**GCSE Computer Science (7517)  
  
The Practical Project**  
  
**“Enter the Dead Zone”**

**Analysis - Overview**

# Project Background

In the last few months, I have been playing a lot of various games during my breaks and free times with a couple of friends. Most of these games feature local multiplayer or online multiplayer, however due to the restrictions of being in a school environment we are limited to local multiplayer games. As a group, we have gotten bored of many of the games we have played and thus, in this project I want to create a fun and engaging multiplayer game that will keep us entertained for a while longer.

With the production of this game I want to also solve a multitude of accessibility problems that we have had when trying to setup many of the already available games:

1. **Controller Support:** Many local games lack good controller support such as the ability to rebind buttons preventing the use of SNES USB controllers which do not have analogue sticks. This is problematic as not everyone owns the standard Xbox / PS4 controller.
2. **Lack of Controllers:** Sometimes there are not enough controllers to provide to everyone who wants to play causing people to be left out. This is mostly due to the lack of remote play support for most multiplayer games. Since everyone normally has their laptop with them the lack of controllers would not matter with remote play as one person can simply host the game and let others play via remote play on their own devices.
3. **Performance:** Since many of us do not have high-end laptops we are unable to play performance heavy games.

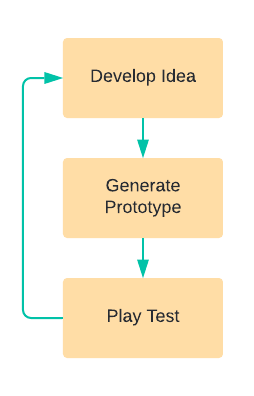
# Project Outline

As described above, I want to create a multiplayer game that fixes many of the accessibility problems of the currently existing games. In this project I also intend on improving replay ability and modding capabilities. This is because many existing games have become stale due to the lack of variation with each playthrough and the inability to change some features to make the game more interesting on a second playthrough. My clients for this project are going to be my group of friends that I play with.

**Analysis - Research**

# Secondary Research

When making a game, many developers have an initial idea or plan and they build upon this idea through progressive play testing. One way to develop on an initial idea is to *“Follow the fun”*. This is a methodology to making games where the developer should ignore their original plans and preconceived ideas and instead look to their game (first prototype) to find where the development should lead. For example, the game *Into the Breach* was originally intended to be a turn-based strategy game like *Xcom* where the player would have to manage their squad and resources to defeat their enemies. However, the designers needed something innovative as they were otherwise making a very generic tactics game. To do this, they decided to show the player the intentions of one of their enemies allowing the player to make decisions based on what that single enemy was going to do next. When play testing they found that this single mechanic was the most fun and interesting part of the game and so as Ma, one of the developers of *Into the Breach*, said in an interview, “We cut everything that didn’t inform the combat” [[[1]](#footnote-1)] thus resulting in the game revolving all around telegraphed attacks.



For this project I think this methodology of development would work very well as it will allow for me to come up with various ideas and create quick prototypes to try out to help my follow the fun. As Marc Leblanc, a designed who worked on the game *Thief: The Dark Project* and the person who originally coined the term “follow the fun”, says “Fail faster, and follow the fun” [[[2]](#footnote-2)] which briefly describes the process of quickly making a prototype of an idea as quickly as possible to see what works and what doesn’t. With each failure you can iterate and develop the original idea further into something a lot more fun / interesting saying a lot about what direction the next attempt should take. The flow diagram on the right shows the iterative process of this workflow.

# Existing Products

## Unrailed!

*Unrailed!* is a 2-4 player roguelike game in which the players must gather resources to produce rails and dig out a path for a train to reach its next station. This game is very simple by design but through its very smart systems it encourages player cooperation and creates very tense moments for a seemingly easy game.

These design choices include simple controls involving just the analogue stick for movement and a single button for interaction. This makes the game incredibly accessible for any player which is important when introducing a game to others. It also features individual tools that define player roles rather than classes / characters such that players are not restricted to one roll mid-game allowing for more dynamic gameplay as players can switch tools with each other effectively changing their identity and purpose. For example, if a player was holding the pickaxe, they were the miner but if they were holding the axe, they were the tree cutter. By allowing player roles to change throughout the game fixes the problem in other role-based games where a role may become temporarily useless due to the context that they are in; in the case of *Unrailed!* this could be the absence of trees for the tree cutter. In this way *Unrailed!* also provides each player their own unique decisions that are integral to “winning”. Each of these roles are also all equally important to beating the game, this makes every player feel like they are contributing to the greater goal giving a real sense of achievement upon completing the game which is important when it comes to cooperative gameplay. Through this, the chances of beating the *Unrailed!* massively improve the better players communicate which is integral to a cooperative game. Another important feature of *Unrailed!*’s design is how there are multiple ways to lose ranging such as running out of resources, getting blocked by the train, leaving a tool behind and not digging out a path fast enough before the train reaches the end. Through this the game is able to create high tension which keeps players engaged and on their toes constantly. *Unrailed!*,very importantly, allows player mistakes that “hurt” or effect their coop partners directly which encourage communication such as through the simple act of letting players collide with each other and get in the way. These sorts of mistakes create moments for players to have a laugh or rage which improves the fun as player interaction always adds an element of randomness and allows for unexpected moments.

src: https://store.steampowered.com/app/1016920/Unrailed/

From this I compiled a list of points to think about when developing my game if I were to revolve gameplay around cooperation:

* Each player needs to have their own roles that provide them with unique decisions that are integral to winning.
* Different roles that are all equally important.
* Dynamically changing roles to prevent the temporary exclusion of one role in various contexts of the game.
* Promote player interaction throw allowing mistakes that actively “hurt” others.
* Multiple ways of losing to increase tension.
* Direct player interaction for added randomness.
* Accessibility through the game being easy to learn and pickup.

## Towerfall Ascension | PS4 Games | PlayStationTowerfall Ascension

*Towerfall Ascension* is a 2-4 player competitive duelling game that has players shooting arrows at each other to be the last player standing. Similarly to *Unrailed!*, *Towerfall Ascension* offers very simple controls with the D-pad / analogue stick for movement two other buttons; one for shooting and another for performing a dash.

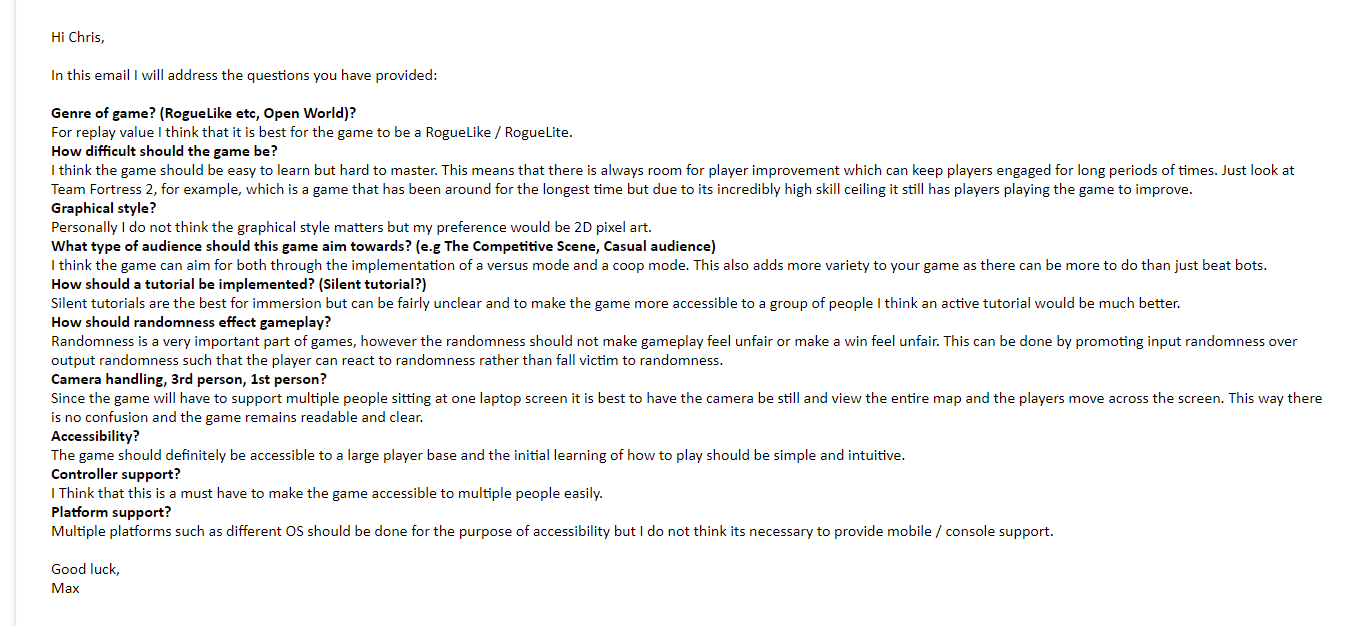
*Towerfall Ascension* offers very fair gameplay through making every player equal as every player character has the same abilities. This design choice makes each loss in game feel fair and balanced which is important when it comes to anything player versus player (PvP). *Towerfall Ascension* also makes use of powerups and varied different types of arrows such as “drill arrows” which can shoot through walls adding a surprising amount of depth to the gameplay as players have to account for different arrow types keeping gameplay fresh and interesting. The design choice to add powerups and allow for players that fall behind in points to start with a shield allows for clutch comebacks which makes losing players never feel like they really are losing keeping them playing what seems to be a lost round. For better controller support the game also allows arrows to very slightly “home” in on nearby players stopping those that play on D-pad to still land shots and not be at a disadvantage to those that play with an analogue stick. Another interesting design choice is how customizable the game is as it allows complete control on how various powerups spawn, the number of rounds players play, what powerups are banned and more. This means that the base game can be tailored to match what the players want which makes the game accessible to a wider player base.

src: https://store.steampowered.com/app/251470/TowerFall\_Ascension/

From this I determined a couple main points I would like to consider when developing my game:

* All players can be created equal to negate the problem of balance.
* There should be no advantage from playing on a different controller.
* Use of a comeback system to keep players that are losing playing the game and not giving up.
* Use of some random powerups to allow for funny unexpected moments.
* Customizable settings for increased accessibility.

# Client Interview

As noted previously, my intended clients are my group of friends that I often play with and who will be the primary user of my product. One of member from the group, Max, had agreed to answer some questions over email:

Email response from Max, a primary user for my game, addressing some of my questions for the game.

Max also commented on the fact that when developing a game, I need to formulate an initial idea that is unique such that it stands out from all the other games that already exist. He expressed that this innovation is important to ensure that players remain interested in my game because otherwise gameplay can feel boring and stale as without some form of unique gimmick, I would be making something generic.

**Analysis – General Objectives**

Before I plan out a game idea and start prototyping, I want to define some base minimal requirements that I must have. Since my game will support both remote play and local play, I will split this into this base specification into server and client:

## The server should:

1. Establish a connection between multiple clients
   1. Allow the means for 2-way communication between the server and client
   2. A standardised packet format will be designed in the design section of the project
   3. The server should adjust for packet loss and handle high ping / delayed packets appropriately for both incoming, and outgoing data
   4. Each client should be assigned a unique ID
2. Authorise the clients incoming data about position and client state
   1. If the server disagrees with the client, the server takes priority for server-authoritative control
3. Constantly broadcast a snapshot of its current world state to its clients
   1. Snapshots should be small, and only contain relevant data towards its respective client to reduce bandwidth usage
      * Such as only the area of the world that a client can see
   2. Snapshots are sent once every server tick
4. Calculate physics of entities
   1. Players are user-controlled entities that act on standard physics that can be controlled by commands sent via the clients
   2. Each entity and entity interaction should be assigned a unique ID such that they can be referenced in snapshots sent by the server
5. Receive packets relating to player controls from clients
   1. The server should account for ping and delay from the clients when performing actions (if the player is 200ms behind, handle the packet with the world rolled back 200ms)
6. Read from a configuration file which allows the user to set the server port

## The client should:

1. Provide a GUI for the user
   1. This should be usable by a naïve user
2. Host a server on the client pc with given settings / options that the user provides
3. Handle more than one player on a device and tell the server accordingly to allow for local play to work over multiplayer as well
4. Connect to a server with the IP address and port a user provides
5. Receive packets from the server
   1. Unwrap the packets and generate the snapshot client side for the user
   2. The client should account for the server tick rate and interpolate between snapshots sent to ensure smooth physics client side despite the slower tick rate of the server
   3. The client should account for lost snapshots / high ping and correct for disagreements in position with the server in a smooth fashion to increase quality for the user
6. Display / Render the player and world onto the screen
7. Provide an interface for the user to interact with the world
   1. User can control their player character
      * This can be done via keyboard / controller:
        + The client should provide an interface to change these controls
        + The client should detect when a new input device is connected
          - The client should save various control schemes for already recognised controllers on the local machine
8. Provide a method of connecting to a given server
   1. GUI
      * User can input the server’s IP and Port and the game will attempt to connect to that server
   2. The client should handle time out and connection errors appropriately
      * On disconnect, the user should be made aware of the error and should be sent back to the connect GUI menu where they can attempt to reconnect
9. Send groups of player actions in “action snapshot” packets to the server
   1. These should be sent periodically (not every frame) and as a result should include a queue of all actions / button presses the player did between each packet send

**Analysis – Initial Game Design and Prototyping**

My plan is to create a roguelike tower defence game with a catch. The catch is going to be the fact that the towers the player places can also hit the player themselves. This essentially mixes the traditional tower defence genre with bullet hells and thus creating intense rounds as the player must dodge their own towers whilst placing down more towers to defend the oncoming waves of enemies.

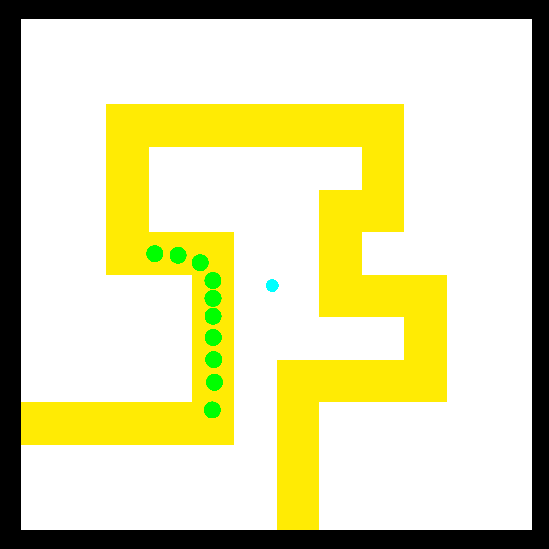
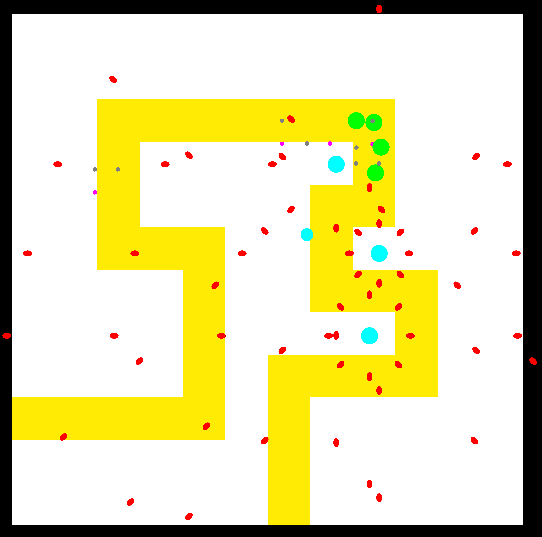
In a traditional tower defence game the towers actively target the incoming enemies, however since the game needs to factor the player into account I will make towers shoot in 8 directions around them such that the player will always be in the cross fire of the towers. Because of this, towers will also have to have infinite range such that the player cannot just rest outside of a towers range and they will have to shoot periodically to keep projectiles on the screen:



Tower (blue) shooting bullets (red) in 8 directions

Due to towers now shooting in a predictable manner it is straight forward for the player to place towers in such a way that they can sit still in a spot where the bullets will never reach them. One way to fix this is to make enemies drop the currency required to place towers as it will force the player to move to where the enemy dropped the money and pick it up so they can improve their defences.

For the time being I think this is a good starting point and thus I decided to produce a prototype version using these core concepts. I’ll address how multiplayer will affect this design later in the design process:

In this prototype the path the enemies will follow is shown in yellow and the enemies themselves are in green. The player character is denoted by the small blue dot and the larger blue dots represent the players towers. The red dots represent the projectiles that the player must dodge and that the enemies will die from and the small grey dots represent the money dropped from dead enemies. Through early playtesting I found that the game was very challenging. In order to stay alive, I found myself moving the player opposite to the enemies such that the enemies would block the projectiles for me. This also put me in a good position to collect the money that was dropped by enemies when they died. I think that this strategy of “wave hugging” is good as it promotes player movement and is a niche strategy that works when enemies are packed closely together in a line.

# Client Opinions

After producing a quick prototype, I sent it over to my primary user Max and spoke with him at length about the direction of this idea and how to “Follow the fun”. Below is a transcript of part of what we spoke about:

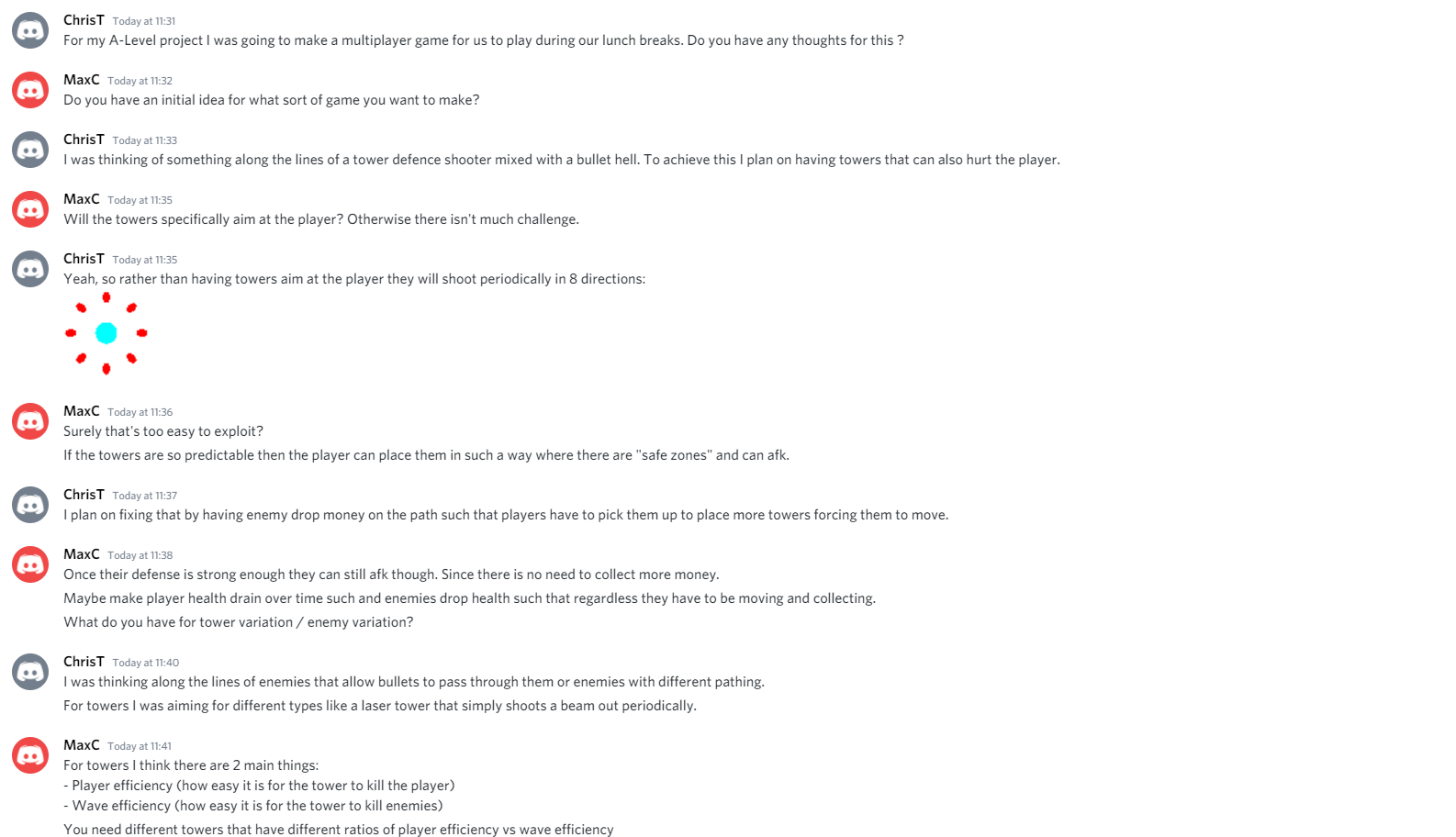
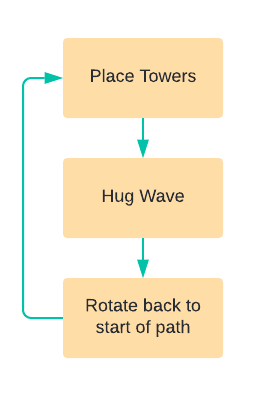


Image of conversation I had with Max

After play testing, Max and I were very happy with the game, it felt fun and fair. Whilst playing, Max commented how he found the wave manipulation such as “wave hugging” (the ability to interact physically with the enemies such that they block the tower shots for you) to be the most interesting and fun. Because of this we thought that a step in the right direction would be to allow the player to collide and interact with enemies such that they can form better wave states which could be very interesting and fun.

We also discussed the general gameplay loop of the game. Currently with a single infinite level to see how far the player could get, the gameplay loop was very simple:

Gameplay loop or strategy of the prototype proposed.

Max suggested that an easy way to add variety to this gameplay loop and to build upon wave manipulation would simply be to vary enemy behaviour. For example, having enemies that where more spread out reduces the amount of wave hugging the player can perform. Different enemy behaviours can also be more complex involving enemies that seem to have a personality through pausing at areas with no bullets passing by only to dash past the area filled with bullets as if they were timing their push to not get hit. This would add depth to the gameplay and give enemies character which would be fun to strategize against especially with proper player-enemy interactions.

Another problem with this prototype is that with a single infinite level there is no real end goal for the player and due to the games nature of enemies getting stronger as time goes on and how more towers to deal with said enemies will hindrance the player, the game feels unbeatable. To solve this, I am going to make the player survive for a pre-determined number of waves per level and then at the end of each level the player will be placed into some form of level selection to proceed to the next level. The game would then also have a final boss level which will be hard for the players to complete at the end, but since the game will now have an ending it no longer feels unbeatable.

Through the addition of perma-death such that when the player dies, they lose all progress and must start again at the beginning and all the levels are procedurally generated, I can add a lot of replay ability.

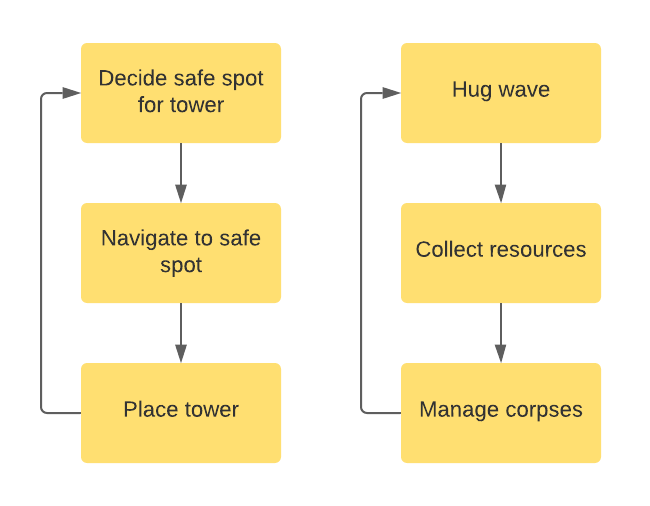
# Scaling into multiplayer / cooperative gameplay

With the core gameplay out of the way, I now need to scale the idea up to work in a multiplayer setting. For the multiplayer, I want to promote cooperative gameplay and communication and to do this I need to identify the different roles in my game:

* Tower placement.
* Resource collection (money collection).

I want to make a clear distinction between these two roles; however, I also want both players to be able to interchange and swap roles on their own. Another problem is that currently, tower placement as a role becomes much less important as time goes on as there will be enough towers on the field. To fix this I am going to give towers a form of lifetime such that over a time the tower disappears and needs to be replaced to keep tower placement relevant. Another interesting thought would be to make towers damage each other; this not only makes tower placement more important but increases the important of the tower placing role. To make navigating waves, and thus “wave hugging” more interesting I also thought about enemies dying and creating a corpse that protects their fellow enemies from shots for a bit, and thus it is important for the corpses to be pushed out of the way of the path.

With these changes there are now two distinct roles with their own unique gameplay loops:



The left flow diagram shows the gameplay loop for the tower placement role and the right shows the gameplay loop for resource collection.

In the above diagram I mention a “Tower Builder” this is essentially a random post on the map in which players drop resources the picked up at and it drops towers for another player to pick up and place. This forces players to move around the map and not stick to distinct parts as they need to fall back towards the “Tower Builder”. It also adds slightly more complexity as the player placing towers can keep into account its location and place towers accordingly such that the bullet hell is less severe around the “Tower Builder”.

# Gameplay Objectives

With the core gameplay design figured out I can now create a specification for the game:

## Stage 1: Minimum Viable Product (Create core gameplay)

1. The game should have a lobby showing the players that are playing.
2. Each playthrough should be procedurally generated.
3. Upon entering a level, the game should:
   1. Display the layout of the path the enemies will take.
   2. Allow players to move around the level.
   3. Have enemies spawn in waves that follow the path.
   4. Abide by standard tower defence rules:
      1. Enemies spawn at one end of the path and upon reaching the end the player loses (either entirely or some form of health system).
      2. Players can kill enemies using towers.
      3. Enemies drop a collectable resource used in creating towers.
   5. Tower shots can hurt the players as well.
   6. Towers self-destruct at the end of their lifetime.

