facilitator can, at any time, execute orders such as: Move squad, use tools, use resources and use vehicle. At "Passive Mode", these orders may be executed only by the facilitator.
Voice chat: Facilitator can communicate with the clients via voice chat.
Modify objects: Depending on the flow of the scenario, facilitator can create or dispose objects, or modify attributes of an object.



Server: In-simulation state

6.2.5 Server and Client: Pause State Use Case

This diagram explains available actions for the server and the user when the simulation is paused.
Resume: Selecting this will switch simulation's current to in-simulation state.
Voice chat: During the Pause State, users will be able to voice chat.



Server and Client: Pause state

7 Tools

First of all, project's main platform is decided to be Microsoft .NET. Then all of the team members chose C# as their MS .NET language. This wasn't an easy choose though because in the last 10-15 years 3D computer graphics software (games, simulators, 3D modelers ...) developments have been dominated by C++. And most of the related libraries, APIs and engines have been built and optimized for C++. But on the other side, C++ has become an inefficient programming language compared to fresh languages like Java and Python.

To come to .NET and C#, .NET has a large collection of common libraries, which allows developers to avoid reinventing the machine. C# supports most popular programming language paradigms, also has a large community support on the internet by Microsoft's official and some unofficial sites and forums .Also it's the MS Visual Studio's best integrated language, which speeds up coding, makes debugging and team collaboration easier.

Some people claim that C# isn't suitable for professional real-time 3D graphics programming (like games) for its performance issues. But some other people assume that it will be good enough by making code optimizations in the remaining times since it significantly speeds developing. Also Microsoft sees XNA as future's game development environment and chose C# as the standard language for XNA. (Although XNA is currently used for indie gaming, its creation goal is making game programming easier, for both amateur and professional game developers. its professional edition is planned to be released in the future by the Microsoft (Currently it has only express edition).)

There were free game engines like NeoAxis and Blade 3D which integrated graphics, physics, network and so on. But they were still in beta stages, unstable and slow even in their own samples, lacking documentation and samples. So we decided using/making sub-engines/modules for the project.

There are huge amounts of graphics engines, both amateur and professional, free and commercial. We focused on semi-professional and free ones and eliminated them to three ones, which are OGRE, Irrlicht and Crystal Space. All were popular and matured products. They have a nice community support, well documented manuals, easy to understand tutorials and samples. OGRE

had come into prominence by being used by some professional game projects and Irrlicht had come into prominence by supporting official .NET API. Since Irrlicht's graphics features were enough for the project, it has been chosen as project's graphics engine mostly by its official .NET API support. OGRE and Crystal Space have .NET wrappers but they are not official and seemed a bit amateurish compared to their original C++ APIs and Irrlicht's .NET API.

After searching for networking, we came up with three options for networking, using Managed DirectPlay, .NET's networking libraries or XNA 2.0's network library. .NET's networking libraries were good in general but were not suitable for the project; they were not designed for real-time applications. Managed DirectPlay and XNA.Framework.Net were just designed for real-time 3D graphics applications, and they were both high-level libraries. But Managed DirectPlay is deprecated and XNA 2.0 is very new API (released in December 2007). They both have a nice community support but Managed DirectX 9.0c has obviously more samples and books over XNA 2.0, which made it to be chosen for the project's network API. Also we looked for some C++ network libraries like RakNet and HawkNL, but we skipped them for their integration issues and for a fully managed coded project.

For graphics modeling, there are two products which actually dominate the market; 3DSMax and Maya. Although both are excellent modeling tools, 3DSMax's wide variety of exporting tools which made it easier for us to integrate the models in our graphics module was a plus for it. Also considering that we had some previous experience with it, 3DSMax was our choice for object modeling.

8 So Far...

As predicted, we managed to integrate foretold libraries successfully and presented a prototype demo. Also began designing maps and models, some of which we used in the prototype. Especially our network and graphics modules are running smoothly. We need to implement the engine to establish a good communication between the modules. Also AI and scripting modules are to be integrated.

9 Schedule

	Task Name	Duration	Start	Finish
1	Scenario Design	15 days	Mon 15.10.07	Fri 02.11.07
2	Concept Research	15 days?	Mon 15.10.07	Fri 02.11.07
3	Requirement Analysis Rep	15 days?	Tue 16.10.07	Sun 04.11.07
4	Server Core Design	30 days?	Mon 03.12.07	Fri 11.01.08
5	Client Core Design	30 days?	Mon 03.12.07	Fri 11.01.08
6	Graphics Design	46 days?	Sun 04.11.07	Fri 04.01.08
7	Network Design	46 days?	Sun 04.11.07	Fri 04.01.08
8	AI Design	46 days?	Sun 04.11.07	Fri 04.01.08
9	Physics Design	46 days?	Sun 04.11.07	Fri 04.01.08
10	Graphics Demo	15 days?	Mon 24.12.07	Fri 11.01.08
11	Network Demo	15 days?	Mon 24.12.07	Fri 11.01.08
12	Physics Demo	15 days?	Mon 24.12.07	Fri 11.01.08
13	AI Demo	15 days?	Mon 24.12.07	Fri 11.01.08
14	Audio Demo	15 days?	Mon 24.12.07	Fri 11.01.08
15	Map Design	55 days	Mon 17.12.07	Fri 29.02.08
16	Models Design	65 days?	Mon 03.12.07	Fri 29.02.08
17	User Interface Design	25 days?	Mon 10.12.07	Fri 11.01.08
18	Initial Design Report	1 day?	Fri 30.11.07	Fri 30.11.07
19	Integration Demos	11 days?	Mon 19.11.07	Mon 03.12.07
20	Final Design Report	1 day?	Fri 11.01.08	Fri 11.01.08
21	Prototype Implementation	10 days	Mon 31.12.07	Fri 11.01.08
22	Prototype Demo	0 days	Fri 18.01.08	Fri 18.01.08
23	Graphics Implementation	55 days?	Mon 21.01.08	Fri 04.04.08
24	Client Core Implementation	60 days?	Mon 21.01.08	Fri 11.04.08
25	Server Core Implementatio	60 days	Mon 21.01.08	Fri 11.04.08
26	Input Manager Implementat	10 days?	Mon 21.01.08	Fri 01.02.08
27	User Interface Implementat	15 days?	Mon 17.03.08	Fri 04.04.08
28	AI Implementation	45 days?	Mon 04.02.08	Fri 04.04.08
29	Physics Implementation	17 days	Mon 03.03.08	Tue 25.03.08
30	Server Network Implement	60 days	Mon 21.01.08	Fri 11.04.08
31	Client Network Implementa	60 days?	Mon 21.01.08	Fri 11.04.08
32	Voice Chat Implementation	30 days?	Mon 03.03.08	Fri 11.04.08
33	Alpha Testing	21 days?	Mon 31.03.08	Mon 28.04.08
34	Beta Testing	27 days?	Tue 29.04.08	Wed 04.06.08
35	Quality Assurance	14 days	Tue 13.05.08	Fri 30.05.08
36	Documentation	15 days?	Mon 12.05.08	Fri 30.05.08
37	Final Product Presentation	10 days?	Mon 19.05.08	Fri 30.05.08
38	Final Product Release	6 days?	Fri 23.05.08	Fri 30.05.08