## Stage 2: Enemy variation

1. When generating each level, the game will also define what enemy types will appear in each level and for which waves.
2. Enemy variation through different game mechanics or wave formats.
   1. Enemies that enter in a tightly packed wave.
   2. Enemies that are spread out.
   3. Enemies that move faster / in odd patterns.
3. Possible enemy variation through different behaviour.
   1. Enemies may stagger and stall in “safe areas” along the path where bullets do not cross and hastily cross “dangerous areas” filled with bullets.
   2. Enemies may move quickly in a straight line but slowly along turns.
   3. Enemies may wait for other enemies in “safe areas” and stick together before proceeding.

## Stage 3: Quality of life:

1. Settings to customize the gameplay:
   1. Ability to disable of certain enemy types.
   2. Game modifiers:
      1. Slow motion / Bullet time.
      2. All homing bullets.
      3. Enemies getting through the path instantly cause a loss.
   3. Ability to disable permanent death.
   4. Ability to disable different tower types.
   5. Slow down default game speed.

## Stage 4: Polish:

1. Entity ragdolls (physics-based corpses)
2. Particles and effects.
3. Character animations.
   1. Inverse Kinematics

**Design – Programming Solution**

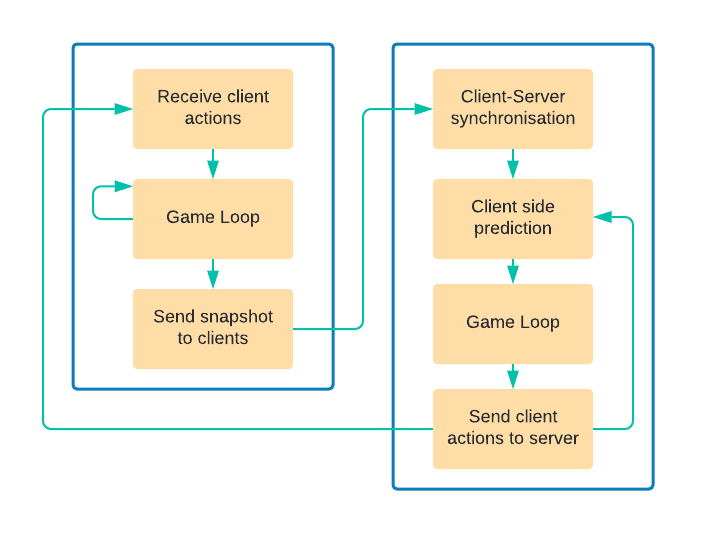
I intend to program this game in Unity 2D using C# as it provides an easy method for rendering a 2D scene as well as providing a physics engine. It is also a well-known and reliable engine for game development.

**Design – Overall System Summary**

# Local and Remote Play

## Base design

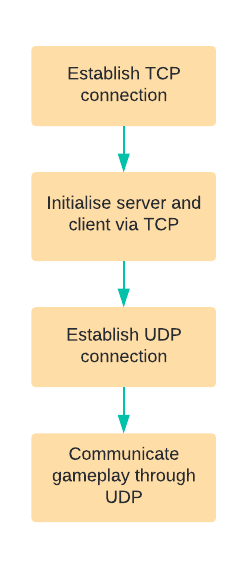
As described in the analysis, my game will support both local play and remote play. Because of this I will be developing my system with a server and client in mind and since my game is played in real time I will need to factor in synchronisation issues that come with players being on different devices. I will discuss the specifics for this synchronisation later in the design process. For my multiplayer system I will also run the server at a lower framerate as it will not perform any rendering or be required for smooth animations and game mechanics alongside its physics calculations do not require that many frames. A lower framerate will also reduce the chance that the server fails to fulfil its target framerate and skips frames which can cause all kinds of gameplay and synchronisation problems. This lower framerate should also improve the servers performance and as in my context it is very likely that the host will also be running the client on the same device, thus it will be important that the server can perform optimally whilst the client is also running. Below is a flow diagram for my basic system.



Flow diagram showing how the server (left) and client (right) will interact with each other.

To handle local play, the server considers each client as a group of players of size “n” and when sending commands between each other they refer to which player via an index.

## Networking

To establish a connection between the server and client I will be using the TCP protocol, however once the connection is established, I will be using the UDP protocol for communicating gameplay data. This is because TCP is a connection-oriented protocol meaning that TCP requires an established connection between a sender and receiver before data is sent whereas UDP is a connection-less protocol meaning that a connection does not need to be established to send data. This makes UDP simpler, faster and more efficient than TCP which is important for a real time system. TCP is still required as although UDP is faster, UDP does not care for packet loss. For a game this is not a problem as if a packet is lost, the data in that packet is soon no longer valid as it becomes “out of date” as the game time progresses, but for initially establishing a connection and sending important initialising data between the server and client, UDP is not very reliable and thus TCP must also be used. The below diagram shows how a connection would be established in this system:

Flow diagram showing the use of TCP and UDP in establishing a connection.

However, there is a key problem with using both TCP and UDP. This is mainly due to how TCP and UDP are protocols built on top of the Internet Protocol (IP) and the way they interact and affect each other is super complicated and relates to how TCP performs reliability and flow control which can cause TCP to induce packet loss in UDP packets [[[3]](#footnote-3)].

Because of this I will only use UDP but implement my own protocol on top of UDP but implement the specific features of TCP that I would need as well as other features I may need:

* Virtual Connections
* Reliability System
* Splitting data into packets
* Congestion Avoidance

## Networking UDP – Splitting up data into packets

UDP does not have a way to split up data that I want to send into packets and thus I must implement it myself. To do this, I simply will have a predefined byte count for the maximum number of bytes that can be sent in a singular packet. The data can then be split into packets by chunking it into the groups of bytes that can fit into a packet, using additional packets whenever there are more bytes than what I defined as the maximum. Each packet will also then be provided with a header containing information on what data the packet belongs to and which portion of the data it contains such that on receiving a packet reconstruction of the data can be done.

The reconstruction of the data from each packet can just as easily be done by queuing all received packets until all the packets required for a given block of data has been received. Once received the information in the header of each packet can be used to correctly order the data.

## Networking UDP – Virtual Connections

I will define a virtual connection as two devices exchanging packets at some given rate and thus if both devices are receiving packets, I can consider them to be virtually connected. With this the inverse is also true, if a device is not receiving a flow of packets it can consider itself as disconnected.

With this system my software needs to distinguish between packets that are received using my UDP protocol over other protocols that I may use in the future. To do this I will provide each packet with a *protocol ID* which will be some predefined unique integer. This way, when a packet is received, the first 4 bytes are inspected and if they do not match the *protocol ID* they will be processed differently. If they do match, then the packet can be processed using my protocol.

## Networking UDP – Reliability

For reliability I will implement something like TCP using *sequence numbers*. This number acts like a “packet id” such that each packet sent will have a unique ID. This can be implemented by having a value as the *sequence number* and then incrementing it with every packet sent such that the first packet sent is “packet 0” and the second is “packet 1” etc… This *sequence number* is important since it allows the receiver to identify what each packet is as UDP does not guarantee the order of packets so the 100th packet received may not be the 100th packet sent. There is still a problem with this system which is that the *sequence number* can top out if it increments over its maximum value. This can simply be fixed by allowing it to overflow back to 0 once its maximum value is reached and this can be detected on the client side by checking if the difference in the received sequence number and the previous sequence number is very large, so large that it is very unlikely due to a packet being received late.

Next is to reply with acknowledgements such that the server knows what packets the client has received and vice versa. To do this the packets will also include an *acknowledgement* value which corresponds to which packet has been received via use of the *sequence number*. This introduces another problem, such as what happens if the server and client are on different flow rates such that the server sends a packet 30 times a second and the client sends only 10 times a second. Since only 1 acknowledgement is sent, the client will only be able to acknowledge 10 of the 30 packets. To solve this, I can simply send more than 1 acknowledgement per packet. I am going to use 32 acknowledgements per packet for convenience as it can be stored using an integer value treated as a bit field such that each bit in the bit field represents another acknowledgement of the packet’s *acknowledgment* value minus the position of the bit in the bit field. For example, if a packet of *acknowledgment* 100 is received with the 1st and 3rd bit of the acknowledgement bitfield being set then the client has received packet 100, 99 and 97.

This system also means that each acknowledgement is sent an additional 32 times as each packet contains its acknowledgement and the previous 32 acknowledgements which may overlap. This is okay as with this redundancy, even if a few packets are lost, the server still has hopes of receiving the acknowledgement due to this redundancy and if the server does not receive an acknowledgement within a certain time frame it is incredibly likely that the packet was lost. For example, if the server sends 30 packets per second and acknowledgements are sent 32 additional times, then after 1 second it is incredibly likely the packet was lost.

## Networking UDP – Congestion Avoidance

TCP has a very robust congestion avoidance algorithm, but UDP does not have any form of congestion avoidance. If packets are just sent without any flow control, then there is a risk of flooding a connection and gaining severe latency. This happens as routers try very hard to deliver all packets they receive and may buffer up packets in a queue before they drop them.

Since my game will, for the most part, be run mainly in a LAN setting I can for the most part rule out this problem.

## Network Structure

I have two options when it comes to designing the structure of my network:

* Peer to Peer network
* Server Client network

For a peer-to-peer network I would still need one device to be allocated as the host as I want the game to follow server-authoritative design which means that the server is assumed to be right and will make decisions as to how the clients should act. Because of this the only real benefit of a peer-to-peer network is the fact that the bandwidth would be spread over multiple devices rather than all connections being made to one device as it is in a server-client based network. In my context of a small group of friends playing this game, it is unlikely that the benefit from this will make any difference at all. A peer-to-peer network will also be less efficient as data from the server has to be “trickled” down the network to reach players that are not directly connected to the server. For these reasons I will be using a server-client design.

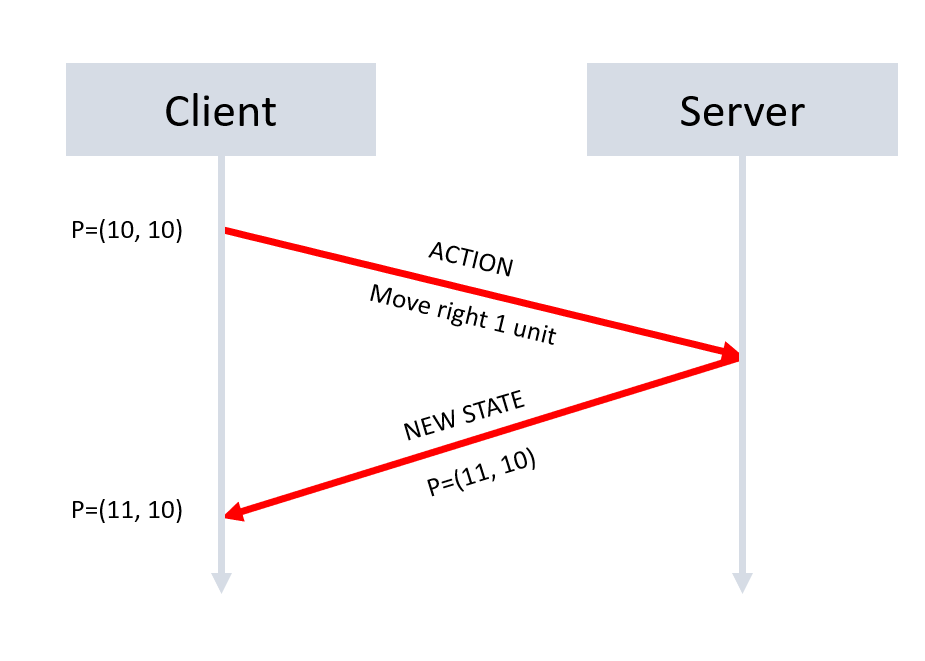
## Network synchronisation and handling bad connections

My game’s network will use server authoritative design. This means that everything happens in the server whilst the clients act as “privileged spectators” of the game. In this way the clients will send inputs such as key presses and commands to the server rather than information such as the clients player position.

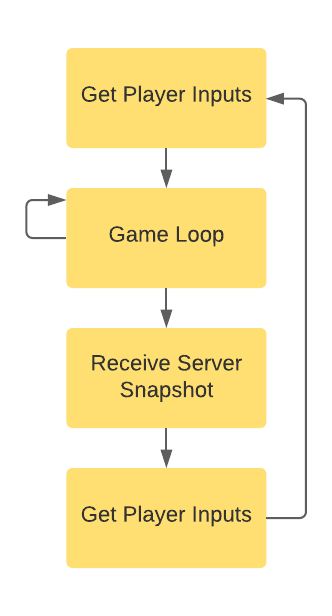
This design has the advantage of using an authoritative server that can be trusted over trusting the clients to be correct / truthful. However, this design comes with a few problems:

### Problem 1: Input Lag

The problem with this system comes from the fact that this would mean all clients are viewing the game in the past and all player inputs will be delayed as they must be passed to the server and then wait for a server response:



Simple client-server interaction showing how the client inputs are handled over time where p is the position of the player

For fast connections (low ping), this delay will be mostly unnoticeable, but for slower connections (high ping) it can ruin the player’s experience. One way to fix this is to use client-side prediction:

In this way, the client will have the same update loops as the server such that it can run the same physics and game loop to update the player and other objects. This would allow for the player to update immediately locally as according to new input commands and other objects can update as according to physics. When it comes to predicting the movement of other players, the game loop will just use their previous input commands from the last server snapshot / response and assume movement in the same direction using “Entity Interpolation”.

Once the client finally receives an update from the server it can resolve the disagreements with its prediction and with what the server had sent. This resolving cannot be as simple as just moving everything to match the server snapshot since due to the lag, the server snapshot would be in the past whilst the client-side prediction is resolving for the present.

Flow diagram showing client- side prediction

Below shows a diagram of a client using client-side prediction and what happens when it receives the past snapshots from the server after inputting a move right command twice:

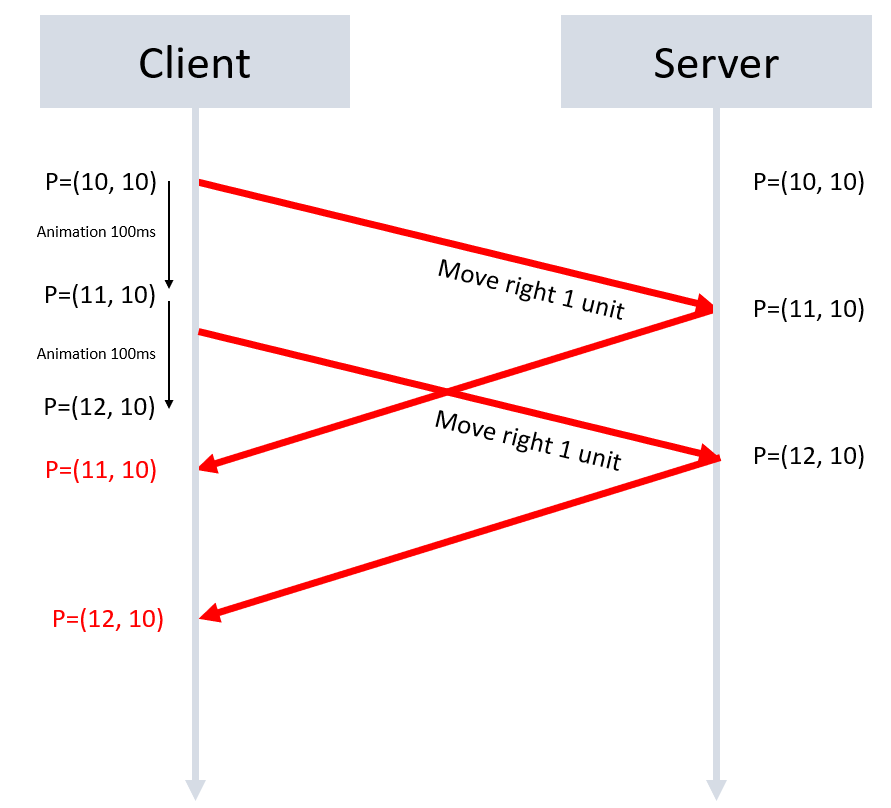


Diagram showing client-side prediction where p is the position of the player

Here it can be seen that the client correctly predicts the player movement in the first 200ms but due to the lag the server confirms this movement after the prediction. If resolving conflicts simple moved the player to the position noted by the server, the player would teleport back after the prediction which should not happen.

To fix this I will implement “Server reconciliation”. This involves having the client save each given input from the player with a “request” number such that, in our case, the first move right input is request #1 and the second is request #2. The server will then send snapshots with the players input request such that the client can see that the server got a given position after resolving input request #1. Assuming the client keeps a copy of the requests it sends to the server, it knows that the server has just resolved request #1 so it can apply client side prediction of request #2 from the server’s position provided from its response to request #1 and update the player’s present position for request #2. Request #1 on the client can then be discarded as it has been confirmed by the server. This can then be repeated once the client receives request #2 from the server.

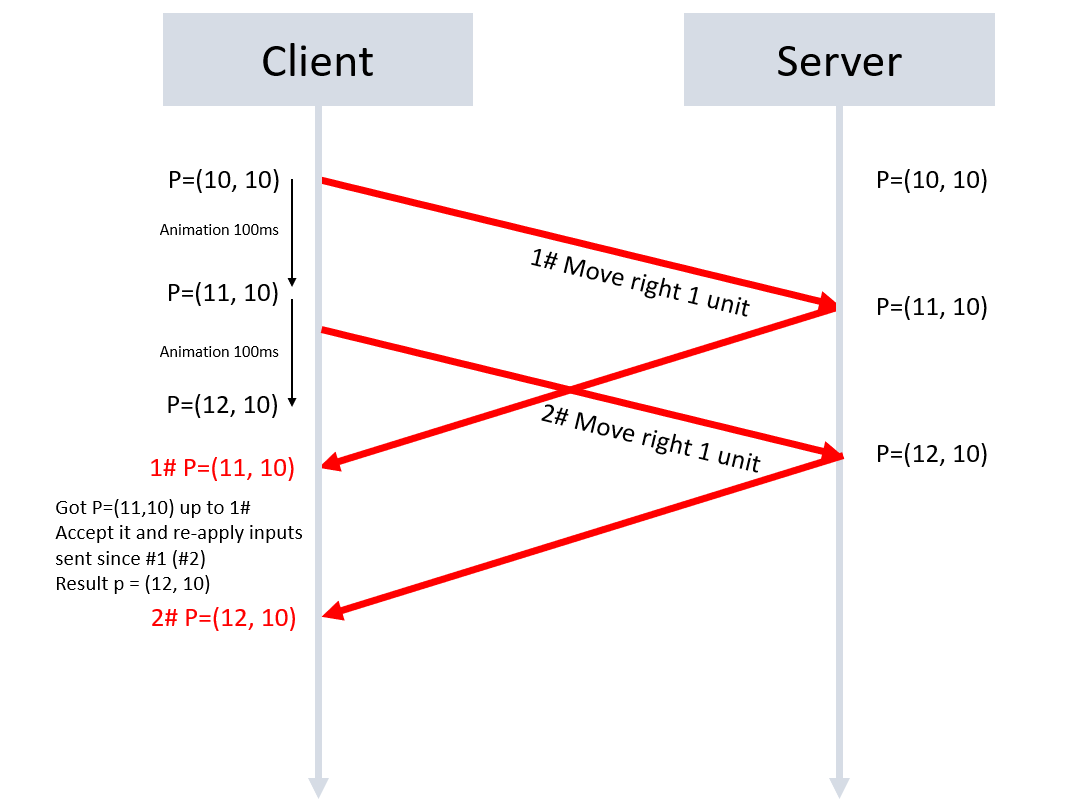


Diagram showing client-side prediction with server reconciliation where p is the position of the player

Although this example uses movement, this system can be applied to almost anything else required synchronizing.

### Problem 2: Low Frequency Updates (Low frame rate server)

The system described above works for a single client on the server, but with multiple clients, once the server receives a request, it needs to relay this to all other clients. If the server uses low-frequency updates this can create choppy movement on other clients as one will perceive the other “jumping” between positions:

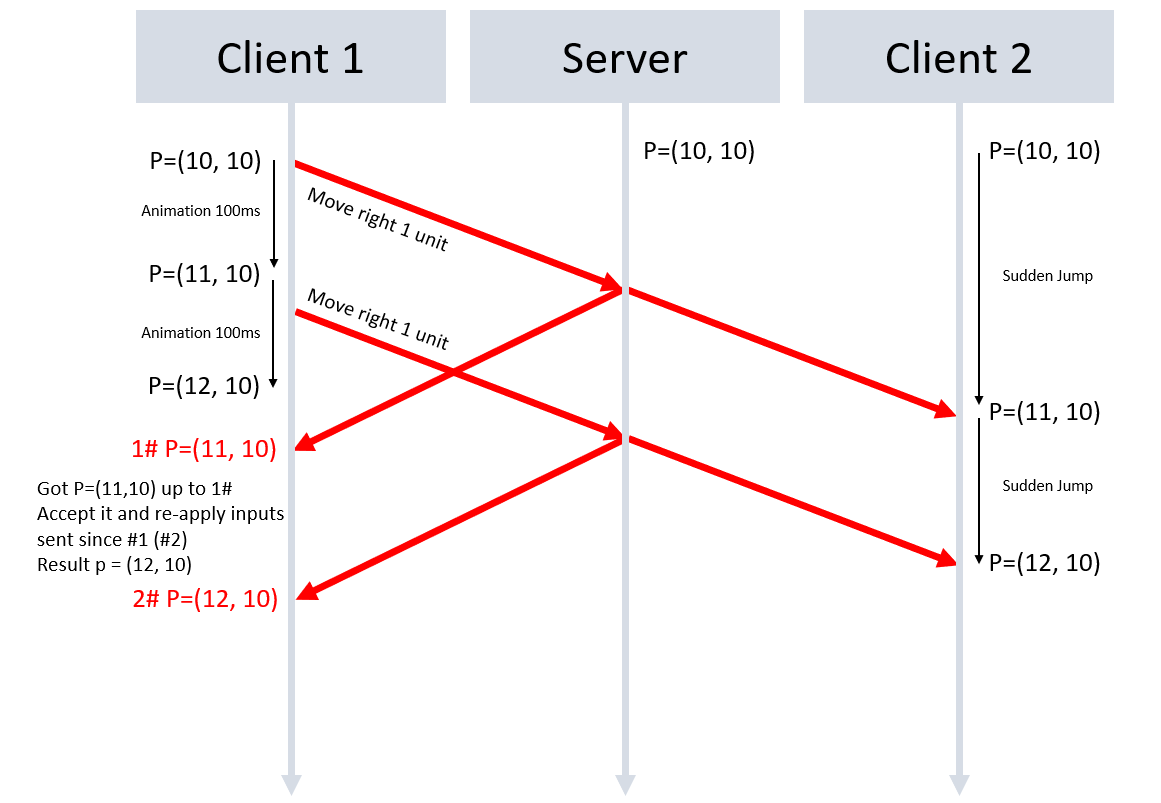


Diagram showing 2 clients receiving updates from the server where p is the position of the player

To handle this, I plan on implementing “Entity Interpolation” [3]. This involves showing the client player as in the present but other players as in the past. For example, if the server sent updates out every 100ms and the current time was t=1000ms, then from t=1000ms to t=1100ms the client will show the movement of the player that the server had sent from t=900ms to t=1000ms. In this way the client is always showing actual movement data except its 100ms late:

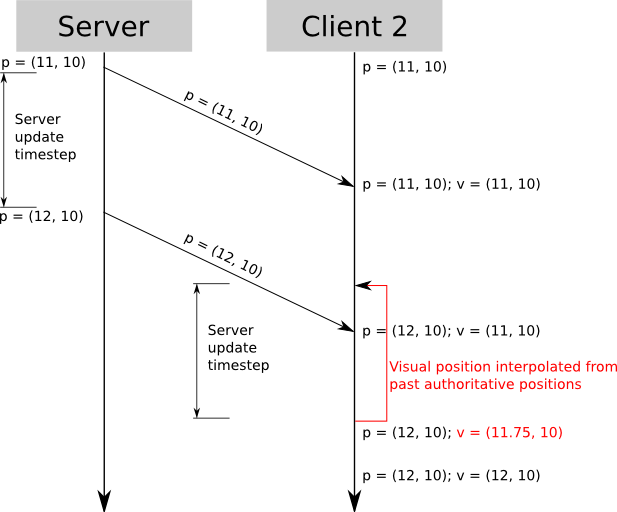


Diagram showing client 2 using the past server’s data to show entity movement in the past where p is the position sent from the server and v is the position shown by client 2

Using this form of entity interpolation comes with a problem since the players will see themselves in the present but others in the past. This becomes problematic for very time and space sensitive events, such as shooting another player / interacting with them.

This can be solved using “server rollback” [[[4]](#footnote-4)] which involves having the client send all inputs / events with timesteps such that the server can “rollback” the world to the past where the client supposedly performed its action and process it at that point in time before updating the other clients. This rollback will need to be capped as if client 1 has a ping of 2000ms and they shoot client 2 who has a ping of 50ms, with non-capped rollback, client 2 can be shot despite standing behind a wall (from client 2’s perspective) as client 1 is 2000ms in the past which was when client 2 was not behind a wall. Typically, rollback would be capped at ~250ms. This method only really applies to instantaneous actions such as the shot of a gun in an first person shooter, if the game is more physics based using projectiles, roll back may not be necessary.

### Problem 3: Bandwidth usage

With this current system the server sends the client a world state which represents how the world should look. The problem is that these world states can be very large and consume a lot of bandwidth which is not good. To solve this, I am planning to use “Delta Compression”. This involves sending world states relative to a baseline. For example, if a world state involves a cube, the server can send to the client “The cube has not moved” which can be represented in 1 byte. Of course, the problem with this is that it requires the client to have a baseline and the server must also know this baseline. Not only this, but the baseline may be different per client. Baselines being different between clients is not a big deal as the server can store multiple baseline snapshots for each client but synchronizing the baseline between the server and client is a challenge as the client needs to send some form of acknowledgement for a snapshot to be used as a baseline. An easy fix for this would be to have the server send a full world state at a slow rate and use delta world states to fill in between the full world states. The client would then send a response saying which full world state they are using for a baseline and update accordingly for new full world states they receive.

Once again, since I am most likely using this on a LAN setting this is not much of an issue and I may be able to use standard compression methods such as storing states as single bits etc…

## Network Protocol

For my game I will be designing a simply protocol for how the server and client should communicate. Since my game is relatively simple, I only really need to define 3 layers:

* Initial connection
* Communication
* End of connection

### Initial connection

The initial connection will involve a client sending the first *sync* packet to the server. Upon the server receiving this, the server will respond with a replying *sync* packet.The *sync* packet will contain all the information necessary for the client and server to sync up their base states such as what tick the server / client is on to sync timings, how many players the client will be joining with etc…

### Communication

Once the initial connection is made the client and server can begin communicating gameplay. This involves the server sending snapshots of the world to the client which the client will unwrap and show to the player. The client will also do the same sending snapshots of the client state containing information on what keys have been pressed.

### End of connection

The end of a connection will be defined as the loss of communication between the server and client, in other words, when either party stops sending a stream of packets the connection is considered closed.

### Packet Format

The packet format my protocol will use will first contain a header which holds the information required for UDP as discussed previously such as the *Protocol ID* and *Sequence Number*. This also includes a checksum of the packet for verification on the receiving end. After that, a packet *Server Code* is attached which is simply a number that tells the server / client the purpose of the packet:

|  |  |  |
| --- | --- | --- |
| Server Code | Name | Function |
| 1 | SyncPlayers | This is a packet sent to synchronise the players between the client and the server, for example the information that 2 players from the client is joining the server would be sent on this packet |
| 2 | ClientSnapshot | This is a packet sent from the client containing a snapshot of the client’s state including key presses, client tick rate, and current number of players |
| 3 | ServerSnapshot | This is a packet sent from the server containing a snapshot of the server’s state including object / entity states and server tick rate |

Finally comes the main body of data the packet is storing according to its *Server Code*. The final packet header will look something like:

|  |  |
| --- | --- |
| 32 bits | |
| Protocol ID | |
| Checksum | |
| PacketID | Packet Sequence |
| Packet Ack |  |
| Packet Ack bit-field | |
| Byte count of data | |
| Packet number | |

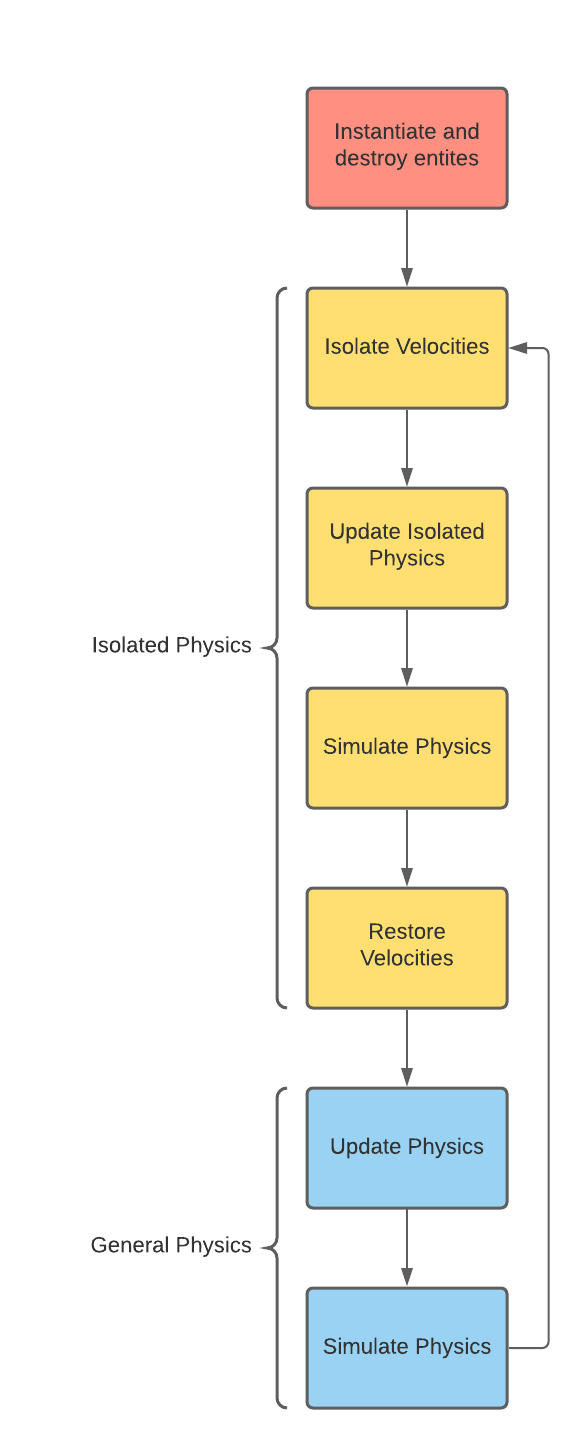
Diagram showing the header format of a packet.  
 Note: the packet number and byte count are for reconstructing split packets.

# Engine / System design

I will be using Unity 2D engine to handle most of the rendering and physics in my game and I will be designing my underlying engine to run in conjunction with Unity.

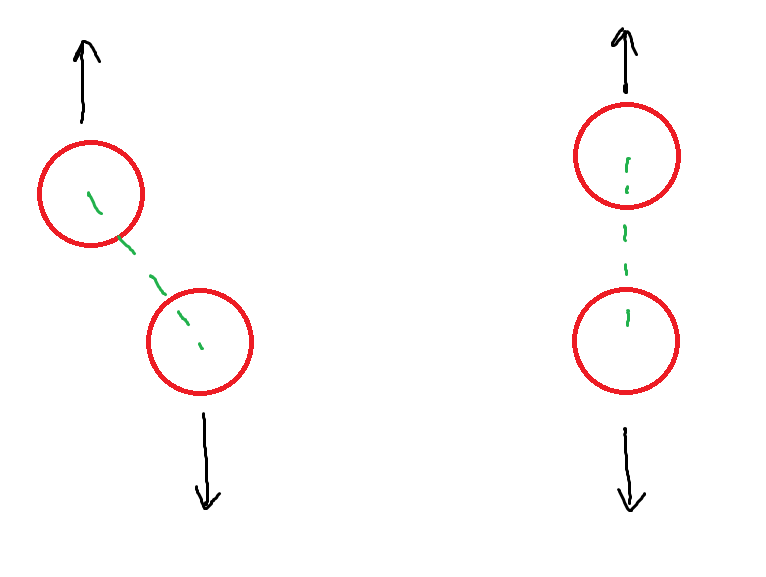
## Physics

My engine uses a Unity 2D mostly for its physics and was made to implement custom physics components as well as handle general entity behaviour. Below is a flow chart that shows how I plan my engine to interact with Unity:

This system was designed with the intention of allowing for me to implement custom physics to work with Unity. To do this, I have setup Unity to allow me to control when it performs its physics simulation as denoted by the blocks in the flow chart labelled “Simulate Physics”. I have also decided to split the physics into two parts:

* Isolated Physics
* General Physics

This was done to implement specific body physics. For example, if a character body consisted of two nodes that are joined through a distance joint and I wanted the body to right itself such that the two nodes would sit upright, I would apply an upward force to one node and an equal downward force to the lower node:



The above image shows the before and after state of a body:  
- The green dotted line represents the distance joint whilst the black arrows represent the force being applied to each node (red).

Flow chart showing how my engine interacts with Unity

The problem arises when the “righting” force is equal to the force of gravity as this would result in the top node having no net force and thus it would not move to right itself above the lower node. This is solved through the method of “Isolated Physics” as it performs character physics such as “standing upright” in an isolated setting without external forces such as gravity and simulates a physics timestep. The purpose of this functionality for my game is because I plan on implementing character bodies and ragdolls which describes a form of animation that relies on physics such as a death animation having a character fall over due to gravity and interact with other physics objects due to physic collisions.

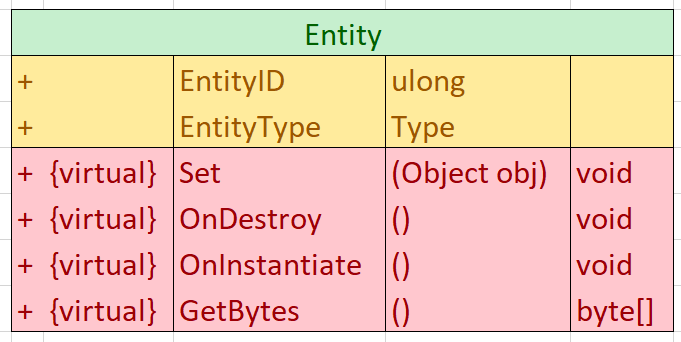
“General Physics” is used for standard physics updates such as player and enemy movement. It is also going to be used for updates not necessarily required for physics such as updating player states and enemy pathing.

## Memory Management

Since I will be using some unmanaged resources such as GPU buffers and sockets, I need to dispose of them when my program closes. To do this I will most implement a memory manager that contains a static list of all unmanaged resources and at the end of execution this list can be looped over, and all unmanaged resources can be disposed of.

# Entities

I plan for all objects and components to inherit from an abstract entity class. Below is the UML class definition:



UML diagram for abstract class ‘Entity’

“EntityID” and “EntityType” are used to identify specific entities across the server and client. “EntityID” represents the unique ID of each entity whilst “EntityType” is used to determine the type of entity that the object is supposed to be.

“Set”, “OnDestroy” and “OnInstantiate” are virtual functions specific to initialising and destroying a given entity and “GetBytes” is used to return the byte format for a given entity for storing in packets and sending it over the network. This byte format will differ from entity to entity and will be discussed when covering each entity individually later.

I also plan to have each entity use a different update format depending on what they are. For example, if an entity requires character body physics then they will use the isolated physics update described above. This way, entities that do not require physics updates do not get iterated over.

## Entity Interfaces

Since different entities will interact with the engine differently, I am going to write different systems as interfaces, for example, if an entity uses the render loop it will implement the *IRenderer* interface. The different interfaces I will most likely need (including some of their base methods):

**public** **interface** \_IInstantiatableDeletable

{

**void** Delete();

**void** Instantiate();

**object** Create();

}

**public** **interface** IServerSendable : \_IInstantiatableDeletable

{

EntityID ID { **get**; **set**; }

**void** ServerUpdate();

**byte**[] GetBytes();

**object** GetSnapshot();

**void** ParseBytes(DZNetwork.Packet Data);

**void** ParseSnapshot(**object** Data);

}

**public** **interface** IRenderer : \_IInstantiatableDeletable

{

**void** InitializeRenderer();

**void** Render();

}

**public** **interface** IUpdatable : \_IInstantiatableDeletable

{

**void** Update();

}

**public** **interface** IPhysicsUpdatable : \_IInstantiatableDeletable

{

**void** FixedUpdate();

}

**public** **interface** IIteratableUpdatable : \_IInstantiatableDeletable

{

**void** PreUpdate();

**void** IteratedUpdate();

}

Here *\_IInstantiatableDeletable* will be an interface all entities must implement since I am planning on using it for handling entity generation in my main engine. The rest of the interfaces serve their own role:

* *IServerSendable :* Implements all methods required for an item to be sent over a network where *EntityID* is a unique ID identifying this object over another. The other methods are simply for parsing byte data received from packets.
* *IRenderer :* Describes an object that is used in the render loop and will be rendered into unity.
* *IUpdate :* Describes an object that updates every frame.
* *IPhysicsUpdate :* Describes an object that updates on a fixed frame rate for deterministic physics.
* *IIteratableUpdatable* *:* Describes an object that uses the impulse physics[[5]](#footnote-5) engine for calculating physics.

# Entity – Base Components

Before implementing any entities such as the player, I want to declare some entity components. These base components are abstract classes that describe specific entities, for example I am planning to implement:

* *PhysicalJoint -* Implements the interface *IIteratableUpdatable* as I am planning on using it to define physics relationships between entities and I will be using the impulse physics engine architecture to do so.
* *PhysicalObject -* Implements the interface *IPhysicsUpdate* and is being used to define any physics object that needs to be simulated.

For the most part *PhysicalObject* is used to encapsulate Unity’s physics objects away from my engine. This means that it implements an interface for Unity’s rigid bodies that I can use with my own system.

# DistanceJoint : PhysicalJoint

To implement basic physics into my game I am going to mainly be using distance joints that hold *body chunks* of characters together. This distance joint will be implemented using the impulse engine architecture (impulse/velocity solver) which involves solving physics constraints. In the case of a distance joint, a distance constraint is being solved. My implementation of this solver is heavily based on Erin Catto’s Box2D engine’s implementation.[[6]](#footnote-6)

# BodyChunk : PhysicalObject

A body chunk will be my primary physics object. It will simply implement a basic circle physics object that I can use for most of my other entities. For example, If I want to create a player entity, it will have a “body” that will be composed of these body chunks and the player entity itself will only have to implement player logic such as movement.

# BodyChunk and DistanceJoint – Networking

The BodyChunk and DistanceJoint classes will most likely contain methods for converting their data into bytes for sending over a network, but they themselves will not implement *IServerSendable* as I plan for other classes to be composed of these.

The byte format of a body chunk and distance joint will most likely only contain their relevant physics values:

**public** **struct** BodyChunkPacketData

{

**public** Vector2 Position;

**public** **float** Rotation;

**public** Vector2 Velocity;

**public** **float** AngularVelocity;

**public** **float** InvMass;

**public** **float** InvInertia;

**public** **float** ColliderRadius;

}

**public** **struct** DistanceJointPacketData

{

**public** **float** Distance;

**public** Vector2 Anchor;

**public** **float** ARatio;

**public** **float** BRatio;

}

# Player

The player entity will most likely be a class composed of *Body Chunks* and *Distance Joints* and will provide an interface to treat them as the player. The player needs to have certain functionality implemented for my game:

1. Needs to be able to move.
2. Needs to be able to place towers.
3. Requires client-side prediction and server reconciliation.
4. Requires an interface for sending over the network.

## Player – Movement

Movement of the player will be controlled externally. I will most likely accomplish this by having a primary controller class that feeds keyboard / controller inputs into the player class via a movement Vector. This will also allow for the movement logic to be the same for the server and client, just a different primary controller would be used, such as the parsing of client snapshots for the server, and some form of input manager on the client.

## Player – Placing Towers

I will most likely have this functionality done on the server-side such and have the towers sync with the client via the network. Essentially the client performs the place tower action and that action is sent to the server which performs the action and lets the tower sync with the next snapshot delivery.

## Player – Client-Side Prediction and Server Reconciliation

Performing client-side prediction and server reconciliation would require the player, on the client side, to store all the inputs it has been performing. I could do this in a dictionary, tagging each input with an ID that the server can reply with for reconciliation, however a dictionary is not very cut out for the number of key snapshots being enqueued and dequeued. A queue implementation could work, but in the case that the connection is dropped for a couple of seconds, I would be dequeuing several key snapshots at once to clear them all. Instead, I will use a Linked List such that I can very easily queue and dequeue items as well as split the linked list and dequeue a block of items at once if needed.

The key snapshots themselves will most likely be small structures containing the inputs in a meaningful format such as a vector to represent a joystick or arrow key input.

# Enemy

The enemy entity will most likely be implemented similarly to the player and have the primary controller be some form of algorithm to have the enemy traverse a given path. Because of this I might make the enemy and player class both inherit from another abstract class.

## Enemy – Movement

The movement of the enemy will be controlled on the server. The algorithm being used to have the enemy traverse a path is quite simple as it uses the fact that a path can be defined with waypoints such that the enemy can move from waypoint to waypoint tracing out the path:

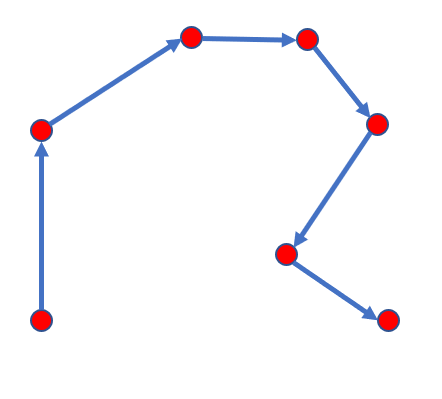


Image showing how an enemy may trace a path provided some waypoints (red circles).

I would have each waypoint stored in a list and simply move to the next element when the current waypoint is reached.

# Projectiles / Bullets

Projectiles such as bullets shot from towers will also be handled primary by the server and have the client interpolate.

## Projectiles / Bullets – Collision Detection

Since the client and server will most likely be seeing very different things I will stick with authoritative design and have the server say whether a client got hit by a projectile or not. Because of this, high ping / bad connections can cause the player to get hit by a projectile client side, but not server-side as on the client they may have walked into a projectile (due to client-side prediction), but the server has yet to receive that you moved yet. Sadly, nothing can really be done about this scenario.

# Towers

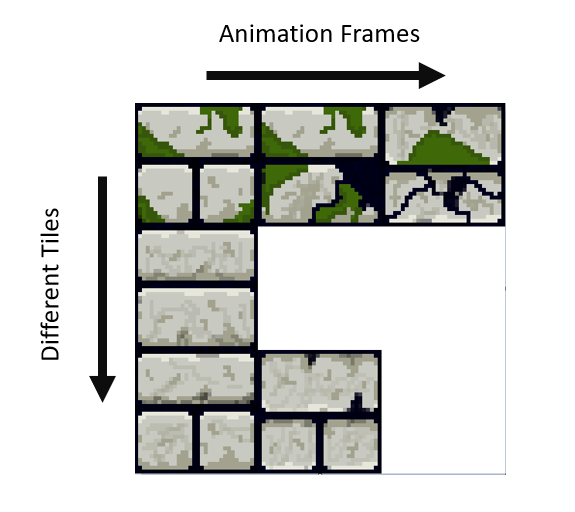
As discussed before the placement of towers is handled server-side, however, because of this there is a noticeable delay between the player placing a tower and having it appear. I do not think this delay is bad as it does not effect have that large of an impact as the responsiveness of player movement. If I were to compensate for this delay, I could very simply implement a similar system to player movement and place the towers and wait for a reconciliation response from the server.

# Tile maps

The levels and world layout that I will be using involve tile maps. For this I will not be using Unity’s inbuilt tile map class as it is optimized for level design rather than procedurally generated maps. My tile map implementation will use the GPU to render the tiles onto a single texture that can be rendered in Unity on a singular sprite for optimal performance.

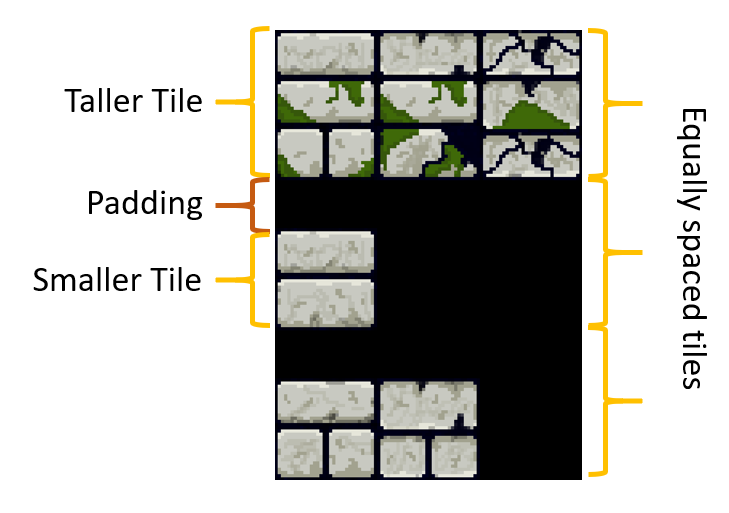
## Tile maps – Tile Pallets

Each tile map is provided with a texture which contains the tile pallet for what tiles a given tile map will use. This texture will be formatted such that textures going down represent different tiles, and textures going right are for different frames of each tile to support tile animations:



Example tile pallet for a tile sheet (courtesy of <https://alcwilliam.itch.io/azulejo-32x32> for the tile sheet)

Since I want my game to be 2.5D to give a sense of height and depth, taller wall tiles will need to be rectangular in shape meaning that the tile sheet will need padding to fit these taller tiles. The padding size will be a predefined value tailored for each tile pallet:



Example tile pallet showing rectangular tiles (courtesy of <https://alcwilliam.itch.io/azulejo-32x32> for the tile sheet)

Each tile map will also have to be split into chunks of a pre-defined size such that I do not have to pass the entire world map to another client over the network but only specific chunks around each client. This is not terribly relevant however since my game will primarily be played on small maps.

## Tile maps – Data Format

Each tile map will firstly need to store which tile pallet it is using. This can simply be done by having each tile pallet be associated with a unique ID and reference it in each tile map. The tile map also needs to store the tiles that makes up the tile map with each tile storing which tile it is rendering from the tile pallet, which frame of animation it is rendering and whether the tile is blank or not. Below is pseudo-code for how I might define a tile type:

**public** **struct** Tile

{

**public** **int** AnimationFrame; //Which animation frame from tile pallet

**public** **int** TileIndex; //Which tile from tile pallet

**public** **int** Blank; //Is this tile blank?

**public** **int** Render; //Is this tile being rendered?

}

These tiles can then be stored in a list of tiles to represent what tiles make up the tile map. I will need 2 of these such that one can represent the wall tiles and the other can represent the floor tiles. The list of tiles could be stored using a 2D array however the tile data needs to be sent to the GPU so the GPU knows how to render the tile map and the format of a 2D array cannot be easily sent to the GPU and thus I will be using a 1D array but treat it as a 2D array as I can simply treat each row of the tile map being placed next to each other:



2D representation of tiles



1D representation of tiles showing how it can be treated as a 2D representation by joining each row

This means that I will need to convert from a 2D coordinate of a tile to a index on a 1D array, this can easily be done since I know the width and height of my tile map, so given the *x* and *y* position of a tile and the *width* of the tile map, the singular index is equal to [*y \* width + x]* where x and y are both 0 based.

As the player will need to interact with each tile map through colliding with the wall tiles, the tile map will also need to store a collision map which contains all the colliders for a given tile map. This can be stored in the same format as described above. As for the colliders I will be using Unity’s in-built physics colliders.

## Tile maps – Rendering

When it comes to rendering each tile map there is a lot to consider. Firstly, the player needs to render behind the wall tiles but in front of the floor tiles. The wall tiles also need to render behind the player depending on their position:

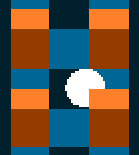


Image showing how a white ball should be rendered above the floor map (dark blue) but behind or in front of the wall tiles (orange)

Unity, however, does not allow for different parts of a sprite to render behind or in front of another sprite, and thus the tile map will need to be split into different sprites. Because of this I can render each tile onto individual sprites and render those in Unity. These sprites can sample their textures from a larger texture generated by the GPU which contains each sprite for the wall and floor maps:



Image of floor texture that is sampled for sprites

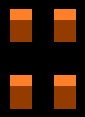


Image of wall texture that is sampled for sprites

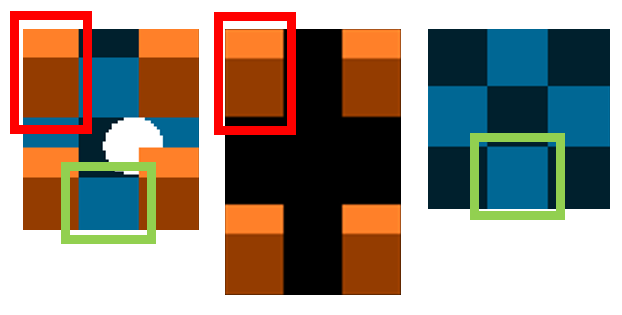


Diagram showing how sprites would be sampled from the main textures

The GPU would generate these texture maps for the sprites to sample from using the tile pallet and tile data provided. I would most likely implement it using 2 thread groups for that represent the rows and columns of a tile map. Each thread would then draw a tile onto the texture such that each the GPU is rendering all tiles of the tile map simultaneously.

For getting the wall tiles to render above a given object I will be using the *sorting order* property that Unity provides each sprite. This sorting order is an integer value that determines what gets drawn to the screen first, starting from lowest to highest. This results in the objects of highest sorting order to render above everything and vice versa. I simply need an algorithm to determine what this sorting order should be. Firstly, I will define how when an object becomes “behind” another object. Since my game is 2.5D where it is 2D but the walls seem 3D, an object becomes “behind” a wall when it has a *y* position that is smaller than the *y* position of a wall tile:

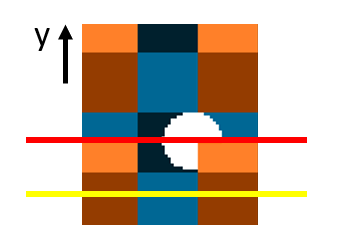


Diagram showing how the orange walls beneath the white ball have a y position (shown by yellow line) lower than the ball’s y position (shown by red line) and is thus rendered above it as the ball is considered to be “behind”

I can simply implement this by having each y position correspond to a *sorting order* value. For example, if the sorting order of all sprites was equal to its negative *y* position truncated as an int, then the sprites of lower y value would have a larger *sorting order* value and vice versa. To accommodate for the *y* values getting truncated as integers the *sorting order* for wall sprites will be their *y* position truncated plus 1. For the floor tiles to render behind I can use Unity’s *sorting layers* which simply groups sprites such that sprites in each group follow their respective *sorting order* values but will always render behind or in front of another group regardless of *sorting order* depending on how the *sorting layers* are ordered.

## Tile maps – Byte data for network transmission

Each tile map will only transmit vital data over the network such as:

* Tile pallet index referring to which tile pallet it is using
* Tile map position
* Size of tile map
* Floor Tiles
* Wall Tiles

Storing most of these properties is easy, for example the tile pallet index can simply be a single byte as I doubt that I will need more than 255 tile pallets, and for position and size I can simply use integer and float values. However, for the floor and wall tiles there are a few space optimizations I can make. For example, if a tile is blank, I do not need to send any data relating to *tile index* or *animation frame* etc… and thus for blank tiles I only need to store the fact that it is blank. Similarly, if the tile map does not change, then I do not even need to send the tile data at all.

## Tile maps – Optimization

In Unity creation and destruction of objects is a very expensive process and having lots of objects in at once can tank performance. Because of this my tile map will group each row of tiles into 1 sprite and 1 object since the *sorting order* is only dependent on the *y* position:

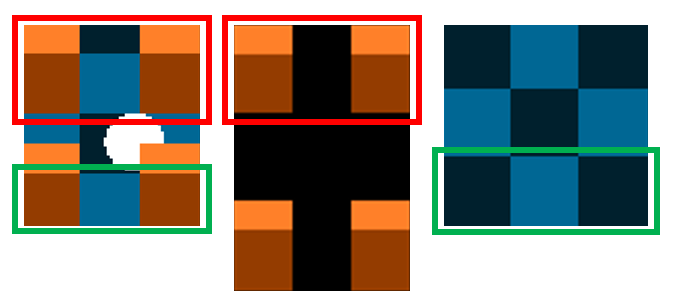


Diagram showing how sprites would be sampled where 1 sprite represents 1 row of a tile map

Whenever a tile map gets resized to be smaller, rather than destroying the unused rows I will simply disable the objects such that they can be reused. The same goes for the GPU and its buffers where I will simply reuse them and only decrease the buffer sizes when necessary.

Each tile map will also cache the byte data representing its floor and wall map such that when generating the byte data for a network transmission, it does not need to be regenerated every time.

## Tile maps – Procedural Path Generation

For my game I will need to procedurally generate a path for the enemies to take. This can be done in several ways; my implementation will use a simple waypoint system. This is useful since the waypoints can also be used for traversal of the path. Simply pick a starting point along the edge of the tile map. This will be the first way point. From here the path can continue in any direction, however I think it looks nicer if the paths were straighter and did not run alongside the walls, so the first way point at the edge of the tile map will always have the path point away from the edge:

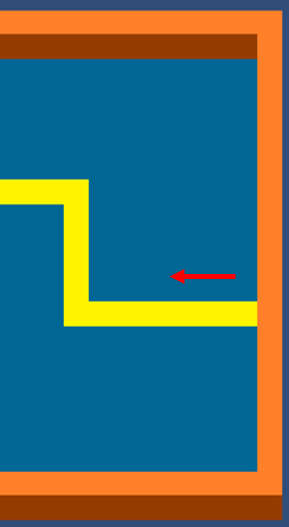
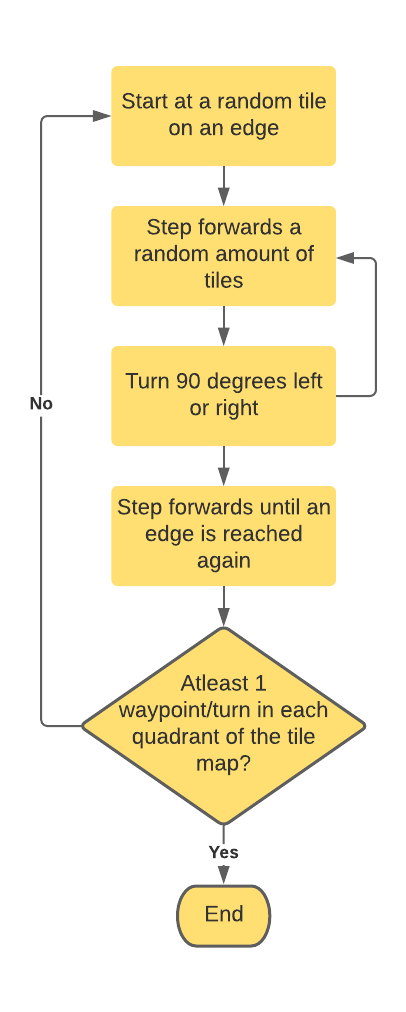
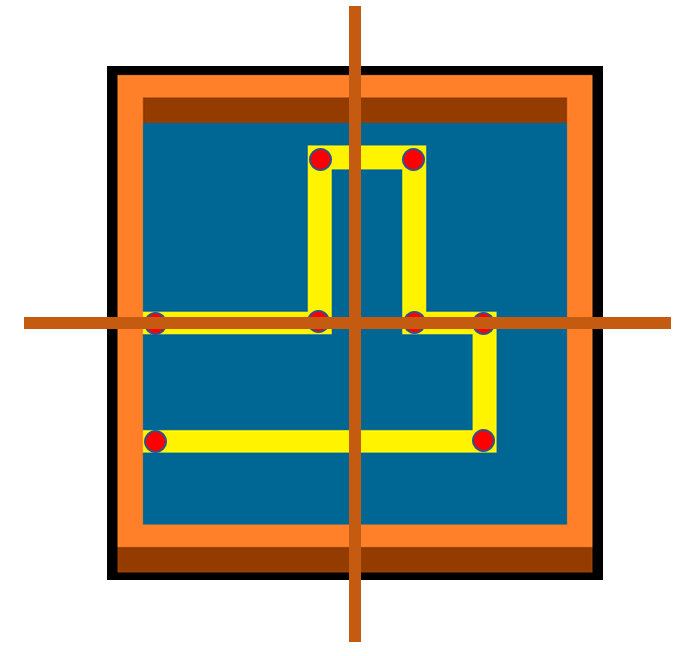


Diagram showing a yellow path leaving the edge (defined by the orange walls) of the tile map.

From this point the path can be extended by a random number of units before another waypoint is made. At a waypoint, the path can change direction, but I will restrict the path to only change direction at 90-degree angles. This can be repeated for as many turns as you want and then on the final turn simply extend the path until it hits the edge of the tile map again.

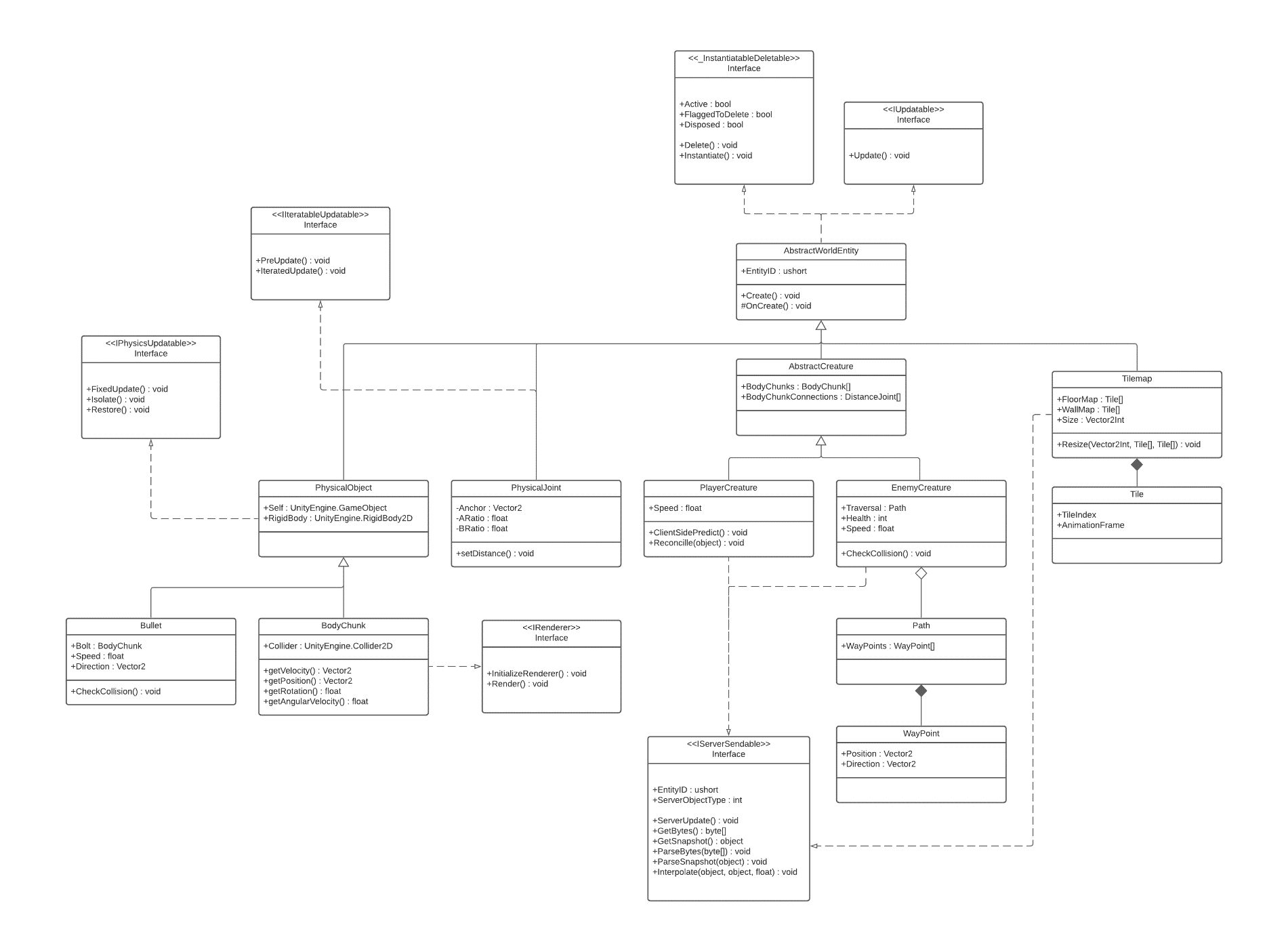
This simple algorithm does have a few issues, firstly, since the path lengths are random, the path generated may not scale across the entire provided area and may simply move in a loop in the corner. This can be easily fixed by doing the generation multiple times until a path is generated where the waypoints are evenly spread out. The method I’ll use to define what “spread out” is will simply be a check that sees if a waypoint is present in all 4 corners (quadrants) of a tile map:



As can be seen here, there is at least 1 waypoint (red circle) in each quadrant of the tile map (defined by orange lines)

Flowchart of algorithm used to procedurally generate paths.

# Full UML diagram



**Technical Solution**

# Overview Guide

|  |  |  |
| --- | --- | --- |
| Group | Overview | Location |
| A | Use of queues for storing packets to process | ServerHandle.cs Line:39-59 |
| A | Implementation of linked list for reducing network jitter and queuing snapshots | JitterBuffer.cs Line:9-118, Client/Game.cs Line:78-157 |
| A | Complex client-server model | DZUDPSocket.cs, DZClient.cs, DZServer.cs, Game.cs, Packet.cs |
| A | Hashing | DZUDPSocket.cs Line:95-102 |
| A | Complex user defined algorithm - optimisation on the GPU, optimisation of tilemap rendering and caching objects | TilemapComputeShader.compute, Tilemap.cs Line:316-372, 379-548 |
| A | Advanced Matrix operations | Math2DExtensions.cs Line:14-67, DistanceJoint.cs Line:90-138 |
| A | Complex OOP model | UpdatableAndDeletable.cs |
| B | Multi dimensional arrays (although stored as 1 dimensional arrays) | Tilemap.cs Line:157-165, PacketHandler.cs Line: 73-126 |
| B | Use of Dictionaries | DZUDPSocket.cs Line:66-82 |
| B | Reading text file | Server/Loader.cs Line:28 |
| B | Simple user defined algorithm - Path generation | Server/Main.cs Line:107-239 |
| C | Linear Search | Client/Main.cs Line:78-86 |
| C | Single dimensional array | PacketHandler.cs Line: 73-126 |

**Technical Solution – Full Code**

**Assets/DZNetwork/DZClient.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** System.Net.Sockets;

**using** System.Net;

**namespace** DZNetwork

{

**public** **class** DZClient : DZUDPSocket

{

**public** Action<RecievePacketWrapper> PacketHandle; //Delegate that is called on recieving a packet

**public** Action DisconnectHandle;

**private** **bool** DisconnectTrigger = **true**;

**public** Action ConnectHandle;

**public** **const** **int** ConnectionLifeTime = 150;

**public** **uint** TicksSinceLastConnection = 0;

**public** Action<SentPacketWrapper> PacketLostHandle;

**public** **bool** Connected = **false**;

**public** **bool** SocketConnected

{

**get** { **return** Socket.Connected; }

**private** **set** { }

}

**public** DZClient() : **base**(4096)

{

TicksSinceLastConnection = ConnectionLifeTime;

}

**public** **void** FixedUpdate()

{

Tick();

TicksSinceLastConnection++;

**if** (TicksSinceLastConnection > ConnectionLifeTime)

{

Connected = **false**;

**if** (!DisconnectTrigger)

{

DisconnectHandle();

PacketHandler.RemoveAcknowledgement(Socket.RemoteEndPoint **as** IPEndPoint);

DisconnectTrigger = **true**;

}

}

**else**

{

Connected = **true**;

DisconnectTrigger = **false**;

}

}

**public** **void** Connect(**string** Address, **int** Port)

{

Socket.Connect(IPAddress.Parse(Address), Port);

BeginReceive();

}

**public** **void** Send(Packet Packet, ServerCode ServerCode)

{

Packet.InsertServerCode(ServerCode);

PacketHandler.PacketGroup PacketGroup = PacketHandler.GeneratePackets(Packet, Socket.RemoteEndPoint **as** IPEndPoint);

**for** (**int** i = 0; i < PacketGroup.Packets.Length; i++)

Send((**ushort**)(PacketGroup.StartingPacketSequence + i), ServerCode, PacketGroup.Packets[i]);

}

Dictionary<**long**, PacketReconstructor> PacketsToReconstruct = **new** Dictionary<**long**, PacketReconstructor>();

**private** **class** PacketReconstructor

{

**public** **int** PacketByteCount;

**public** **int** ProcessedPacketCount;

**public** **byte**[] PacketIndex;

**public** **byte**[] Data;

}

**protected** **override** **void** OnReceive(IPEndPoint ReceivedEndPoint)

{

TicksSinceLastConnection = 0;

**if** (Connected == **false**)

{

Connected = **true**;

ConnectHandle();

}

}

**protected** **override** **void** OnReceiveConstructedPacket(RecievePacketWrapper Packet)

{

PacketHandle?.Invoke(Packet);

}

**protected** **override** **void** OnPacketLost(SentPacketWrapper Packet)

{

PacketLostHandle?.Invoke(Packet);

}

}

}

**Assets/DZNetwork/DZServer.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** System.Net.Sockets;

**using** System.Net;

**namespace** DZNetwork

{

**public** **class** DZServer : DZUDPSocket

{

**public** Action<RecievePacketWrapper> PacketHandle; //Delegate that is called on recieving a packet

**public** Action<IPEndPoint> DisconnectHandle;

**public** Action<IPEndPoint> ConnectHandle;

**public** Action<SentPacketWrapper> PacketLostHandle;

**public** **const** **int** ConnectionLifeTime = 150;

**private** **object** DeviceUpdate = **new** **object**();

**public** Dictionary<IPEndPoint, **uint**> ConnectedDevices;

**public** DZServer() : **base**(4096)

{

ConnectedDevices = **new** Dictionary<IPEndPoint, **uint**>(**new** IPEndPointComparer());

}

**private** List<IPEndPoint> Disconnects = **new** List<IPEndPoint>();

**public** **void** FixedUpdate()

{

Tick();

Disconnects.Clear();

List<IPEndPoint> Connections = ConnectedDevices.Keys.ToList();

**foreach** (IPEndPoint EndPoint **in** Connections)

{

ConnectedDevices[EndPoint]++;

**if** (ConnectedDevices[EndPoint] > ConnectionLifeTime)

{

Disconnects.Add(EndPoint);

}

}

**for** (**int** i = 0; i < Disconnects.Count; i++)

{

PacketHandler.RemoveAcknowledgement(Disconnects[i]);

ConnectedDevices.Remove(Disconnects[i]);

DisconnectHandle(Disconnects[i]);

}

}

**public** **void** Connect(**int** Port)

{

Socket.Bind(**new** IPEndPoint(IPAddress.Any, Port));

UnityEngine.Debug.Log("Server opened on port: " + Port);

BeginReceive();

}

**public** **void** Send(Packet Packet, ServerCode ServerCode)

{

List<IPEndPoint> Connections = ConnectedDevices.Keys.ToList();

**if** (Connections.Count == 0) **return**;

Packet.InsertServerCode(ServerCode);

**foreach** (IPEndPoint EndPoint **in** Connections)

**if** (EndPoint != **null**)

{

PacketHandler.PacketGroup PacketGroup = PacketHandler.GeneratePackets(Packet, EndPoint);

**for** (**int** i = 0; i < PacketGroup.Packets.Length; i++)

SendTo((**ushort**)(PacketGroup.StartingPacketSequence + i), ServerCode, PacketGroup.Packets[i], EndPoint);

}

}

**public** **void** SendTo(Packet Packet, ServerCode ServerCode, IPEndPoint EndPoint)

{

Packet.InsertServerCode(ServerCode);

PacketHandler.PacketGroup PacketGroup = PacketHandler.GeneratePackets(Packet, EndPoint);

**for** (**int** i = 0; i < PacketGroup.Packets.Length; i++)

SendTo((**ushort**)(PacketGroup.StartingPacketSequence + i), ServerCode, PacketGroup.Packets[i], EndPoint);

}

**protected** **override** **void** OnReceive(IPEndPoint ReceivedEndPoint)

{

**lock** (DeviceUpdate)

{

**if** (!ConnectedDevices.ContainsKey(ReceivedEndPoint))

{

ConnectHandle(ReceivedEndPoint);

ConnectedDevices.Add(ReceivedEndPoint, 0);

}

**else**

ConnectedDevices[ReceivedEndPoint] = 0;

}

}

**protected** **override** **void** OnReceiveConstructedPacket(RecievePacketWrapper Packet)

{

PacketHandle?.Invoke(Packet);

}

**protected** **override** **void** OnPacketLost(SentPacketWrapper Packet)

{

PacketLostHandle?.Invoke(Packet);

}

}

}

**Assets/DZNetwork/DZUDPSocket.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** System.Net.Sockets;

**using** System.Net;

**namespace** DZNetwork

{

**public** **class** DZUDPSocket

{

**public** **const** **int** PacketLifetime = 60;

**public** **float** RoundTripTime = 0;

**public** **readonly** **int** BufferSize;

**protected** **readonly** **int** BufferStride;

**private** **object** ReceiveBufferLock = **new** **object**();

**protected** **byte**[] ReceiveBuffer;

**protected** Socket Socket;

**protected** EndPoint EndPoint = **new** IPEndPoint(IPAddress.Any, 0);

**public** DZUDPSocket(**int** BufferSize, AddressFamily AddressFamily = AddressFamily.InterNetwork)

{

**this**.BufferSize = BufferSize;

BufferStride = BufferSize - PacketHandler.HeaderSize;

ReceiveBuffer = **new** **byte**[BufferSize];

Socket = **new** Socket(AddressFamily, SocketType.Dgram, ProtocolType.Udp);

Socket.SetSocketOption(SocketOptionLevel.IP, SocketOptionName.ReuseAddress, **true**);

//https://stackoverflow.com/questions/38191968/c-sharp-udp-an-existing-connection-was-forcibly-closed-by-the-remote-host

Socket.IOControl(

(IOControlCode)(-1744830452),

**new** **byte**[] { 0, 0, 0, 0 },

**null**

); //Ignores UDP exceptions

}

**protected** **void** BeginReceive()

{

Socket.BeginReceiveFrom(ReceiveBuffer, 0, ReceiveBuffer.Length, SocketFlags.None, **ref** EndPoint, ReceiveCallback, **null**);

}

**public** **void** Tick()

{

UpdateReconstructedPackets();

UpdateAcknowledgedPackets();

}

**public** **class** RecievePacketWrapper

{

**public** **int** PacketID;

**public** IPEndPoint Client;

**public** Packet Data;

}

**public** **class** SentPacketWrapper

{

**public** IPEndPoint Client;

**public** **int** Lifetime = 0;

**public** **ushort** PacketSequence = 0;

**public** ServerCode Code = ServerCode.Null;

**public** **long** Epoch = (DateTime.Now - **new** DateTime(1970, 1, 1, 0, 0, 0, DateTimeKind.Utc)).Ticks / 10000;

}

**private** Dictionary<PacketIdentifier, SentPacketWrapper> SentPackets = **new** Dictionary<PacketIdentifier, SentPacketWrapper>();

**private** **void** UpdateAcknowledgedPackets()

{

**lock** (SentPackets)

{

List<PacketIdentifier> Keys = SentPackets.Keys.ToList();

**foreach** (PacketIdentifier Key **in** Keys)

{

SentPackets[Key].Lifetime++;

**if** (SentPackets[Key].Lifetime > PacketLifetime)

{

OnPacketLost(SentPackets[Key]);

SentPackets.Remove(Key);

}

}

}

}

**protected** **virtual** **void** OnPacketLost(SentPacketWrapper Packet) { }

**private** **struct** PacketIdentifier

{

**public** IPEndPoint Client;

**public** **ushort** ID;

**public** **override** **bool** Equals(**object** Obj)

{

**return** Obj **is** PacketIdentifier && **this** == (PacketIdentifier)Obj;

}

**public** **override** **int** GetHashCode()

{

**int** Hash = 27;

**if** (Client != **null**)

Hash = (13 \* Hash) + Client.GetHashCode();

Hash = (13 \* Hash) + ID.GetHashCode();

**return** Hash;

}

**public** **static** **bool** **operator** ==(PacketIdentifier A, PacketIdentifier B)

{

**if** (ReferenceEquals(A, **null**) && ReferenceEquals(B, **null**))

**return** **true**;

**else** **if** (ReferenceEquals(A, **null**) || ReferenceEquals(B, **null**))

**return** **false**;

**return** A.ID == B.ID && A.Client.Equals(B.Client);

}

**public** **static** **bool** **operator** !=(PacketIdentifier A, PacketIdentifier B)

{

**if** (ReferenceEquals(A, **null**) && ReferenceEquals(B, **null**))

**return** **false**;

**else** **if** (ReferenceEquals(A, **null**) || ReferenceEquals(B, **null**))

**return** **true**;

**return** A.ID != B.ID || !A.Client.Equals(B.Client);

}

}

**private** **int** ReconstructedPacketsClear = 0;

**private** HashSet<PacketIdentifier> ReconstructedPackets = **new** HashSet<PacketIdentifier>();

**private** Dictionary<PacketIdentifier, PacketReconstructor> PacketsToReconstruct = **new** Dictionary<PacketIdentifier, PacketReconstructor>();

**private** **void** UpdateReconstructedPackets()

{

ReconstructedPacketsClear++;

**if** (ReconstructedPacketsClear > PacketLifetime)

ReconstructedPackets.Clear();

**lock** (PacketsToReconstruct)

{

List<PacketIdentifier> Keys = PacketsToReconstruct.Keys.ToList();

**foreach** (PacketIdentifier Key **in** Keys)

{

PacketsToReconstruct[Key].Lifetime++;

**if** (PacketsToReconstruct[Key].Lifetime > PacketLifetime)

PacketsToReconstruct.Remove(Key);

}

}

}

**private** **class** PacketReconstructor

{

**public** **int** Lifetime = 0;

**public** **int** PacketByteCount = 0;

**public** **int** ProcessedPacketCount = 0;

**public** **byte**[] PacketIndex;

**public** **byte**[] Data;

}

**private** **void** ReceiveCallback(IAsyncResult Result)

{

Packet Data = **null**;

**int** NumBytesReceived = 0;

IPEndPoint IPEP = **null**;

**lock** (ReceiveBufferLock)

{

NumBytesReceived = Socket.EndReceiveFrom(Result, **ref** EndPoint);

IPEP = EndPoint **as** IPEndPoint;

Data = **new** Packet(ReceiveBuffer, 0, NumBytesReceived);

}

Socket.BeginReceiveFrom(ReceiveBuffer, 0, ReceiveBuffer.Length, SocketFlags.None, **ref** EndPoint, ReceiveCallback, **null**);

**int** ReceivedProtocolID = Data.ReadInt();

**if** (ReceivedProtocolID != PacketHandler.ProtocolID) **return**;

**int** ReceivedCheckSum = Data.ReadInt();

**int** CalculatedCheckSum = PacketHandler.CalculateCheckSum(Data.ReadableBuffer);

**if** (ReceivedCheckSum != CalculatedCheckSum) **return**;

**ushort** PacketID = Data.ReadUShort();

PacketIdentifier PacketIdentifier = **new** PacketIdentifier()

{

Client = IPEP,

ID = PacketID

};

**ushort** RemotePacketSequence = Data.ReadUShort();

**ushort** PacketAcknowledgement = Data.ReadUShort();

**int** PacketAcknowledgementBitField = Data.ReadInt();

**lock** (PacketHandler.PacketAcknowledgements)

{

PacketHandler.Acknowledgement Ack = PacketHandler.GetAcknowledgement(IPEP);

//Update Acknowledgements to return

**if** (RemotePacketSequence > Ack.PacketAcknowledgement)

{

**int** SkippedSequences = RemotePacketSequence - Ack.PacketAcknowledgement;

Ack.PacketAcknowledgement = RemotePacketSequence;

Ack.PacketAcknowledgementBitField = (Ack.PacketAcknowledgementBitField << SkippedSequences) | (1 << (SkippedSequences - 1));

}

**else** **if** (RemotePacketSequence < Ack.PacketAcknowledgement)

{

**int** Difference = Ack.PacketAcknowledgement - RemotePacketSequence;

**if** (Difference < **ushort**.MaxValue / 2)

{

**int** AcknowledgementPosition = Ack.PacketAcknowledgement - RemotePacketSequence;

Ack.PacketAcknowledgementBitField = Ack.PacketAcknowledgementBitField | (1 << (AcknowledgementPosition));

}

**else** //Sequence number wrap around

{

**int** SkippedSequences = **ushort**.MaxValue - Ack.PacketAcknowledgement + RemotePacketSequence;

Ack.PacketAcknowledgement = RemotePacketSequence;

//its different to the normal update as the skipped sequences calculation does not include 0 so its 1 behind

Ack.PacketAcknowledgementBitField = (Ack.PacketAcknowledgementBitField << (SkippedSequences + 1)) | (1 << SkippedSequences);

}

}

}

//Update packet queue to check what packets were lost

**lock** (SentPackets)

{

**long** CurrentEpoch = (DateTime.Now - **new** DateTime(1970, 1, 1, 0, 0, 0, DateTimeKind.Utc)).Ticks / 10000;

PacketIdentifier Identifier = **new** PacketIdentifier()

{

ID = PacketAcknowledgement,

Client = IPEP

};

**if** (SentPackets.ContainsKey(Identifier))

{

RoundTripTime += (CurrentEpoch - SentPackets[Identifier].Epoch - RoundTripTime) \* 0.1f;

SentPackets.Remove(Identifier);

}

**for** (**int** i = 0; i < 32; i++)

{

Identifier.ID--;

**if** (SentPackets.ContainsKey(Identifier) && ((PacketAcknowledgementBitField & (1 << i)) != 0))

{

RoundTripTime += (CurrentEpoch - SentPackets[Identifier].Epoch - RoundTripTime) \* 0.1f;

SentPackets.Remove(Identifier);

}

}

}

**if** (ReconstructedPackets.Contains(PacketIdentifier))

**return**; //Duplicate Packet

**int** PacketByteCount = Data.ReadInt();

**int** PacketIndex = Data.ReadInt();

**byte**[] ByteData = **new** **byte**[NumBytesReceived - PacketHandler.HeaderSize];

Buffer.BlockCopy(Data.ReadableBuffer, PacketHandler.HeaderSize, ByteData, 0, ByteData.Length);

**lock** (PacketsToReconstruct)

{

**if** (!PacketsToReconstruct.ContainsKey(PacketIdentifier))

{

PacketReconstructor Reconstructor = **new** PacketReconstructor()

{

PacketIndex = **new** **byte**[UnityEngine.Mathf.CeilToInt(PacketByteCount / (**float**)BufferSize)], //Ensure that the client and server have the same buffer size, otherwise this code doesnt work as the buffersize referenced here is for client

Data = **new** **byte**[PacketByteCount]

};

PacketsToReconstruct.Add(PacketIdentifier, Reconstructor);

}

**if** (PacketsToReconstruct[PacketIdentifier].PacketIndex[PacketIndex] == 0)

{

PacketsToReconstruct[PacketIdentifier].PacketIndex[PacketIndex] = 1;

PacketsToReconstruct[PacketIdentifier].ProcessedPacketCount += 1;

Buffer.BlockCopy(ByteData, 0, PacketsToReconstruct[PacketIdentifier].Data, PacketIndex \* BufferStride, ByteData.Length);

**if** (PacketsToReconstruct[PacketIdentifier].ProcessedPacketCount == PacketsToReconstruct[PacketIdentifier].PacketIndex.Length)

{

OnReceiveConstructedPacket(**new** RecievePacketWrapper()

{

PacketID = PacketIdentifier.ID,

Client = IPEP,

Data = **new** Packet(PacketsToReconstruct[PacketIdentifier].Data, 0, PacketByteCount)

});

PacketsToReconstruct.Remove(PacketIdentifier);

ReconstructedPackets.Add(PacketIdentifier);

}

}

}

OnReceive(IPEP);

}

**protected** **virtual** **void** OnReceive(IPEndPoint ReceivedEndPoint) { }

**protected** **virtual** **void** OnReceiveConstructedPacket(RecievePacketWrapper ReconstructedPacket) { }

**public** **void** Send(**ushort** PacketSequence, ServerCode ServerCode, **byte**[] Bytes)

{

SentPackets.Add(**new** PacketIdentifier()

{

ID = PacketSequence,

Client = Socket.RemoteEndPoint **as** IPEndPoint

}, **new** SentPacketWrapper()

{

PacketSequence = PacketSequence,

Code = ServerCode

});

Socket.BeginSend(Bytes, 0, Bytes.Length, SocketFlags.None, **null**, **null**);

}

**public** **void** SendTo(**ushort** PacketSequence, ServerCode ServerCode, **byte**[] Bytes, IPEndPoint Destination)

{

SentPackets.Add(**new** PacketIdentifier()

{

ID = PacketSequence,

Client = Destination

}, **new** SentPacketWrapper()

{

PacketSequence = PacketSequence,

Code = ServerCode

});

Socket.BeginSendTo(Bytes, 0, Bytes.Length, SocketFlags.None, Destination, SendToCallback, **null**);

}

**private** **void** SendToCallback(IAsyncResult Result)

{

**int** NumBytesSent = Socket.EndSendTo(Result);

OnSendTo(NumBytesSent);

}

**protected** **virtual** **void** OnSendTo(**int** NumBytesSent) { }

**public** **void** Dispose()

{

Socket.Dispose();

OnDispose();

}

**protected** **virtual** **void** OnDispose() { }

}

}

**Assets/DZNetwork/JitterBuffer.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** DZNetwork

{

**public** **class** JitterBuffer<T> where T : **class**

{

**public** **class** Key

{

**public** T Value;

**public** Key Next;

**public** Key(T Value)

{

**this**.Value = Value;

}

}

**private** **int** \_Count = 0;

**public** **int** Count

{

**get**

{

**return** \_Count;

}

}

**private** Key Start = **null**;

**private** Key End = **null**;

**public** T First

{

**get**

{

**if** (Start != **null**)

**return** Start.Value;

**return** **default**;

}

}

**public** T Last

{

**get**

{

**if** (End != **null**)

**return** End.Value;

**return** **default**;

}

}

**public** Key FirstKey

{

**get**

{

**return** Start;

}

}

**public** Key LastKey

{

**get**

{

**return** End;

}

}

**public** **void** Add(T Value)

{

\_Count++;

**if** (Start == **null**)

{

Start = **new** Key(Value);

End = Start;

**return**;

}

End.Next = **new** Key(Value);

End = End.Next;

}

**public** **void** Clear()

{

Start = **null**;

End = **null**;

\_Count = 0;

}

**public** **void** Dequeue(**int** Index)

{

**for** (**int** i = 0; i < Index; i++)

{

Start = Start.Next;

\_Count--;

}

}

**public** **void** Dequeue(T From)

{

**while** (!EqualityComparer<T>.Default.Equals(Start.Value, From))

{

**if** (Start.Next == **null**) **return**;

Start = Start.Next;

\_Count--;

}

}

**public** **void** Iterate(Action<Key> IterateOperation, Func<Key, **bool**> BreakCondition = **null**)

{

Key Current = Start;

**for** (**int** i = 0; i < \_Count; i++)

{

IterateOperation(Current);

**if** (BreakCondition != **null** && BreakCondition(Current)) **return**;

Current = Current.Next;

}

}

}

}

**Assets/DZNetwork/Packet.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Net;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** DZNetwork

{

**public** **class** IPEndPointComparer : IEqualityComparer<IPEndPoint>

{

**public** **bool** Equals(IPEndPoint A, IPEndPoint B)

{

**return** A.Equals(B);

}

**public** **int** GetHashCode(IPEndPoint A)

{

**return** A.GetHashCode();

}

}

**public** **static** **class** PacketHandler

{

**public** **static** **int** ProtocolID = 0;

**private** **static** **int** PacketHeaderSize = **sizeof**(**int**) \* 2 + **sizeof**(**ushort**);

**public** **static** **int** HeaderSize = PacketHeaderSize + **sizeof**(**ushort**) \* 2 + **sizeof**(**int**) \* 3;

**public** **static** **ushort** PacketID = 0;

**public** **static** **ushort** LocalPacketSequence = 0;

**public** **class** Acknowledgement

{

**public** **ushort** PacketAcknowledgement = 0;

**public** **int** PacketAcknowledgementBitField = 0;

}

**public** **static** Dictionary<IPEndPoint, Acknowledgement> PacketAcknowledgements = **new** Dictionary<IPEndPoint, Acknowledgement>(**new** IPEndPointComparer());

**public** **struct** PacketGroup

{

**public** **ushort** StartingPacketSequence;

**public** **byte**[][] Packets;

}

**public** **static** Acknowledgement GetAcknowledgement(IPEndPoint EndPoint)

{

**if** (!PacketAcknowledgements.ContainsKey(EndPoint)) PacketAcknowledgements.Add(EndPoint, **new** Acknowledgement());

**return** PacketAcknowledgements[EndPoint];

}

**public** **static** **void** RemoveAcknowledgement(IPEndPoint EndPoint)

{

**if** (PacketAcknowledgements.ContainsKey(EndPoint))

PacketAcknowledgements.Remove(EndPoint);

}

**public** **static** **int** CalculateCheckSum(**byte**[] Data, **int** Offset = **sizeof**(**int**) \* 2)

{

**int** Sum = 0;

**for** (**int** i = Offset; i < Data.Length; i++)

Sum += Data[i];

**return** Sum;

}

**public** **static** **int** CalculateCheckSum(List<**byte**> Data, **int** Offset = **sizeof**(**int**) \* 2)

{

**int** Sum = 0;

**for** (**int** i = Offset; i < Data.Count; i++)

Sum += Data[i];

**return** Sum;

}

**public** **static** PacketGroup GeneratePackets(Packet P, IPEndPoint EndPoint)

{

**byte**[] Data = P.GetBytes();

**float** NumPacketsNoHeader = UnityEngine.Mathf.Ceil((**float**)Data.Length / Loader.Socket.BufferSize);

**int** NumPackets = UnityEngine.Mathf.CeilToInt((Data.Length + NumPacketsNoHeader \* HeaderSize) / Loader.Socket.BufferSize);

**byte**[][] Packets = **new** **byte**[NumPackets][];

**byte**[] HeaderBytes = **new** **byte**[PacketHeaderSize];

**int** WriteHead = 0;

Buffer.BlockCopy(BitConverter.GetBytes(ProtocolID), 0, HeaderBytes, WriteHead, **sizeof**(**int**)); WriteHead += **sizeof**(**int**) \* 2;

Buffer.BlockCopy(BitConverter.GetBytes(PacketID), 0, HeaderBytes, WriteHead, **sizeof**(**ushort**));

PacketGroup PacketGroup = **new** PacketGroup()

{

StartingPacketSequence = LocalPacketSequence

};

**lock** (PacketAcknowledgements)

{

Acknowledgement Ack = GetAcknowledgement(EndPoint);

**int** RemainingPacketSize = Data.Length;

**int** ReadHead = 0;

**for** (**int** i = 0; i < NumPackets; i++)

{

**int** PacketSize = Math.Min(RemainingPacketSize, Loader.Socket.BufferSize - HeaderSize);

Packets[i] = **new** **byte**[PacketSize + HeaderSize];

Buffer.BlockCopy(HeaderBytes, 0, Packets[i], 0, HeaderBytes.Length);

**int** HeaderIndex = HeaderBytes.Length;

Buffer.BlockCopy(BitConverter.GetBytes(LocalPacketSequence), 0, Packets[i], HeaderIndex, **sizeof**(**ushort**)); HeaderIndex += **sizeof**(**ushort**);

Buffer.BlockCopy(BitConverter.GetBytes(Ack.PacketAcknowledgement), 0, Packets[i], HeaderIndex, **sizeof**(**ushort**)); HeaderIndex += **sizeof**(**ushort**);

Buffer.BlockCopy(BitConverter.GetBytes(Ack.PacketAcknowledgementBitField), 0, Packets[i], HeaderIndex, **sizeof**(**int**)); HeaderIndex += **sizeof**(**int**);

Buffer.BlockCopy(BitConverter.GetBytes(Data.Length), 0, Packets[i], HeaderIndex, **sizeof**(**int**)); HeaderIndex += **sizeof**(**int**);

Buffer.BlockCopy(BitConverter.GetBytes(i), 0, Packets[i], HeaderIndex, **sizeof**(**int**));

Buffer.BlockCopy(Data, ReadHead, Packets[i], HeaderSize, PacketSize);

**int** CheckSum = CalculateCheckSum(Packets[i]);

Buffer.BlockCopy(BitConverter.GetBytes(CheckSum), 0, Packets[i], **sizeof**(**int**), **sizeof**(**int**));

ReadHead += PacketSize;

RemainingPacketSize -= PacketSize;

LocalPacketSequence++;

}

}

PacketID++;

PacketGroup.Packets = Packets;

**return** PacketGroup;

}

}

**public** **class** Packet

{

**public** **byte**[] ReadableBuffer;

**private** List<**byte**> Buffer;

**public** **int** ReadPosition { **get**; **private** **set**; } = 0;

/// <summary>

/// Generates a blank packet

/// </summary>

**public** Packet()

{

Buffer = **new** List<**byte**>();

}

/// <summary>

/// Generates a packet from which data can be read, making a copy

/// </summary>

/// <param name="Data">Bytes to be read</param>

**public** Packet(**byte**[] Buffer, **int** Start, **int** Count)

{

ReadableBuffer = **new** **byte**[Count];

System.Buffer.BlockCopy(Buffer, Start, ReadableBuffer, 0, Count);

}

/// <summary>

/// Generates a packet from which data can be read, without making a copy

/// </summary>

/// <param name="Data">Bytes to be read</param>

**public** Packet(**byte**[] Buffer)

{

ReadableBuffer = Buffer;

}

**public** **void** InsertServerCode(ServerCode Code)

{

Buffer.InsertRange(0, BitConverter.GetBytes((**int**)Code));

}

**public** **void** InsertCheckSum(**int** Offset)

{

Buffer.InsertRange(0, BitConverter.GetBytes(PacketHandler.CalculateCheckSum(Buffer, Offset)));

}

**public** **void** SeekHeader()

{

ReadPosition = PacketHandler.HeaderSize;

}

/// <summary>

/// Reset the packets buffers if passed true

/// </summary>

/// <param name="Reset"></param>

**public** **void** Reset(**bool** Reset)

{

**if** (!Reset)

**return**;

Buffer.Clear();

ReadableBuffer = **null**;

ReadPosition = 0;

}

/// <summary>

/// Converts buffer to byte array

/// </summary>

/// <returns></returns>

**public** **byte**[] GetBytes()

{

ReadableBuffer = Buffer.ToArray();

**return** ReadableBuffer;

}

/// <summary>

/// Writes a range of bytes and sets it to the readable buffer

/// </summary>

/// <param name="Data"></param>

**public** **void** WriteRange(**byte**[] Data)

{

Buffer.AddRange(Data);

ReadableBuffer = Buffer.ToArray();

}

/// <summary>

/// Writes a range of bytes without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**byte**[] Data)

{

Buffer.AddRange(Data);

}

/// <summary>

/// Writes a string without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**string** Value)

{

Write(Value.Length); //Add length of string

Buffer.AddRange(Encoding.ASCII.GetBytes(Value));

}

/// <summary>

/// Writes a byte without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**byte** Value)

{

Buffer.Add(Value);

}

/// <summary>

/// Writes an int without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**int** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Writes an ushort without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**ushort** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Writes a float without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**float** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Writes a long without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**long** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Writes an ulong without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**ulong** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Writes a boolean without setting ReadableBuffer

/// </summary>

/// <param name="Data"></param>

**public** **void** Write(**bool** Value)

{

Buffer.AddRange(BitConverter.GetBytes(Value));

}

/// <summary>

/// Returns the unread length of the packet

/// </summary>

/// <param name="Data"></param>

**public** **int** UnreadLength()

{

**return** ReadableBuffer.Length - ReadPosition;

}

/// <summary>

/// Set the reading position for the packet

/// </summary>

/// <param name="ReadPosition"></param>

**public** **void** Seek(**int** ReadPosition)

{

**this**.ReadPosition = ReadPosition;

}

/// <summary>

/// Skip bytes of a packet

/// </summary>

/// <param name="ReadPosition"></param>

**public** **void** Skip(**int** NumBytes)

{

ReadPosition += NumBytes;

}

/// <summary>

/// Reads a byte value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **byte** ReadByte(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**byte**))

{

**byte** Value = ReadableBuffer[ReadPosition];

**if** (MoveRead)

ReadPosition += **sizeof**(**byte**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Byte value");

}

}

/// <summary>

/// Reads a boolean value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **bool** ReadBool(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**bool**))

{

**bool** Value = BitConverter.ToBoolean(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**bool**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Boolean value");

}

}

/// <summary>

/// Reads a long value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **long** ReadLong(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**long**))

{

**long** Value = BitConverter.ToInt64(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**long**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Long value");

}

}

/// <summary>

/// Reads an ulong value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **ulong** ReadULong(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**ulong**))

{

**ulong** Value = BitConverter.ToUInt64(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**ulong**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Unsigned Long value");

}

}

/// <summary>

/// Reads a Short value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **short** ReadShort(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**short**))

{

**short** Value = BitConverter.ToInt16(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**short**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Short value");

}

}

/// <summary>

/// Reads a ushort value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **ushort** ReadUShort(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**ushort**))

{

**ushort** Value = BitConverter.ToUInt16(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**ushort**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read UShort value");

}

}

/// <summary>

/// Reads a int value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **int** ReadInt(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**int**))

{

**int** Value = BitConverter.ToInt32(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**int**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Int value");

}

}

/// <summary>

/// Reads a uint value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **uint** ReadUInt(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**int**))

{

**uint** Value = BitConverter.ToUInt32(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**uint**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read UInt value");

}

}

/// <summary>

/// Reads a float value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **float** ReadFloat(**bool** MoveRead = **true**)

{

**if** (UnreadLength() >= **sizeof**(**float**))

{

**float** Value = BitConverter.ToSingle(ReadableBuffer, ReadPosition);

**if** (MoveRead)

ReadPosition += **sizeof**(**float**);

**return** Value;

}

**else**

{

**throw** **new** Exception("Could not read Int value");

}

}

/// <summary>

/// Reads a string value from the current ReadPosition of the packet

/// </summary>

/// <param name="MoveRead">Move the ReadPosition after read</param>

/// <returns></returns>

**public** **string** ReadString(**bool** MoveRead = **true**)

{

**try**

{

**int** Length = ReadInt();

**string** Value = Encoding.ASCII.GetString(ReadableBuffer, ReadPosition, Length);

**if** (MoveRead && Value.Length > 0)

ReadPosition += Length;

**return** Value;

}

**catch**

{

**throw** **new** Exception("Could not read String value");

}

}

}

}

**Assets/DZNetwork/ServerHandle.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Net;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DZNetwork

{

**public** **static** **class** ServerHandle

{

**public** **static** Action<DZUDPSocket.RecievePacketWrapper> PacketHandle = **null**;

**public** **static** Action<DZUDPSocket.SentPacketWrapper> LostPacketHandle = **null**;

**private** **static** **readonly** List<DZUDPSocket.RecievePacketWrapper> PacketsToProcess = **new** List<DZUDPSocket.RecievePacketWrapper>();

**private** **static** **readonly** Queue<DZUDPSocket.RecievePacketWrapper> PacketsProcessing = **new** Queue<DZUDPSocket.RecievePacketWrapper>();

**private** **static** **readonly** List<DZUDPSocket.SentPacketWrapper> LostPacketsToProcess = **new** List<DZUDPSocket.SentPacketWrapper>();

**private** **static** **readonly** Queue<DZUDPSocket.SentPacketWrapper> LostPacketsProcessing = **new** Queue<DZUDPSocket.SentPacketWrapper>();

**public** **static** **void** ProcessPacket(DZUDPSocket.RecievePacketWrapper Packet)

{

**lock** (PacketsToProcess)

{

PacketsToProcess.Add(Packet);

}

}

**public** **static** **void** HandleLostPacket(DZUDPSocket.SentPacketWrapper Packet)

{

**lock** (LostPacketsToProcess)

{

LostPacketsToProcess.Add(Packet);

}

}

**public** **static** **void** FixedUpdate()

{

**lock** (PacketsToProcess)

{

**if** (PacketsToProcess.Count > 0)

{

**for** (**int** i = 0; i < PacketsToProcess.Count; i++)

PacketsProcessing.Enqueue(PacketsToProcess[i]);

PacketsToProcess.Clear();

}

}

**lock** (LostPacketsToProcess)

{

**if** (LostPacketsToProcess.Count > 0)

{

**for** (**int** i = 0; i < LostPacketsToProcess.Count; i++)

LostPacketsProcessing.Enqueue(LostPacketsToProcess[i]);

LostPacketsToProcess.Clear();

}

}

**while** (PacketsProcessing.Count > 0)

{

PacketHandle?.Invoke(PacketsProcessing.Dequeue());

}

**while** (LostPacketsProcessing.Count > 0)

{

LostPacketHandle?.Invoke(LostPacketsProcessing.Dequeue());

}

}

}

}

**Assets/Resources/ComputeShaders/  
TilemapComputeShader.compute**

#pragma kernel TilemapRender

struct Tile

{

int NumFrames; //Total number of animation frames

int AnimationFrame; //Which animation frame to render

int TileIndex; //Which tile from the tile pallet

int Blank; //Is this tile blank

int Render; //Should this tile be rendered

};

RWTexture2D<float4>Result;

Texture2D<float4> TilePallet;

RWStructuredBuffer<Tile> Map;

int TileStride;

int TilePalletCount;

uint MapWidth;

uint MapHeight;

int TileWidth;

int TileHeight;

//Produces a tilemap texture using the provided tilemappallet

**[numthreads(4,4,1)]**

void TilemapRender(uint3 id : SV\_DispatchThreadID)

{

if (id.x < MapWidth && id.y < MapHeight)

{

Tile T = Map[id.y \* MapWidth + id.x];

if (T.Blank == 0 && T.Render == 1)

{

**for** (int x = 0; x < TileWidth; x++)

{

**for** (int y = 0; y < TileHeight; y++)

{

//Calculate what pixel to render onto the texture from the tilepallet

uint2 TilePalletIndex = uint2(T.AnimationFrame \* TileWidth + x, (TilePalletCount - T.TileIndex - 1) \* TileStride + y);

uint2 RenderIndex = uint2(id.x \* TileWidth + x, (MapHeight - id.y - 1) \* TileHeight + y);

Result[RenderIndex] = TilePallet[TilePalletIndex];

}

}

}

}

}

**Client/Assets/Render/ResizeCanvas.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** UnityEngine;

**using** UnityEngine.UI;

**static** **class** CanvasExtensions

{

**public** **static** Vector2 SizeToParent(**this** RawImage Image, **float** Padding = 0)

{

**var** Parent = Image.transform.parent.GetComponentInParent<RectTransform>();

**var** Transform = Image.GetComponent<RectTransform>();

**if** (!Parent) { **return** Transform.sizeDelta; } //if we don't have a parent, just return our current width

Padding = 1 - Padding;

**float** Ratio = Image.texture.width / (**float**)Image.texture.height;

**var** Bounds = **new** Rect(0, 0, Parent.rect.width, Parent.rect.height);

**if** (Mathf.RoundToInt(Transform.eulerAngles.z) % 180 == 90)

{

//Invert the bounds if the image is rotated

Bounds.size = **new** Vector2(Bounds.height, Bounds.width);

}

//Size by height first

**float** Height = Bounds.height \* Padding;

**float** Width = Height \* Ratio;

**if** (Width > Bounds.width \* Padding)

{ //If it doesn't fit, fallback to width

Width = Bounds.width \* Padding;

Height = Width / Ratio;

}

Transform.sizeDelta = **new** Vector2(Width, Height);

**return** Transform.sizeDelta;

}

}

**public** **class** ResizeCanvas : MonoBehaviour

{

RawImage Render;

// Start is called before the first frame update

**void** Start()

{

Render = GetComponent<RawImage>();

}

// Update is called once per frame

**void** Update()

{

**if** (Render != **null**) Render.SizeToParent();

}

}

**Assets/Scripts/Creatures/AbstractCreatures.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**public** **abstract** **class** AbstractCreature : AbstractWorldEntity, IUpdatable, IRenderer

{

**public** **int** SortingLayer { **get**; **set**; }

**public** BodyChunk[] BodyChunks;

**public** DistanceJoint[] BodyChunkConnections;

**public** AbstractCreature() { }

**public** AbstractCreature(**ushort** ID) : **base**(ID) { }

**public** **virtual** **void** Update() { }

**public** **virtual** **void** BodyPhysicsUpdate() { }

**protected** **override** **void** OnDelete() { }

**public** **virtual** **void** InitializeRenderer() { }

**public** **virtual** **void** Render() { }

}

**Client/Assets/Scripts/Creatures/BulletEntity.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DZNetwork;

**using** DeadZoneEngine;

**public** **class** BulletEntity : AbstractWorldEntity, IPhysicsUpdatable, IRenderer, IServerSendable

{

**public** **int** SortingLayer { **get**; **set**; }

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.BulletEntity;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

BodyChunk Bolt;

**public** **float** Speed = 100;

**public** Vector2 Direction = Vector2.up;

**public** BulletEntity(**ushort** ID) : **base**(ID)

{

Init();

}

**public** BulletEntity() : **base**()

{

Init();

}

**public** **void** Init()

{

Bolt = **new** BodyChunk();

Bolt.Collider.radius = 0.1f;

Bolt.Kinematic = **true**;

}

**public** Vector2 Position

{

**get**

{

**if** (Bolt != **null**)

**return** Bolt.Position;

**return** Vector2.zero;

}

**set**

{

**if** (Bolt != **null**)

Bolt.Position = value;

}

}

**public** **void** InitializeRenderer()

{

}

**public** **void** Render()

{

Bolt.RenderObject.transform.localScale = **new** Vector2(0.2f, 0.2f);

Bolt.RenderColor = Color.red;

}

**public** **void** ServerUpdate()

{

}

**private** RaycastHit2D[] RayCasts = **new** RaycastHit2D[6];

**public** **void** FixedUpdate()

{

MoveBullet(Time.fixedDeltaTime);

}

**private** **void** MoveBullet(**float** Time)

{

**float** ScaledSpeed = Speed \* Time;

Vector2 NormalDirection = Vector2.Perpendicular(Direction).normalized \* (Bolt.Collider.radius + 0.01f);

RayCasts[0] = Physics2D.Raycast(Bolt.Position, Direction, ScaledSpeed);

RayCasts[1] = Physics2D.Raycast(Bolt.Position + NormalDirection, Direction, ScaledSpeed);

RayCasts[2] = Physics2D.Raycast(Bolt.Position - NormalDirection, Direction, ScaledSpeed);

Vector2 End = Bolt.Position + Direction \* ScaledSpeed;

RayCasts[3] = Physics2D.Raycast(End, -Direction, ScaledSpeed - Bolt.Collider.radius - 0.1f);

RayCasts[4] = Physics2D.Raycast(End + NormalDirection, -Direction, ScaledSpeed);

RayCasts[5] = Physics2D.Raycast(End - NormalDirection, -Direction, ScaledSpeed);

**bool** FoundHit = **false**;

**int** Index = 0;

**for** (**int** i = 0; i < RayCasts.Length; i++)

{

**if** (RayCasts[i].collider != **null** && Vector2.Dot(RayCasts[i].normal, Direction) < 0)

{

FoundHit = **true**;

Index = i;

**break**;

}

}

**if** (FoundHit)

{

RaycastHit2D Hit = RayCasts[Index];

**float** Distance = Mathf.Abs((Hit.point - Bolt.Position).magnitude) - Bolt.Collider.radius;

Vector2 NewPosition = Bolt.Position + Direction \* Distance;

AbstractWorld WorldContext = Hit.collider.gameObject.GetComponent<AbstractWorld>();

**if** (WorldContext != **null**)

{

**if** (WorldContext.Type == DZSettings.EntityType.PlayerCreature)

{

PlayerCreature Player = (PlayerCreature)WorldContext.Context;

}

}

Direction = Vector2.Reflect(Direction, Hit.normal).normalized;

Bolt.Position = NewPosition + Direction \* 0.1f + Hit.normal \* 0.1f;

}

**else**

{

Bolt.Position += Direction \* ScaledSpeed;

}

}

**public** **void** IsolateVelocity() { }

**public** **void** RestoreVelocity() { }

**protected** **override** **void** OnDelete()

{

DZEngine.Destroy(Bolt);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Speed));

Data.AddRange(BitConverter.GetBytes(Direction.x));

Data.AddRange(BitConverter.GetBytes(Direction.y));

Data.AddRange(Bolt.GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(Packet Data)

{

ParseSnapshot(ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **float** Speed;

**public** Vector2 Direction;

**public** BodyChunk.Data Bolt;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Speed = Speed,

Direction = Direction,

Bolt = (BodyChunk.Data)Bolt.GetSnapshot()

};

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Speed = Data.ReadFloat(),

Direction = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

Bolt = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Speed = Data.Speed;

Direction = Data.Direction;

Bolt.ParseSnapshot(Data.Bolt);

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Direction = From.Direction;

Speed = From.Speed;

Bolt.Interpolate(From.Bolt, To.Bolt, Time);

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

Data From = (Data)FromData;

Direction = From.Direction;

Speed = From.Speed;

MoveBullet(Time);

}

}

**Client/Assets/Scripts/Creatures/CoinEntity.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DZNetwork;

**public** **class** CoinEntity : AbstractWorldEntity, IUpdatable, IRenderer, IServerSendable

{

**public** **int** SortingLayer { **get**; **set**; }

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.CoinEntity;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** Money = 1;

**public** **int** Health = 0;

**public** BodyChunk Coin;

**public** **float** Decay = 10;

**public** CoinEntity(**ushort** ID) : **base**(ID)

{

Init();

}

**public** CoinEntity() : **base**()

{

Init();

}

**public** **void** Init()

{

Coin = **new** BodyChunk();

Coin.Context = **this**;

Coin.ContextType = DZSettings.EntityType.CoinEntity;

Coin.Collider.radius = 0.01f;

Coin.Velocity = **new** Vector2(UnityEngine.Random.Range(-5f, 5f), UnityEngine.Random.Range(-5f, 5f));

}

**public** Vector2 Position

{

**get**

{

**if** (Coin != **null**)

**return** Coin.Position;

**return** Vector2.zero;

}

**set**

{

**if** (Coin != **null**)

Coin.Position = value;

}

}

**public** **void** InitializeRenderer()

{

}

**public** **void** Render()

{

Coin.RenderObject.transform.localScale = **new** Vector2(0.2f, 0.2f);

**if** (Health > 0)

Coin.RenderColor = Color.red;

**else**

Coin.RenderColor = Color.magenta;

}

**public** **void** ServerUpdate()

{

}

**public** **void** Update()

{

Decay -= Time.fixedDeltaTime;

**if** (Decay < 0)

{

DZEngine.Destroy(**this**);

}

Collider2D[] C = Physics2D.OverlapCircleAll(Position, 1f);

List<PlayerCreature> NearbyCreatures = **new** List<PlayerCreature>();

**for** (**int** i = 0; i < C.Length; i++)

{

**if** (C[i] != **null**)

{

AbstractWorld AW = C[i].GetComponent<AbstractWorld>();

**if** (AW != **null** && AW.Type == DZSettings.EntityType.PlayerCreature)

{

NearbyCreatures.Add((PlayerCreature)AW.Context);

}

}

}

**for** (**int** i = 0; i < NearbyCreatures.Count; i++)

{

Vector2 Dir = NearbyCreatures[i].Position - Coin.Position;

**if** (Dir.magnitude < 0.3f)

{

Main.Money += Money;

Main.GainLifeForce(Health);

DZEngine.Destroy(**this**);

}

**float** Speed = 10;

Coin.Velocity += Dir.normalized \* Speed \* Time.fixedDeltaTime;

}

Coin.Velocity \*= 0.9f;

}

**public** **void** BodyPhysicsUpdate() { }

**public** **void** IsolateVelocity() { }

**public** **void** RestoreVelocity() { }

**protected** **override** **void** OnDelete()

{

DZEngine.Destroy(Coin);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Money));

Data.AddRange(BitConverter.GetBytes(Health));

Data.AddRange(Coin.GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(Packet Data)

{

ParseSnapshot(ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **int** Money;

**public** **int** Health;

**public** BodyChunk.Data Coin;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Money = Money,

Health = Health,

Coin = (BodyChunk.Data)Coin.GetSnapshot()

};

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Money = Data.ReadInt(),

Health = Data.ReadInt(),

Coin = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Money = Data.Money;

Health = Data.Health;

Coin.ParseSnapshot(Data.Coin);

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Money = From.Money;

Health = From.Health;

Coin.Interpolate(From.Coin, To.Coin, Time);

}

}

**Client/Assets/Scripts/Creatures/EnemyCreature.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**public** **class** EnemyCreature : AbstractCreature, IServerSendable

{

**public** **struct** WayPoint

{

**public** **int** Direction;

**public** Vector2Int Position;

}

**public** **struct** Path

{

**public** List<WayPoint> Traversal;

**public** **string** Map;

}

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.EnemyCreature;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** CurrentWayPoint = 0;

**public** Path Traversal;

**public** **int** CorpseHP = 5;

**public** **int** Health = 5;

**public** **float** Speed = 1;

**private** **float**[] DynamicRunSpeed;

**public** BodyState State;

**public** **enum** BodyState

{

Standing,

Limp

}

**public** EnemyCreature(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** EnemyCreature()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

BodyChunks[1].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

**if** (State == BodyState.Limp) BodyColor = Color.grey;

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

Color BodyColor;

**private** **void** Initialize()

{

BodyChunks = **new** BodyChunk[2];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[1] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.25f;

BodyChunks[1].Collider.radius = 0.25f;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.EnemyCreature;

BodyChunks[1].Context = **this**;

BodyChunks[1].ContextType = DZSettings.EntityType.EnemyCreature;

SetGravity(0f);

BodyChunkConnections = **new** DistanceJoint[1];

BodyChunkConnections[0] = **new** DistanceJoint();

BodyChunkConnections[0].Set(**new** DistanceJointData(BodyChunks[0], BodyChunks[1], 0.5f, Vector2.zero));

BodyChunkConnections[0].Active = **false**;

Physics2D.IgnoreCollision(BodyChunks[0].Collider, BodyChunks[1].Collider, **true**); //Ignore collisions between body parts

DynamicRunSpeed = **new** **float**[2];

BodyColor = **new** Color(0, 1, 0);

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

**if** (BodyChunks[1] != **null**)

BodyChunks[1].Position = value;

}

}

**public** **void** ApplyVelocity(Vector2 Direction, **float** Force)

{

BodyChunks[0].Velocity += Direction \* Force;

}

**public** **void** ApplyVelocity(Vector2 Vel)

{

BodyChunks[0].Velocity += Vel;

}

**public** **void** ServerUpdate()

{

}

**public** **override** **void** Update()

{

UpdateBodyState();

UpdateMovement();

}

**private** **void** UpdateBodyState()

{

}

**private** Vector2 MovementDirection;

**private** **void** UpdateMovement()

{

**switch** (State)

{

**case** BodyState.Limp:

{

BodyChunks[0].Velocity \*= 0.3f;

BodyChunks[1].Velocity \*= 0.3f;

}

**break**;

**case** BodyState.Standing:

{

DynamicRunSpeed[0] = 1f;

DynamicRunSpeed[1] = 1.5f;

BodyChunks[0].Velocity += **new** Vector2(Speed \* DynamicRunSpeed[0] \* MovementDirection.x, Speed \* DynamicRunSpeed[0] \* MovementDirection.y);

BodyChunks[1].Velocity += **new** Vector2(Speed \* DynamicRunSpeed[1] \* MovementDirection.x, Speed \* DynamicRunSpeed[1] \* MovementDirection.y);

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**break**;

}

}

**public** **override** **void** BodyPhysicsUpdate()

{

**switch** (State)

{

**case** BodyState.Limp:

{

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, Vector2.zero, 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **true**;

}

**break**;

**case** BodyState.Standing:

{

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, **new** Vector2(0, 0.3f), 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **false**;

**float** Dist = Vector2.Distance(BodyChunks[0].Position, BodyChunks[1].Position);

Vector2 Dir = (BodyChunks[0].Position - BodyChunks[1].Position).normalized;

BodyChunks[1].Position += Dist \* Dir \* 0.8f;

BodyChunks[1].Velocity += Dist \* Dir \* 0.8f;

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**break**;

}

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

BodyChunks[1].Gravity = Gravity;

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

BodyChunks[1].Delete();

BodyChunkConnections[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes((**int**)State));

Data.AddRange(BodyChunks[0].GetBytes());

Data.AddRange(BodyChunks[1].GetBytes());

Data.AddRange(BodyChunkConnections[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** BodyState State;

**public** BodyChunk.Data BodyChunk0;

**public** BodyChunk.Data BodyChunk1;

**public** DistanceJoint.Data BodyChunkConnections0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

State = (BodyState)Data.ReadInt(),

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunk1 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunkConnections0 = (DistanceJoint.Data)DistanceJoint.ParseBytesToData(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

State = Data.State;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

BodyChunks[1].ParseSnapshot(Data.BodyChunk1);

BodyChunkConnections[0].ParseSnapshot(Data.BodyChunkConnections0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

State = State,

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot(),

BodyChunk1 = (BodyChunk.Data)BodyChunks[1].GetSnapshot(),

BodyChunkConnections0 = (DistanceJoint.Data)BodyChunkConnections[0].GetSnapshot()

};

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

State = From.State;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

BodyChunks[1].Interpolate(From.BodyChunk1, To.BodyChunk1, Time);

BodyChunkConnections[0].Interpolate(From.BodyChunkConnections0, To.BodyChunkConnections0, Time);

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

Data From = (Data)FromData;

State = From.State;

BodyChunks[0].Extrapolate(From.BodyChunk0, Time);

BodyChunks[1].Extrapolate(From.BodyChunk1, Time);

BodyChunkConnections[0].Extrapolate(From.BodyChunkConnections0, Time);

}

}

**Client/Assets/Scripts/Creatures/PlayerCreature.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** ClientHandle;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**public** **class** PlayerCreature : AbstractCreature, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.PlayerCreature;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **bool** Out;

**public** **float** RunSpeed;

**public** **class** Control

{

**public** PlayerController Owner;

**public** Vector2 MovementDirection;

**public** Vector2 ShieldVector;

**public** **float** Interact;

**public** **struct** Snapshot

{

**public** **ulong** InputID;

**public** Vector2 MovementDirection;

}

**public** **ulong** InputID;

**public** Snapshot GetSnapshot()

{

**return** **new** Snapshot()

{

InputID = InputID++,

MovementDirection = MovementDirection

};

}

**public** **void** ParseSnapshot(Snapshot Snapshot)

{

MovementDirection = Snapshot.MovementDirection;

}

}

**public** Control Controller { **get**; **private** **set**; } //Controller for player movement

**private** **float**[] DynamicRunSpeed; //Controls Speed of each bodychunk

**public** PlayerCreature(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** PlayerCreature()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

BodyChunks[1].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

}

Color BodyColor;

**private** **void** Initialize()

{

**if** (DZSettings.ClientSidePrediction)

Histogram = **new** DZNetwork.JitterBuffer<PlayerSnapshot>();

Controller = **new** Control();

RunSpeed = 2f;

BodyChunks = **new** BodyChunk[2];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[1] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.25f;

BodyChunks[1].Collider.radius = 0.25f;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.PlayerCreature;

BodyChunks[1].Context = **this**;

BodyChunks[1].ContextType = DZSettings.EntityType.PlayerCreature;

SetGravity(0f);

BodyChunkConnections = **new** DistanceJoint[1];

BodyChunkConnections[0] = **new** DistanceJoint();

BodyChunkConnections[0].Set(**new** DistanceJointData(BodyChunks[0], BodyChunks[1], 0.5f, Vector2.zero));

BodyChunkConnections[0].Active = **false**;

Physics2D.IgnoreCollision(BodyChunks[0].Collider, BodyChunks[1].Collider, **true**); //Ignore collisions between body parts

DynamicRunSpeed = **new** **float**[2];

BodyColor = **new** Color(UnityEngine.Random.Range(0f, 1f), UnityEngine.Random.Range(0f, 1f), UnityEngine.Random.Range(0f, 1f));

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

**if** (BodyChunks[1] != **null**)

BodyChunks[1].Position = value;

}

}

**public** **void** ServerUpdate()

{

**if** (Controller.Owner == **null** || DZSettings.ClientSidePrediction == **false**) **return**;

UpdateReconcilliation();

LerpReconcilleError();

BodyChunks[0].PhysicallyActive = **true**;

BodyChunks[1].PhysicallyActive = **true**;

BodyChunkConnections[0].PhysicallyActive = **true**;

BodyChunks[0].Kinematic = **false**;

BodyChunks[1].Kinematic = **false**;

}

**public** **override** **void** Update()

{

UpdateBodyState();

UpdateMovement();

}

**private** **void** UpdateBodyState()

{

}

**private** **void** UpdateMovement()

{

DynamicRunSpeed[0] = 1f;

DynamicRunSpeed[1] = 2f;

**if** (Controller != **null**)

{

BodyChunks[0].Velocity += **new** Vector2(RunSpeed \* DynamicRunSpeed[0] \* Controller.MovementDirection.x, RunSpeed \* DynamicRunSpeed[0] \* Controller.MovementDirection.y);

BodyChunks[1].Velocity += **new** Vector2(RunSpeed \* DynamicRunSpeed[1] \* Controller.MovementDirection.x, RunSpeed \* DynamicRunSpeed[1] \* Controller.MovementDirection.y);

}

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**public** **override** **void** BodyPhysicsUpdate()

{

BodyChunks[0].Kinematic = **false**;

BodyChunks[1].Kinematic = **false**;

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, **new** Vector2(0, 0.3f), 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **false**;

**float** Dist = Vector2.Distance(BodyChunks[0].Position, BodyChunks[1].Position);

Vector2 Dir = (BodyChunks[0].Position - BodyChunks[1].Position).normalized;

BodyChunks[1].Position += Dist \* Dir \* 0.8f;

BodyChunks[1].Velocity += Dist \* Dir \* 0.8f;

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

BodyChunks[1].Gravity = Gravity;

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

BodyChunks[1].Delete();

BodyChunkConnections[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Controller.InputID));

Data.AddRange(BodyChunks[0].GetBytes());

Data.AddRange(BodyChunks[1].GetBytes());

Data.AddRange(BodyChunkConnections[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **ulong** InputID;

**public** BodyChunk.Data BodyChunk0;

**public** BodyChunk.Data BodyChunk1;

**public** DistanceJoint.Data BodyChunkConnections0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

InputID = Data.ReadULong(),

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunk1 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunkConnections0 = (DistanceJoint.Data)DistanceJoint.ParseBytesToData(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

**if** (Controller.Owner != **null** && DZSettings.ClientSidePrediction && !Reconcille)

**return**;

Data Data = (Data)ObjectData;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

BodyChunks[1].ParseSnapshot(Data.BodyChunk1);

BodyChunkConnections[0].ParseSnapshot(Data.BodyChunkConnections0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

InputID = Controller.InputID,

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot(),

BodyChunk1 = (BodyChunk.Data)BodyChunks[1].GetSnapshot(),

BodyChunkConnections0 = (DistanceJoint.Data)BodyChunkConnections[0].GetSnapshot()

};

}

**public** **class** PlayerSnapshot

{

**public** Data Snapshot;

**public** Control.Snapshot Controls;

}

**public** DZNetwork.JitterBuffer<PlayerSnapshot> Histogram = **null**;

**private** **void** UpdateReconcilliation()

{

Histogram.Add(**new** PlayerSnapshot()

{

Snapshot = (Data)GetSnapshot(),

Controls = Controller.GetSnapshot()

});

}

**private** **void** LerpReconcilleError()

{

**if** (!Loader.Socket.Connected) **return**;

**const** **float** Amount = 4f;

**float** Error = (ReconcilledSelf.BodyChunk0.Position - BodyChunks[0].Position).SqrMagnitude();

**if** (Error < 1)

{

BodyChunks[0].Position = Vector3.Lerp(BodyChunks[0].Position, ReconcilledSelf.BodyChunk0.Position, Amount \* Time.fixedDeltaTime);

BodyChunks[1].Position = Vector3.Lerp(BodyChunks[1].Position, ReconcilledSelf.BodyChunk1.Position, Amount \* Time.fixedDeltaTime);

}

**else**

{

BodyChunks[0].Position = ReconcilledSelf.BodyChunk0.Position;

BodyChunks[1].Position = ReconcilledSelf.BodyChunk1.Position;

}

}

**private** PlayerSnapshot Current = **null**;

**public** Data CurrentSelf;

**private** **bool** ValidPredictPass;

**private** **bool** FinishedPredict;

**public** **void** StartClientPrediction(Game.ServerSnapshot FromData)

{

ValidPredictPass = FromData.Data.ContainsKey(ID);

CurrentSelf = (Data)GetSnapshot();

Reconcille = **true**;

**if** (!ValidPredictPass) **return**;

Data ClientPredictBaseline = (Data)FromData.Data[ID].Data;

**if** (LastReconcilled >= ClientPredictBaseline.InputID)

{

ValidPredictPass = **false**;

**return**;

}

LastReconcilled = ClientPredictBaseline.InputID;

Histogram.Iterate(S =>

{

**if** (S.Value.Controls.InputID >= ClientPredictBaseline.InputID)

{

Current = S.Value;

}

}, S => S.Value.Controls.InputID >= ClientPredictBaseline.InputID);

**if** (Current != **null**)

{

Histogram.Dequeue(Current);

ParseSnapshot(ClientPredictBaseline);

FinishedPredict = **false**;

CurrentKey = Histogram.FirstKey;

}

**else**

{

Histogram.Clear();

ValidPredictPass = **false**;

}

}

**private** DZNetwork.JitterBuffer<PlayerSnapshot>.Key CurrentKey;

**public** **void** ClientPrediction()

{

**if** (!ValidPredictPass) **return**;

**if** (CurrentKey != **null**)

{

Controller.ParseSnapshot(CurrentKey.Value.Controls);

**if** (!FinishedPredict && CurrentKey.Next == **null**)

{

FinishedPredict = **true**;

ReconcilledSelf = (Data)GetSnapshot();

}

CurrentKey = CurrentKey.Next;

}

}

**public** **void** EndClientPrediction()

{

ParseSnapshot(CurrentSelf);

Reconcille = **false**;

}

**private** Data ReconcilledSelf;

**private** **bool** Reconcille = **false**;

**private** **ulong** LastReconcilled = 0;

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

**if** (Controller.Owner != **null** && DZSettings.ClientSidePrediction)

**return**;

Data From = (Data)FromData;

Data To = (Data)ToData;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

BodyChunks[1].Interpolate(From.BodyChunk1, To.BodyChunk1, Time);

BodyChunkConnections[0].Interpolate(From.BodyChunkConnections0, To.BodyChunkConnections0, Time);

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

**if** (Controller.Owner != **null** && DZSettings.ClientSidePrediction)

**return**;

Data From = (Data)FromData;

BodyChunks[0].Extrapolate(From.BodyChunk0, Time);

BodyChunks[1].Extrapolate(From.BodyChunk1, Time);

BodyChunkConnections[0].Extrapolate(From.BodyChunkConnections0, Time);

}

}

**Client/Assets/Scripts/Creatures/Turret.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**public** **class** Turret : AbstractCreature, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.Turret;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** Timer;

**public** **int** FireRate;

**public** Turret(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** Turret()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.7f, 0.7f);

}

Color BodyColor;

**private** **void** Initialize()

{

BodyChunks = **new** BodyChunk[1];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.35f;

BodyChunks[0].Kinematic = **true**;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.Turret;

SetGravity(0f);

BodyColor = **new** Color(0.56f, 0.56f, 0.56f);

BodyChunks[0].RenderColor = BodyColor;

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

**if** (BodyChunks[1] != **null**)

BodyChunks[1].Position = value;

}

}

**public** **void** ServerUpdate()

{

}

**public** **override** **void** Update()

{

}

**private** **void** UpdateBodyState()

{

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BodyChunks[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** BodyChunk.Data BodyChunk0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot()

};

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

Data From = (Data)FromData;

BodyChunks[0].Extrapolate(From.BodyChunk0, Time);

}

}

**Assets/DZEngine/Controllers/InputMapping.cs**

**using** System;

**using** System.Collections.ObjectModel;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine.InputSystem;

**using** UnityEngine.InputSystem.LowLevel;

**using** UnityEngine.InputSystem.Controls;

**using** UnityEngine;

**using** **static** DeadZoneEngine.Controllers.InputMapping;

**using** DZNetwork;

**using** ClientHandle;

**namespace** DeadZoneEngine.Controllers

{

**public** **enum** ControllerType

{

PlayerController

}

**public** **static** **class** InputMapping

{

**public** **static** Action<InputDevice> OnDeviceAdd;

**public** **static** Action<InputDevice> OnDeviceReconnect;

**public** **static** Action<InputDevice> OnDeviceRemove;

**public** **static** Action<InputDevice> OnDeviceDisconnect;

**public** **class** DeviceController

{

**public** **bool** Enabled { **get**; **private** **set**; } = **false**;

**public** List<Controller> Controllers = **new** List<Controller>();

**public** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Controllers.Count));

**for** (**int** i = 0; i < Controllers.Count; i++)

{

Data.AddRange(BitConverter.GetBytes((**int**)Controllers[i].Type));

Data.AddRange(Controllers[i].GetBytes());

}

**return** Data.ToArray();

}

**public** **void** Tick()

{

**for** (**int** i = 0; i < Controllers.Count; i++)

{

Controllers[i].Tick();

}

}

**public** **void** OnInput(ButtonControl Control)

{

**for** (**int** i = 0; i < Controllers.Count; i++)

Controllers[i].OnInput(Control);

}

**public** **void** Enable()

{

Enabled = **true**;

**for** (**int** i = 0; i < Controllers.Count; i++)

Controllers[i].Enable();

}

**public** **void** Disable()

{

Enabled = **false**;

**for** (**int** i = 0; i < Controllers.Count; i++)

Controllers[i].Disable();

}

}

**private** **class** DeviceComparer : IEqualityComparer<InputDevice>

{

**public** **bool** Equals(InputDevice A, InputDevice B)

{

**return** A.Equals(B);

}

**public** **int** GetHashCode(InputDevice A)

{

**return** A.GetHashCode();

}

}

**public** **static** Dictionary<InputDevice, DeviceController> Devices = **new** Dictionary<InputDevice, DeviceController>(**new** DeviceComparer());

**public** **static** **void** Initialize()

{

//Detects any key press https://forum.unity.com/threads/check-if-any-key-is-pressed.763751/

InputSystem.onEvent += (Event, Device) =>

{

**if** (!Devices.ContainsKey(Device)) **return**;

**if** (!Event.IsA<StateEvent>() && !Event.IsA<DeltaStateEvent>()) **return**;

**var** Controls = Device.allControls;

**float** ButtonPressPoint = InputSystem.settings.defaultButtonPressPoint;

**for** (**var** i = 0; i < Controls.Count; ++i)

{

ButtonControl Control = Controls[i] **as** ButtonControl;

**if** (Control == **null** || Control.synthetic || Control.noisy)

**continue**;

**if** (Control.ReadValueFromEvent(Event, **out** **var** Value) && Value >= ButtonPressPoint)

{

Devices[Device].OnInput(Control);

**break**;

}

}

};

InputSystem.onDeviceChange += OnDeviceChange;

**for** (**int** i = 0; i < InputSystem.devices.Count; i++)

{

**if** (!(InputSystem.devices[i] **is** Mouse))

{

DeviceController DC = **new** DeviceController();

Devices.Add(InputSystem.devices[i], DC);

OnDeviceAdd?.Invoke(InputSystem.devices[i]);

}

}

}

**public** **static** **void** Tick()

{

List<DeviceController> Controllers = Devices.Values.ToList();

**foreach** (DeviceController DC **in** Controllers)

{

DC.Tick();

}

}

**public** **static** **void** ParseBytes(Packet Packet, Client Client)

{

**int** NumControllers = Packet.ReadInt();

**for** (**int** i = 0; i < NumControllers; i++)

{

**bool** Enabled = Packet.ReadBool();

**if** (!Enabled) **continue**;

**int** NumControls = Packet.ReadInt();

**for** (**int** j = 0; j < NumControls; j++)

{

ControllerType ControlType = (ControllerType)Packet.ReadInt();

**int** PlayerID = Packet.ReadByte();

**switch** (ControlType)

{

**case** ControllerType.PlayerController: Client.Players[PlayerID].Controller.ParseBytes(Packet); **break**;

**default**:

Debug.LogWarning("Unknown controller type...");

**return**;

}

}

}

}

**public** **static** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

List<DeviceController> Controllers = Devices.Values.ToList();

Data.AddRange(BitConverter.GetBytes(Controllers.Count));

**foreach** (DeviceController DC **in** Controllers)

{

Data.AddRange(BitConverter.GetBytes(DC.Enabled));

**if** (DC.Enabled)

Data.AddRange(DC.GetBytes());

}

**return** Data.ToArray();

}

**private** **static** **void** OnDeviceChange(InputDevice Device, InputDeviceChange Change)

{

**switch** (Change)

{

**case** InputDeviceChange.Added:

Debug.Log("Device: " + Device.displayName + " was added");

**if** (!Devices.ContainsKey(Device))

{

Devices.Add(Device, **new** DeviceController());

OnDeviceAdd?.Invoke(Device);

}

Devices[Device].Enable();

**break**;

**case** InputDeviceChange.Removed:

Debug.Log("Device: " + Device.displayName + " was removed");

OnDeviceRemove?.Invoke(Device);

**if** (Devices.ContainsKey(Device))

Devices[Device].Disable();

**break**;

**case** InputDeviceChange.Disconnected:

Debug.Log("Device: " + Device.displayName + " was disconnected");

OnDeviceDisconnect?.Invoke(Device);

**if** (Devices.ContainsKey(Device))

Devices[Device].Disable();

**break**;

**case** InputDeviceChange.Reconnected:

Debug.Log("Device: " + Device.displayName + " has reconnected");

**if** (!Devices.ContainsKey(Device))

Devices.Add(Device, **new** DeviceController());

OnDeviceReconnect?.Invoke(Device);

Devices[Device].Enable();

**break**;

}

}

**public** **static** **void** Rebind(InputAction Action, InputDevice Device)

{

}

}

**public** **abstract** **class** Controller

{

**public** DeviceController DC;

**public** ControllerType Type;

**private** InputDevice Device;

**protected** **bool** IsKeyboard { **get**; **private** **set**; } = **true**;

**protected** InputActionMap ActionMap = **new** InputActionMap("Controller");

**public** Controller()

{

SetType();

}

**public** Controller(InputDevice Device, DeviceController DC)

{

**this**.DC = DC;

**this**.Device = Device;

IsKeyboard = Device **is** Keyboard;

SetType();

}

**protected** **abstract** **void** SetType();

//Triggered when any button on the device is pressed

**public** **virtual** **void** OnInput(ButtonControl Control)

{

}

**public** **void** Enable()

{

ActionMap.Enable();

}

**public** **void** Disable()

{

ActionMap.Disable();

}

**public** **void** RebindAll()

{

**for** (**int** i = 0; i < ActionMap.actions.Count; i++)

{

InputMapping.Rebind(ActionMap.actions[i], Device);

}

}

**public** **void** Reset()

{

ActionMap.RemoveAllBindingOverrides();

}

**public** **void** Reset(**string** ActionName)

{

ActionMap.FindAction(ActionName).RemoveAllBindingOverrides();

}

**public** **void** Reset(**int** Index)

{

ActionMap.actions[Index].RemoveAllBindingOverrides();

}

**public** **void** Rebind(**string** ActionName)

{

InputMapping.Rebind(ActionMap.FindAction(ActionName), Device);

}

**public** **void** Rebind(**int** Index)

{

InputMapping.Rebind(ActionMap.actions[Index], Device);

}

**public** **void** Rebind(InputAction Action)

{

InputMapping.Rebind(Action, Device);

}

**public** **virtual** **void** Tick()

{

}

**public** **abstract** **void** ParseBytes(Packet Data);

**public** **abstract** **byte**[] GetBytes();

}

}

**Assets/DZEngine/Entities/Components/BodyChunk.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DeadZoneEngine.Entities.Components

{

**public** **class** BodyChunk : PhysicalObject, IRenderer<SpriteRenderer>

{

**private** AbstractWorld Info;

**public** **object** Context

{

**get**

{

**if** (Info != **null**)

**return** Info.Context;

**else**

**return** **null**;

}

**set**

{

Info.Context = value;

}

}

**public** DZSettings.EntityType ContextType

{

**get**

{

**if** (Info != **null**)

**return** Info.Type;

**else**

**return** DZSettings.EntityType.Null;

}

**set**

{

Info.Type = value;

}

}

**public** **int** SortingLayer { **get**; **set**; }

**public** SpriteRenderer RenderObject { **get**; **set**; }

**private** GameObject RenderObj;

**public** Vector3 SpriteOffset = Vector3.zero;

**public** Color RenderColor = **new** Color(1, 1, 1);

**public** **virtual** **void** InitializeRenderer()

{

RenderObj = **new** GameObject();

RenderObj.transform.parent = Self.transform;

RenderObj.transform.localPosition = Vector3.zero;

RenderObject = RenderObj.AddComponent<SpriteRenderer>();

RenderObject.sprite = Resources.Load<Sprite>("Sprites/Circle");

}

**public** **virtual** **void** Render()

{

RenderObj.transform.localPosition = SpriteOffset;

RenderObject.color = RenderColor;

}

**public** CircleCollider2D Collider { **get**; **private** **set**; }

**public** ContactPoint2D[] Contacts = **new** ContactPoint2D[10];

**public** **float** Height;

**public** BodyChunk()

{

Init();

}

**public** BodyChunk(AbstractWorldEntity Parent)

{

**this**.Parent = Parent;

Init();

}

**public** BodyChunk(**ushort** ID) : **base**(ID)

{

Init();

}

**private** **void** Init()

{

Info = Self.AddComponent<AbstractWorld>();

Info.Self = **this**;

Collider = Self.AddComponent<CircleCollider2D>();

Collider.radius = 0.5f;

InvInertia = 1;

InvMass = 1;

Gravity = 0;

}

/// <summary>

/// Update Contacts Array => If no contacts are found, the array will not be updated (past values will persist)

/// </summary>

/// <returns>Number of contacts recieved</returns>

**public** **int** GetContacts()

{

**return** Collider.GetContacts(Contacts);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Position.x));

Data.AddRange(BitConverter.GetBytes(Position.y));

Data.AddRange(BitConverter.GetBytes(Rotation));

Data.AddRange(BitConverter.GetBytes(Velocity.x));

Data.AddRange(BitConverter.GetBytes(Velocity.y));

Data.AddRange(BitConverter.GetBytes(AngularVelocity));

Data.AddRange(BitConverter.GetBytes(InvMass));

Data.AddRange(BitConverter.GetBytes(InvInertia));

Data.AddRange(BitConverter.GetBytes(Collider.radius));

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

Data D = (Data)ParseBytesToSnapshot(Data);

ParseSnapshot(D);

}

**public** **struct** Data

{

**public** Vector2 Position;

**public** **float** Rotation;

**public** Vector2 Velocity;

**public** **float** AngularVelocity;

**public** **float** InvMass;

**public** **float** InvInertia;

**public** **float** ColliderRadius;

}

**public** **override** **object** GetSnapshot()

{

Data D = **new** Data()

{

Position = **new** Vector2(Position.x, Position.y),

Rotation = Rotation,

Velocity = **new** Vector2(Velocity.x, Velocity.y),

AngularVelocity = AngularVelocity,

InvMass = InvMass,

InvInertia = InvInertia,

ColliderRadius = Collider.radius

};

**return** D;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Position = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

Rotation = Data.ReadFloat(),

Velocity = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

AngularVelocity = Data.ReadFloat(),

InvMass = Data.ReadFloat(),

InvInertia = Data.ReadFloat(),

ColliderRadius = Data.ReadFloat()

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Position = Data.Position;

Rotation = Data.Rotation;

Velocity = Data.Velocity;

AngularVelocity = Data.AngularVelocity;

InvMass = Data.InvMass;

InvInertia = Data.InvInertia;

Collider.radius = Data.ColliderRadius;

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Position = From.Position + (To.Position - From.Position) \* Time;

Rotation = From.Rotation + (To.Rotation - From.Rotation) \* Time;

Velocity = From.Velocity + (To.Velocity - From.Velocity) \* Time;

AngularVelocity = From.AngularVelocity + (To.AngularVelocity - From.AngularVelocity) \* Time;

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

Data From = (Data)FromData;

Position = From.Position + From.Velocity \* Time;

Rotation = From.Rotation + From.AngularVelocity \* Time;

}

}

}

**Assets/DZEngine/Entities/Components/DistanceJoint.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DeadZoneEngine.Entities.Components

{

**public** **struct** DistanceJointData

{

**public** PhysicalObject A;

**public** PhysicalObject B;

**public** **float** Distance;

**public** Vector2 Anchor;

**public** DistanceJointData(PhysicalObject A, PhysicalObject B, **float** Distance, Vector2 Anchor)

{

**this**.A = A;

**this**.B = B;

**this**.Distance = Distance;

**this**.Anchor = Anchor;

}

}

**public** **class** DistanceJoint : PhysicalJoint

{

PhysicalObject A;

PhysicalObject B;

Mat22 M; //Rotation Matrix

Vector2 LocalAnchorA; //Anchor Points

Vector2 LocalAnchorB;

Vector2 RA; //Relative Anchor position on Body A

Vector2 RB; //Relative Anchor position on Body B

Vector2 Bias; //Bias in Impulse equation

Vector2 AccumulatedImpulse; //stores accumulated Impulse

**public** **float** Relaxation = 1f;

//Strength of pull on object A and B

**public** **float** ARatio = 1;

**public** **float** BRatio = 1;

**float** Distance;

Vector2 Anchor;

**public** DistanceJoint()

{

}

**public** DistanceJoint(**ushort** ID) : **base**(ID)

{

}

**public** **void** Set(**object** Data)

{

DistanceJointData DistanceJointWrapper = (DistanceJointData)Data;

Distance = DistanceJointWrapper.Distance;

Anchor = DistanceJointWrapper.Anchor;

A = DistanceJointWrapper.A;

B = DistanceJointWrapper.B;

//Compute Anchor information (rotation matrices)

Mat22 RotA = **new** Mat22(0);

Mat22 RotB = **new** Mat22(0);

Mat22 RotAT = RotA.Transpose();

Mat22 RotBT = RotB.Transpose();

LocalAnchorA = RotAT \* (Anchor);

LocalAnchorB = RotBT \* (Anchor - **new** Vector2(Distance, 0));

Relaxation = 1.0f;

}

**public** **void** SetDistance(**float** Distance)

{

**this**.Distance = Distance;

Mat22 RotA = **new** Mat22(0);

Mat22 RotB = **new** Mat22(0);

Mat22 RotAT = RotA.Transpose();

Mat22 RotBT = RotB.Transpose();

LocalAnchorA = RotAT \* (Anchor);

LocalAnchorB = RotBT \* (Anchor - **new** Vector2(Distance, 0));

}

**public** **override** **void** PreUpdate()

{

//Pre-compute anchors, mass matrix, and bias => http://twvideo01.ubm-us.net/o1/vault/gdc09/slides/04-GDC09\_Catto\_Erin\_Solver.pdf

**if** (A.Position == B.Position)

A.Position += **new** Vector2(0.01f, 0);

//Same as using atan2(A.Position - B.Position) however faster as skips atan2 math => this is just getting the current angle between the two objects A and B

Mat22 RotA = **new** Mat22((A.Position - B.Position).normalized);

Mat22 RotB = **new** Mat22((B.Position - A.Position).normalized);

/\*Mat22 RotA = new Mat22(A.Rotation); // This is for conserving rotation of connected blocks

            Mat22 RotB = new Mat22(B.Rotation);\*/

**float** AInvMass = A.InvMass \* ARatio;

**float** BInvMass = B.InvMass \* BRatio;

**float** AInvInertia = A.InvInertia \* ARatio;

**float** BInvInertia = B.InvInertia \* BRatio;

RA = RotA \* LocalAnchorA;

RB = RotB \* LocalAnchorB;

Mat22 K1;

K1.Col1.x = AInvMass + BInvMass; K1.Col2.x = 0.0f;

K1.Col1.y = 0.0f; K1.Col2.y = AInvMass + BInvMass;

Mat22 K2;

K2.Col1.x = AInvInertia \* RA.y \* RA.y; K2.Col2.x = -AInvInertia \* RA.x \* RA.y;

K2.Col1.y = -AInvInertia \* RA.x \* RA.y; K2.Col2.y = AInvInertia \* RA.x \* RA.x;

Mat22 K3;

K3.Col1.x = BInvInertia \* RB.y \* RB.y; K3.Col2.x = -BInvInertia \* RB.x \* RB.y;

K3.Col1.y = -BInvInertia \* RB.x \* RB.y; K3.Col2.y = BInvInertia \* RB.x \* RB.x;

Mat22 K = K1 + K2 + K3;

M = K.Invert();

Vector2 p1 = A.Position + RA;

Vector2 p2 = B.Position + RB;

Vector2 dp = p2 - p1;

Bias = -0.1f \* DZEngine.InvDeltaTime \* dp;

//Apply accumulated impulse

AccumulatedImpulse \*= Relaxation;

A.Velocity -= AInvMass \* AccumulatedImpulse;

A.AngularVelocity -= AInvInertia \* Math2D.Cross(RA, AccumulatedImpulse);

B.Velocity += BInvMass \* AccumulatedImpulse;

B.AngularVelocity += BInvInertia \* Math2D.Cross(RB, AccumulatedImpulse);

}

**public** **override** **void** IteratedUpdate()

{

Vector2 RelativeDeltaVelocity = B.Velocity + Math2D.Cross(B.AngularVelocity, RB) - A.Velocity - Math2D.Cross(A.AngularVelocity, RA);

Vector2 Impulse = M \* (-RelativeDeltaVelocity + Bias);

A.Velocity -= A.InvMass \* ARatio \* Impulse;

A.AngularVelocity -= A.InvInertia \* ARatio \* Math2D.Cross(RA, Impulse);

B.Velocity += B.InvMass \* BRatio \* Impulse;

B.AngularVelocity += B.InvInertia \* BRatio \* Math2D.Cross(RB, Impulse);

AccumulatedImpulse += Impulse;

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Distance));

Data.AddRange(BitConverter.GetBytes(Anchor.x));

Data.AddRange(BitConverter.GetBytes(Anchor.y));

Data.AddRange(BitConverter.GetBytes(ARatio));

Data.AddRange(BitConverter.GetBytes(BRatio));

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

Data D = (Data)ParseBytesToData(Data);

ParseSnapshot(D);

}

**public** **struct** Data

{

**public** **float** Distance;

**public** Vector2 Anchor;

**public** **float** ARatio;

**public** **float** BRatio;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Distance = Distance,

Anchor = Anchor,

ARatio = ARatio,

BRatio = BRatio

};

}

**public** **static** **object** ParseBytesToData(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Distance = Data.ReadFloat(),

Anchor = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

ARatio = Data.ReadFloat(),

BRatio = Data.ReadFloat()

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Distance = Data.Distance;

Anchor = Data.Anchor;

ARatio = Data.ARatio;

BRatio = Data.BRatio;

SetDistance(Distance);

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Distance = From.Distance + (To.Distance - From.Distance) \* Time;

ARatio = From.ARatio + (To.ARatio - From.ARatio) \* Time;

BRatio = From.BRatio + (To.BRatio - From.BRatio) \* Time;

SetDistance(Distance);

}

**public** **override** **void** Extrapolate(**object** FromData, **float** Time)

{

Data From = (Data)FromData;

Distance = From.Distance;

ARatio = From.ARatio;

BRatio = From.BRatio;

SetDistance(Distance);

}

}

}

**Assets/DZEngine/Entities/Components/  
AbstractWorldEntity.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DeadZoneEngine.Entities

{

**public** **class** EntityID

{

**public** **static** Dictionary<**ushort**, \_IInstantiatableDeletable> IDToObject = **new** Dictionary<**ushort**, \_IInstantiatableDeletable>();

**public** **static** **ushort** StaticID = 0;

**public** AbstractWorldEntity Self { **get**; **private** **set**; }

**public** **ushort** Value { **get**; **private** **set**; }

**public** EntityID(AbstractWorldEntity Self)

{

**this**.Self = Self;

AssignNewID();

}

**public** EntityID(AbstractWorldEntity Self, **ushort** ID)

{

**this**.Self = Self;

**if** (IDToObject.ContainsKey(ID))

{

Debug.LogError("EntityID(ulong ID) => ID " + ID + " already exists!");

**return**;

}

Value = ID;

IDToObject.Add(Value, Self);

}

**private** **void** AssignNewID()

{

**ushort** Next = StaticID++;

**if** (IDToObject.Count >= **ushort**.MaxValue - 100)

{

Debug.LogError("No more IDs to give!");

**return**;

}

**while** (IDToObject.ContainsKey(Next))

{

Next = StaticID++;

}

Value = Next;

IDToObject.Add(Value, Self);

}

**public** **void** ChangeID()

{

Remove(**this**);

AssignNewID();

}

**public** **void** ChangeID(**ushort** New, **bool** Replace = **false**)

{

**if** (IDToObject.ContainsKey(New))

{

**if** (IDToObject[New] != Self)

{

**if** (Replace)

{

DZEngine.Destroy(IDToObject[New]);

IDToObject[New] = Self;

}

**else**

{

Debug.LogError("Could not change ID as an object at that ID already exists...");

}

}

}

**else**

{

IDToObject.Add(New, IDToObject[Value]);

Remove(**this**);

}

Value = New;

}

**public** **static** **void** Remove(EntityID ID)

{

**if** (IDToObject.ContainsKey(ID))

{

IDToObject.Remove(ID);

}

**else**

Debug.LogError("EntityID.Remove(EntityID ID) => ID " + ID + " does not exist!");

}

**public** **static** \_IInstantiatableDeletable GetObject(**ushort** ID)

{

**if** (IDToObject.ContainsKey(ID))

**return** IDToObject[ID];

**return** **null**;

}

**public** **static** **bool** Exists(**ushort** ID)

{

**return** IDToObject.ContainsKey(ID);

}

**public** **static** **implicit** **operator** **ushort**(EntityID ID)

{

**return** ID.Value;

}

**public** **override** **bool** Equals(**object** Obj)

{

**return** Obj **is** EntityID && **this** == (EntityID)Obj;

}

**public** **override** **int** GetHashCode()

{

**return** Value.GetHashCode();

}

**public** **static** **bool** **operator** ==(EntityID A, EntityID B)

{

**if** (ReferenceEquals(A, **null**) && ReferenceEquals(B, **null**))

**return** **true**;

**else** **if** (ReferenceEquals(A, **null**) || ReferenceEquals(B, **null**))

**return** **false**;

**return** A.Value == B.Value;

}

**public** **static** **bool** **operator** !=(EntityID A, EntityID B)

{

**if** (ReferenceEquals(A, **null**) && ReferenceEquals(B, **null**))

**return** **false**;

**else** **if** (ReferenceEquals(A, **null**) || ReferenceEquals(B, **null**))

**return** **true**;

**return** A.Value != B.Value;

}

}

**public** **abstract** **class** AbstractWorldEntity : \_IInstantiatableDeletable

{

**public** EntityID ID { **get**; **set**; } = **null**;

**public** AbstractWorldEntity()

{

**if** (**this** **is** IServerSendable)

ID = **new** EntityID(**this**);

DZEngine.Instantiate(**this**);

}

**public** AbstractWorldEntity(**ushort** ID)

{

**if** (**this** **is** IServerSendable)

**this**.ID = **new** EntityID(**this**, ID);

DZEngine.Instantiate(**this**);

}

**public** **bool** Active { **get**; **set**; } = **true**;

**public** **bool** PhysicallyActive { **get**; **set**; } = !DZSettings.Client;

**public** **bool** FlaggedToDelete { **get**; **set**; } = **false**;

**public** **bool** Disposed { **get**; **set**; } = **false**;

**public** **virtual** **void** Instantiate() { }

**public** **object** Create()

{

OnCreate();

**return** **this**;

}

**protected** **virtual** **void** OnCreate() { }

**public** **void** Delete()

{

FlaggedToDelete = **true**;

**if** (ID != **null**)

EntityID.Remove(ID);

OnDelete();

}

**protected** **virtual** **void** OnDelete() { }

**public** **abstract** **byte**[] GetBytes();

**public** **abstract** **object** GetSnapshot();

**public** **abstract** **void** ParseBytes(DZNetwork.Packet Data);

**public** **abstract** **void** ParseSnapshot(**object** ObjectData);

**public** **abstract** **void** Interpolate(**object** FromData, **object** ToData, **float** Time);

**public** **abstract** **void** Extrapolate(**object** FromData, **float** Time);

}

}

**Assets/DZEngine/Entities/Components/  
PhysicalJoint.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** DeadZoneEngine.Entities

{

**public** **abstract** **class** PhysicalJoint : AbstractWorldEntity, IIteratableUpdatable

{

**public** PhysicalJoint() { }

**public** PhysicalJoint(**ushort** ID) : **base**(ID) { }

**public** **virtual** **void** PreUpdate() { }

**public** **virtual** **void** IteratedUpdate() { }

}

}

**Assets/DZEngine/Entities/Components/  
PhysicalObject.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DeadZoneEngine.Entities

{

**public** **abstract** **class** PhysicalObject : AbstractWorldEntity, IPhysicsUpdatable

{

**public** GameObject Self;

**public** AbstractWorldEntity Parent;

**protected** Rigidbody2D RB;

**public** PhysicalObject()

{

Self = **new** GameObject();

RB = Self.AddComponent<Rigidbody2D>();

RB.angularDrag = 0;

RB.drag = 0;

RB.gravityScale = 0;

RB.sharedMaterial = Resources.Load<PhysicsMaterial2D>("PhysicsMaterial/Zero");

RB.interpolation = RigidbodyInterpolation2D.None;

RB.isKinematic = DZSettings.Client;

}

**public** PhysicalObject(**ushort** ID) : **base**(ID)

{

Self = **new** GameObject();

RB = Self.AddComponent<Rigidbody2D>();

RB.angularDrag = 0;

RB.drag = 0;

RB.gravityScale = 0;

RB.sharedMaterial = Resources.Load<PhysicsMaterial2D>("PhysicsMaterial/Zero");

RB.interpolation = RigidbodyInterpolation2D.None;

RB.isKinematic = DZSettings.Client;

}

**protected** **override** **void** OnDelete()

{

GameObject.Destroy(Self);

}

**public** **void** PhysicsUpdate(**float** DeltaTime)

{

Self.transform.position += (Vector3)Velocity \* DeltaTime;

Self.transform.eulerAngles += **new** Vector3(0, 0, AngularVelocity) \* DeltaTime;

}

**public** **virtual** **void** FixedUpdate() { }

**public** **virtual** **void** Update() { }

**public** **virtual** **void** BodyPhysicsUpdate() { }

**private** Vector2 PreVelocity;

**public** **void** IsolateVelocity()

{

Vector2 Temp = PreVelocity;

PreVelocity = Velocity;

Velocity = Temp;

}

**public** **void** RestoreVelocity()

{

Vector2 Temp = Velocity;

Velocity = PreVelocity;

PreVelocity = Temp;

}

**public** **bool** Kinematic { **get** { **return** RB.isKinematic; } **set** { RB.isKinematic = value; } }

**public** **int** CollisionLayer { **get** { **return** Self.layer; } **set** { Self.layer = value; } }

**public** Vector2 Position { **get** { **return** Self.transform.position; } **set** { Self.transform.position = value; } }

**public** Vector2 Velocity { **get** { **return** RB.velocity; } **set** { RB.velocity = value; } }

**public** **float** Rotation { **get** { **return** Self.transform.eulerAngles.z \* Mathf.Deg2Rad; } **set** { Self.transform.eulerAngles = **new** Vector3(0, 0, value \* Mathf.Rad2Deg); } }

**public** **float** AngularVelocity { **get** { **return** RB.angularVelocity \* Mathf.Deg2Rad; } **set** { RB.angularVelocity = value \* Mathf.Rad2Deg; } }

**public** **float** \_InvMass = 0;

**public** **float** InvMass { **get** { **return** \_InvMass; } **set** { \_InvMass = value; **if** (\_InvMass == 0) RB.constraints |= RigidbodyConstraints2D.FreezePosition; **else** { RB.mass = 1 / \_InvMass; RB.constraints &= ~RigidbodyConstraints2D.FreezePosition; } } }

**public** **float** \_InvInertia = 0;

**public** **float** InvInertia { **get** { **return** \_InvInertia; } **set** { \_InvInertia = value; **if** (\_InvInertia == 0) RB.constraints |= RigidbodyConstraints2D.FreezeRotation; **else** { RB.inertia = 1 / \_InvInertia; RB.constraints &= ~RigidbodyConstraints2D.FreezeRotation; } } }

**public** **float** Gravity = 1;

}

}

**Assets/DZEngine/Entities/Components/  
UpdatableAndDeletable.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** DeadZoneEngine.Entities

{

**public** **interface** \_IInstantiatableDeletable

{

**bool** Active { **get**; **set**; }

**bool** FlaggedToDelete { **get**; **set**; }

**bool** Disposed { **get**; **set**; }

**void** Delete();

**void** Instantiate();

**object** Create();

}

**public** **interface** IServerSendable : \_IInstantiatableDeletable

{

EntityID ID { **get**; **set**; }

**int** ServerObjectType { **get**; **set**; }

**bool** RecentlyUpdated { **get**; **set**; }

**bool** ProtectedDeletion { **get**; **set**; }

**void** ServerUpdate();

**byte**[] GetBytes();

**object** GetSnapshot();

**void** ParseBytes(DZNetwork.Packet Data);

**void** ParseSnapshot(**object** Data);

**void** Interpolate(**object** FromData, **object** ToData, **float** Time);

**void** Extrapolate(**object** FromData, **float** Time);

}

**public** **interface** IRenderer : \_IInstantiatableDeletable

{

**int** SortingLayer { **get**; **set**; }

**void** InitializeRenderer();

**void** Render();

}

**public** **interface** IRenderer<T> : \_IInstantiatableDeletable, IRenderer where T : **class**

{

T RenderObject { **get**; **set**; }

}

**public** **interface** IUpdatable : \_IInstantiatableDeletable

{

**void** Update();

**void** BodyPhysicsUpdate();

}

**public** **interface** IPhysicsUpdatable : \_IInstantiatableDeletable

{

**bool** PhysicallyActive { **get**; **set**; }

**void** FixedUpdate();

**void** IsolateVelocity();

**void** RestoreVelocity();

}

**public** **interface** IIteratableUpdatable : \_IInstantiatableDeletable

{

**bool** PhysicallyActive { **get**; **set**; }

**void** PreUpdate();

**void** IteratedUpdate();

}

}

**Assets/DZEngine/DZEngine.cs**

**using** System;

**using** System.Collections;

**using** System.Collections.Generic;

**using** System.Collections.ObjectModel;

**using** System.Linq;

**using** System.Reflection;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**namespace** DeadZoneEngine

{

**public** **static** **class** DZEngine

{

**public** **static** **float** InvDeltaTime = 0; // 1 / DeltaTime of frame

/// <summary>

/// Called on startup

/// </summary>

**public** **static** **void** Initialize()

{

}

/// <summary>

/// Adds a given entity to a DZEngine.ManagedList if its of the correct type

/// </summary>

/// <typeparam name="T">ManagedList Type</typeparam>

/// <param name="List">List to append to</param>

/// <param name="Entity">Entity to append</param>

**private** **static** **void** AddIfContainsInterface<T>(**this** List<T> List, **object** Entity) where T : **class**

{

T Interface = Entity **as** T;

**if** (Interface != **null**)

List.Add(Interface);

}

/// <summary>

/// Calls relevant initialization functions and adds entity to DZEngine

/// </summary>

/// <param name="Entity"></param>

**private** **static** **void** InstantiateAndAddEntity(**object** Entity)

{

\_IInstantiatableDeletable Instantiatable = Entity **as** \_IInstantiatableDeletable;

Instantiatable?.Instantiate();

**if** (DZSettings.ActiveRenderers)

{

IRenderer Renderer = Entity **as** IRenderer;

Renderer?.InitializeRenderer();

}

\_AbstractWorldEntities.AddIfContainsInterface(Entity);

\_UpdatableObjects.AddIfContainsInterface(Entity);

\_PhysicsUpdatableObjects.AddIfContainsInterface(Entity);

\_IteratableUpdatableObjects.AddIfContainsInterface(Entity);

\_RenderableObjects.AddIfContainsInterface(Entity);

\_ServerSendableObjects.AddIfContainsInterface(Entity);

}

        #region DZEngine.ManagedList

**private** **static** HashSet<Type> ManagedListTypes = **new** HashSet<Type>(); //Contains all created managed lists

**private** **static** Dictionary<(Type, Type), Delegate> GetInvokeCache = **new** Dictionary<(Type, Type), Delegate>(); //Caching delegate functions used for calling relevant add functions

**private** **static** Dictionary<Type, (Delegate, Delegate)> GetManagedInvokeCache = **new** Dictionary<Type, (Delegate, Delegate)>(); //Caching delegate functions used for clearing and updating managed lists

/// <summary>

/// Invokes a given delegate on every item that contains the provided interface

/// </summary>

/// <typeparam name="SearchType">Interface the item should contain</typeparam>

/// <typeparam name="ListType">Type of list being checked</typeparam>

/// <param name="Method">Delegate to call</param>

/// <param name="List">List being checked</param>

**private** **static** **void** InvokeIfContainsInterface<SearchType, ListType>(Delegate Method, List<ListType> List) where SearchType : **class**

{

**for** (**int** i = 0; i < List.Count; i++)

{

SearchType Item = List[i] **as** SearchType;

**if** (Item != **null**)

{

((Action<SearchType>)Method)(Item);

}

}

}

/// <summary>

/// Returns the given delegate to add an item to a managed list

/// </summary>

/// <typeparam name="InvokeType">Type of list being invoked onto</typeparam>

/// <param name="T">Type of item</param>

/// <returns></returns>

**private** **static** Action<Delegate, List<InvokeType>> GetInvokeFromType<InvokeType>(Type T)

{

**var** Label = (T, **typeof**(InvokeType)); //Key for cache dictionary

**if** (GetInvokeCache.ContainsKey(Label)) //Check if it does not already exist

**return** (Action<Delegate, List<InvokeType>>)GetInvokeCache[Label]; //If so return cached delegate

//Find the right method to generate delegate from

MethodInfo Method = **typeof**(DZEngine).GetMethods(BindingFlags.NonPublic | BindingFlags.Static).Single(I => I.Name == nameof(DZEngine.InvokeIfContainsInterface));

//Generate delegate from method

Action<Delegate, List<InvokeType>> DelegateAction = (Action<Delegate, List<InvokeType>>)Delegate.CreateDelegate(**typeof**(Action<Delegate, List<InvokeType>>), Method.MakeGenericMethod(T, **typeof**(InvokeType)));

//Add delegate to cache

GetInvokeCache.Add(Label, DelegateAction);

**return** DelegateAction;

}

**private** **static** **void** UpdateManagedLists()

{

**foreach** (Type T **in** ManagedListTypes) //Loop through all existing managed lists

{

//Find the approapriate update and clear delegates for handling the lists

Delegate UpdateListMethod = **null**;

Delegate ClearListMethod = **null**;

**if** (GetManagedInvokeCache.ContainsKey(T))

{

UpdateListMethod = GetManagedInvokeCache[T].Item1;

ClearListMethod = GetManagedInvokeCache[T].Item2;

}

**else**

{

Type ActionGeneric = **typeof**(Action<>).MakeGenericType(T);

Type Generic = **typeof**(ManagedList<>).MakeGenericType(T);

MethodInfo UpdateListMethodInfo = Generic.GetMethod(nameof(ManagedList<**object**>.UpdateExistingLists));

MethodInfo ClearListMethodInfo = Generic.GetMethod(nameof(ManagedList<**object**>.ClearExistingLists));

UpdateListMethod = Delegate.CreateDelegate(ActionGeneric, UpdateListMethodInfo);

ClearListMethod = Delegate.CreateDelegate(**typeof**(Action), ClearListMethodInfo);

GetManagedInvokeCache.Add(T, (UpdateListMethod, ClearListMethod));

}

((Action)ClearListMethod)(); //Clear the managed list of items

//Update the managed list with new items

GetInvokeFromType<AbstractWorldEntity>(T)(UpdateListMethod, \_AbstractWorldEntities);

GetInvokeFromType<IPhysicsUpdatable>(T)(UpdateListMethod, \_PhysicsUpdatableObjects);

GetInvokeFromType<IUpdatable>(T)(UpdateListMethod, \_UpdatableObjects);

GetInvokeFromType<IIteratableUpdatable>(T)(UpdateListMethod, \_IteratableUpdatableObjects);

GetInvokeFromType<IRenderer>(T)(UpdateListMethod, \_RenderableObjects);

GetInvokeFromType<IServerSendable>(T)(UpdateListMethod, \_ServerSendableObjects);

}

}

/// <summary>

/// Defines a list that is automatically updated to contain all entities of type T assigned to DZEngine

/// This is useful for simply getting a list of specific IRender<>

/// </summary>

/// <typeparam name="T">Type of entity</typeparam>

**public** **class** ManagedList<T> : HashSet<T> where T : **class**

{

**public** **static** List<WeakReference> ExistingLists = **new** List<WeakReference>();

**public** ManagedList()

{

//Keep track of all existing managed lists with weak references to allow Garbage Collection (GC)

ExistingLists.Add(**new** WeakReference(**this**));

//Add Type that is being managed to type list

ManagedListTypes.Add(**typeof**(T));

}

/// <summary>

/// Removes lists that have been cleaned up by GC

/// </summary>

**public** **static** **void** ClearExistingLists()

{

ExistingLists.RemoveAll(I =>

{

**if** (I.IsAlive)

{

ManagedList<T> L = (ManagedList<T>)I.Target;

L.Clear();

**return** **false**;

}

**return** **true**;

});

}

/// <summary>

/// Adds a new item to all lists of type T

/// </summary>

/// <param name="Item"></param>

**public** **static** **void** UpdateExistingLists(T Item)

{

**for** (**int** i = 0; i < ExistingLists.Count; i++)

{

ManagedList<T> L = (ManagedList<T>)ExistingLists[i].Target;

L.Add(Item);

}

}

}

        #endregion

**public** **static** **void** Instantiate(**object** Item)

{

EntitiesToPush.Add(Item);

}

**private** **static** List<**object**> EntitiesToPush = **new** List<**object**>(); //List of entities to push to DZEngine

//Lists of entity interfaces that define DZEngine

**private** **static** List<IServerSendable> \_ServerSendableObjects = **new** List<IServerSendable>(); //All entities that are sendable across the server and client

**private** **static** List<AbstractWorldEntity> \_AbstractWorldEntities = **new** List<AbstractWorldEntity>(); //All abstract world entities

**private** **static** List<IPhysicsUpdatable> \_PhysicsUpdatableObjects = **new** List<IPhysicsUpdatable>(); //All objects that use the seperate (isolated) physics loop

**private** **static** List<IUpdatable> \_UpdatableObjects = **new** List<IUpdatable>(); //All objects that use the standard update loop

**private** **static** List<IIteratableUpdatable> \_IteratableUpdatableObjects = **new** List<IIteratableUpdatable>(); //All objects that use the impulse engine

**private** **static** List<IRenderer> \_RenderableObjects = **new** List<IRenderer>(); //All objects that have a renderer

/// <summary>

/// Destroys an entity

/// </summary>

/// <param name="Item"></param>

**public** **static** **void** Destroy(\_IInstantiatableDeletable Item)

{

Item.FlaggedToDelete = **true**;

}

/// <summary>

/// Adds an unmanaged entity (not of type AbstractWorldEntity), these are called components

/// </summary>

/// <param name="Component"></param>

**public** **static** **void** AddComponent(\_IInstantiatableDeletable Component)

{

EntitiesToPush.Add(Component);

}

//public getters for lists

**public** **static** ReadOnlyCollection<IServerSendable> ServerSendableObjects { **get** { **return** \_ServerSendableObjects.AsReadOnly(); } }

**public** **static** ReadOnlyCollection<AbstractWorldEntity> AbstractWorldEntities { **get** { **return** \_AbstractWorldEntities.AsReadOnly(); } }

**public** **static** ReadOnlyCollection<IPhysicsUpdatable> PhysicsUpdatableObjects { **get** { **return** \_PhysicsUpdatableObjects.AsReadOnly(); } }

**public** **static** ReadOnlyCollection<IUpdatable> UpdatableObjects { **get** { **return** \_UpdatableObjects.AsReadOnly(); } }

**public** **static** ReadOnlyCollection<IIteratableUpdatable> IteratableUpdatableObjects { **get** { **return** \_IteratableUpdatableObjects.AsReadOnly(); } }

**public** **static** ReadOnlyCollection<IRenderer> RenderableObjects { **get** { **return** \_RenderableObjects.AsReadOnly(); } }

/// <summary>

/// Releases and disposes of all entities and their managed resources

/// </summary>

**public** **static** **void** ReleaseResources()

{

EntitiesToPush.RemoveAll(I =>

{

InstantiateAndAddEntity(I);

**return** **true**;

});

\_ServerSendableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

\_AbstractWorldEntities.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

\_PhysicsUpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

\_UpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

\_IteratableUpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

\_RenderableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I, **true**);

});

}

/// <summary>

/// Checks the deletion of an object

/// </summary>

/// <param name="DeletableObject">Object to delete</param>

/// <param name="ForceDelete">Force delete the object regardless</param>

/// <returns>true if object was disposed, otherwise false</returns>

**private** **static** **bool** DeleteHandle(\_IInstantiatableDeletable DeletableObject, **bool** ForceDelete = **false**)

{

**if** (DeletableObject.FlaggedToDelete || ForceDelete) //Check if the object is flagged to delete or is forced to delete

{

**if** (!DeletableObject.Disposed) //If the object has not already been disposed the perform delete

{

DeletableObject.Disposed = **true**;

DeletableObject.Delete();

}

**return** **true**;

}

**return** **false**;

}

/// <summary>

/// Gets the bytes of a given entity

/// </summary>

/// <param name="Item"></param>

/// <returns></returns>

**public** **static** **byte**[] GetBytes(IServerSendable Item)

{

//Header Contents => EntityID, FlaggedToDelete, EntityType

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Item.ID));

Data.AddRange(BitConverter.GetBytes(Item.FlaggedToDelete));

//Provide actual data if the item is not about to be deleted

//otherwise this data is redundant

**if** (!Item.FlaggedToDelete)

{

Data.AddRange(BitConverter.GetBytes(Item.ServerObjectType));

Data.AddRange(Item.GetBytes());

}

**return** Data.ToArray();

}

**public** **static** **void** NonPhysicsUpdate()

{

//Push entites into DZEngine

EntitiesToPush.RemoveAll(I =>

{

InstantiateAndAddEntity(I);

**return** **true**;

});

//Remove deleted AbstractWorldEntities

\_AbstractWorldEntities.RemoveAll(I =>

{

**return** DeleteHandle(I);

});

//Remove deleted server entites

\_ServerSendableObjects.RemoveAll(I =>

{

I.RecentlyUpdated = **false**;

I.ServerUpdate();

**return** DeleteHandle(I);

});

//Isolate the general physics updates from creature body physics -> this is specific for maintaining physic objects inside of creature bodies

//(the creature body is updated relative to itself without the need to worry about countering general physics (its isolated from general physics))

\_PhysicsUpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I);

});

\_UpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I);

});

//Check and resolve physics constraints from impulse engine

\_IteratableUpdatableObjects.RemoveAll(I =>

{

**return** DeleteHandle(I);

});

//Render renderable entities

\_RenderableObjects.RemoveAll(I =>

{

**if** (!I.FlaggedToDelete && I.Active)

{

**if** (DZSettings.ActiveRenderers)

I.Render();

}

**return** DeleteHandle(I);

});

UpdateManagedLists(); //Update DZEngine.ManagedLists

}

**public** **static** **void** PhysicsUpdate()

{

InvDeltaTime = Game.ServerTickRate;

//Isolate the general physics updates from creature body physics -> this is specific for maintaining physic objects inside of creature bodies

//(the creature body is updated relative to itself without the need to worry about countering general physics (its isolated from general physics))

**for** (**int** i = 0; i < \_PhysicsUpdatableObjects.Count; i++)

{

**if** (\_PhysicsUpdatableObjects[i].Active && \_PhysicsUpdatableObjects[i].PhysicallyActive)

\_PhysicsUpdatableObjects[i].IsolateVelocity();

}

**for** (**int** i = 0; i < \_UpdatableObjects.Count; i++)

{

**if** (\_UpdatableObjects[i].Active)

\_UpdatableObjects[i].BodyPhysicsUpdate(); //This is specific to entites mainly to update self-righting bodies or other body animation specific physics

//its seperated and run in a seperate physics operation to prevent self-righting body physics from being counteracted from normal physics (such as gravity).

//In other words this simply isolates the body physics from the standard physics

}

//Check and resolve physics constraints from impulse engine

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (!\_IteratableUpdatableObjects[i].FlaggedToDelete && \_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

{

\_IteratableUpdatableObjects[i].PreUpdate();

}

}

**for** (**int** j = 0; j < DZSettings.NumPhysicsIterations; j++)

{

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].IteratedUpdate();

}

}

Physics2D.Simulate(Time.fixedDeltaTime / 2);

//Restore the velocities back to normal, we are no longer considering the entity in an isolated system

**for** (**int** i = 0; i < \_PhysicsUpdatableObjects.Count; i++)

{

**if** (\_PhysicsUpdatableObjects[i].Active && \_PhysicsUpdatableObjects[i].PhysicallyActive)

{

\_PhysicsUpdatableObjects[i].RestoreVelocity();

\_PhysicsUpdatableObjects[i].FixedUpdate();

}

}

//Update updatable entities

**for** (**int** i = 0; i < \_UpdatableObjects.Count; i++)

{

**if** (\_UpdatableObjects[i].Active)

\_UpdatableObjects[i].Update();

}

//Check and resolve physics constraints from impulse engine

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].PreUpdate();

}

**for** (**int** j = 0; j < DZSettings.NumPhysicsIterations; j++)

{

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].IteratedUpdate();

}

}

Physics2D.Simulate(Time.fixedDeltaTime / 2);

}

/// <summary>

/// Called once per frame

/// </summary>

**public** **static** **void** FixedUpdate()

{

InvDeltaTime = Game.ServerTickRate;

//Push entites into DZEngine

EntitiesToPush.RemoveAll(I =>

{

InstantiateAndAddEntity(I);

**return** **true**;

});

//Remove deleted AbstractWorldEntities

\_AbstractWorldEntities.RemoveAll(I =>

{

**return** DeleteHandle(I);

});

//Remove deleted server entites

\_ServerSendableObjects.RemoveAll(I =>

{

I.RecentlyUpdated = **false**;

I.ServerUpdate();

**return** DeleteHandle(I);

});

//Isolate the general physics updates from creature body physics -> this is specific for maintaining physic objects inside of creature bodies

//(the creature body is updated relative to itself without the need to worry about countering general physics (its isolated from general physics))

\_PhysicsUpdatableObjects.RemoveAll(I =>

{

**if** (!I.FlaggedToDelete && I.Active && I.PhysicallyActive)

{

I.IsolateVelocity();

}

**return** DeleteHandle(I);

});

\_UpdatableObjects.RemoveAll(I =>

{

**if** (!I.FlaggedToDelete && I.Active)

{

I.BodyPhysicsUpdate(); //This is specific to entites mainly to update self-righting bodies or other body animation specific physics

//its seperated and run in a seperate physics operation to prevent self-righting body physics from being counteracted from normal physics (such as gravity).

//In other words this simply isolates the body physics from the standard physics

}

**return** DeleteHandle(I);

});

//Check and resolve physics constraints from impulse engine

\_IteratableUpdatableObjects.RemoveAll(I =>

{

**if** (!I.FlaggedToDelete && I.Active && I.PhysicallyActive)

{

I.PreUpdate();

}

**return** DeleteHandle(I);

});

**for** (**int** j = 0; j < DZSettings.NumPhysicsIterations; j++)

{

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].IteratedUpdate();

}

}

Physics2D.Simulate(Time.fixedDeltaTime / 2f);

//Restore the velocities back to normal, we are no longer considering the entity in an isolated system

**for** (**int** i = 0; i < \_PhysicsUpdatableObjects.Count; i++)

{

**if** (\_PhysicsUpdatableObjects[i].Active && \_PhysicsUpdatableObjects[i].PhysicallyActive)

{

\_PhysicsUpdatableObjects[i].RestoreVelocity();

\_PhysicsUpdatableObjects[i].FixedUpdate();

}

}

//Update updatable entities

**for** (**int** i = 0; i < \_UpdatableObjects.Count; i++)

{

**if** (\_UpdatableObjects[i].Active)

\_UpdatableObjects[i].Update();

}

//Check and resolve physics constraints from impulse engine

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].PreUpdate();

}

**for** (**int** j = 0; j < DZSettings.NumPhysicsIterations; j++)

{

**for** (**int** i = 0; i < \_IteratableUpdatableObjects.Count; i++)

{

**if** (\_IteratableUpdatableObjects[i].Active && \_IteratableUpdatableObjects[i].PhysicallyActive)

\_IteratableUpdatableObjects[i].IteratedUpdate();

}

}

Physics2D.Simulate(Time.fixedDeltaTime / 2f);

//Render renderable entities

\_RenderableObjects.RemoveAll(I =>

{

**if** (!I.FlaggedToDelete && I.Active)

{

**if** (DZSettings.ActiveRenderers)

I.Render();

}

**return** DeleteHandle(I);

});

UpdateManagedLists(); //Update DZEngine.ManagedLists

}

}

}

**Assets/DZEngine/Math2DExtensions.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**namespace** DeadZoneEngine

{

/// <summary>

/// Defines a 2x2 Matrix for transformations

/// </summary>

**public** **struct** Mat22

{

**public** Vector2 Col1;

**public** Vector2 Col2;

**public** Mat22(**float** Angle)

{

**float** C = Mathf.Cos(Angle);

**float** S = Mathf.Sin(Angle);

Col1.x = C; Col2.x = -S;

Col1.y = S; Col2.y = C;

}

**public** Mat22(Vector2 DirVector) //Dir Vector should be normalized

{

**float** C = DirVector.x;

**float** S = DirVector.y;

Col1.x = C; Col2.x = -S;

Col1.y = S; Col2.y = C;

}

**public** Mat22(Vector2 Col1, Vector2 Col2)

{

**this**.Col1 = Col1;

**this**.Col2 = Col2;

}

**public** Mat22 Transpose()

{

**return** **new** Mat22(**new** Vector2(Col1.x, Col2.x), **new** Vector2(Col1.y, Col2.y));

}

**public** Mat22 Invert()

{

**float** a = Col1.x, b = Col2.x, c = Col1.y, d = Col2.y;

Mat22 B;

**float** det = a \* d - b \* c;

det = 1.0f / det;

B.Col1.x = det\* d; B.Col2.x = -det\* b;

B.Col1.y = -det\* c; B.Col2.y = det\* a;

**return** B;

}

**public** **static** Vector2 **operator** \*(Mat22 A, Vector2 B)

{

**return** **new** Vector2(A.Col1.x \* B.x + A.Col2.x \* B.y, A.Col1.y \* B.x + A.Col2.y \* B.y);

}

**public** **static** Mat22 **operator** +(Mat22 A, Mat22 B)

{

**return** **new** Mat22(A.Col1 + B.Col1, A.Col2 + B.Col2);

}

}

/// <summary>

/// Defines additional Math functions

/// </summary>

**public** **class** Math2D

{

**public** **static** Vector2 Cross(Vector2 A, **float** B)

{

**return** **new** Vector2(B \* A.y, -B \* A.x);

}

**public** **static** Vector2 Cross(**float** A, Vector2 B)

{

**return** **new** Vector2(-A \* B.y, A \* B.x);

}

**public** **static** **float** Cross(Vector2 A, Vector2 B)

{

**return** A.x \* B.y - A.y \* B.x;

}

}

}

**Client/Assets/Templates/ClientHandle.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Net;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** UnityEngine.InputSystem;

**using** DeadZoneEngine;

**using** DZNetwork;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Controllers;

**namespace** ClientHandle

{

**public** **class** ClientID

{

**public** **static** Dictionary<**ushort**, Client> ConnectedClients = **new** Dictionary<**ushort**, Client>();

**public** **static** Dictionary<IPEndPoint, **ushort**> EndPointToID = **new** Dictionary<IPEndPoint, **ushort**>(**new** IPEndPointComparer());

**private** **static** **ushort** StaticID = 0;

**public** Client Self { **get**; **private** **set**; }

**public** IPEndPoint EndPoint { **get**; **private** **set**; }

**private** **ushort** Value;

**public** **ushort** ID

{

**get**

{

**return** Value;

}

**private** **set**

{

Value = value;

**if** (EndPoint != **null**)

**if** (EndPointToID.ContainsKey(EndPoint))

EndPointToID[EndPoint] = Value;

**else**

EndPointToID.Add(EndPoint, Value);

}

}

**public** ClientID(Client Self, IPEndPoint EndPoint)

{

**this**.Self = Self;

**this**.EndPoint = EndPoint;

AssignNewID();

}

**public** **static** Client GetClient(IPEndPoint EndPoint)

{

**if** (EndPoint == **null**)

**return** **null**;

**if** (EndPointToID.ContainsKey(EndPoint))

**if** (ConnectedClients.ContainsKey(EndPointToID[EndPoint]))

**return** ConnectedClients[EndPointToID[EndPoint]];

**return** **null**;

}

**public** **static** Client GetClient(**ushort** ID)

{

**if** (ConnectedClients.ContainsKey(ID))

**return** ConnectedClients[ID];

**return** **null**;

}

**private** **void** AssignNewID()

{

**ushort** Next = StaticID++;

**if** (ConnectedClients.Count >= **ushort**.MaxValue - 100)

{

Debug.LogError("No more IDs to give!");

**return**;

}

**while** (ConnectedClients.ContainsKey(Next))

{

Next = StaticID++;

}

ID = Next;

ConnectedClients.Add(ID, Self);

}

**public** **void** ChangeID()

{

Remove(ID);

AssignNewID();

}

**public** **void** ChangeID(**ushort** New, **bool** Replace = **false**)

{

**if** (ConnectedClients.ContainsKey(New))

{

**if** (ConnectedClients[New] != Self)

{

**if** (Replace)

ConnectedClients[New] = Self;

**else**

Debug.LogError("Could not change ClientID as an object at that ClientID already exists...");

}

}

**else**

{

ConnectedClients.Add(New, Self);

Remove(ID);

}

ID = New;

}

**public** **static** **implicit** **operator** **ushort**(ClientID ID)

{

**return** ID.ID;

}

**public** **static** **void** Remove(**ushort** ID)

{

**if** (ConnectedClients.ContainsKey(ID))

{

**if** (ConnectedClients[ID].EndPoint != **null**)

EndPointToID.Remove(ConnectedClients[ID].EndPoint);

ConnectedClients.Remove(ID);

}

**else**

Debug.LogError("ClientID.Remove(ClientID ID) => ID " + ID + " does not exist!");

}

**public** **static** **void** Remove(IPEndPoint EndPoint)

{

**if** (EndPointToID.ContainsKey(EndPoint))

{

Remove(EndPointToID[EndPoint]);

}

**else**

Debug.LogError("ClientID.Remove(EndPoint EndPoint) => EndPoint does not exist!");

}

}

/// <summary>

/// Contains information on each player and which client they refer to

/// </summary>

**public** **class** Client

{

**public** **static** **int** MaxNumPlayers = 8;

**public** **const** **int** TicksToTimeout = 60;

**public** ClientID ID;

**public** IPEndPoint EndPoint;

**public** Player[] Players;

**public** **byte** NumPlayers { **get**; **private** **set**; }

**public** **bool** LostConnection = **false**;

**public** **int** TicksSinceConnectionLoss = 0;

**private** Client(IPEndPoint EndPoint = **null**)

{

**this**.EndPoint = EndPoint;

ID = **new** ClientID(**this**, EndPoint);

Players = **new** Player[MaxNumPlayers];

}

**public** **static** Client GetClient(IPEndPoint EndPoint = **null**)

{

Client Client = ClientID.GetClient(EndPoint);

**if** (Client == **null**)

{

Client = **new** Client(EndPoint);

}

**return** Client;

}

**public** Player AddPlayer()

{

**for** (**byte** i = 0; i < Players.Length; i++)

{

**if** (Players[i] == **null**)

{

Players[i] = **new** Player(i);

NumPlayers++;

**return** Players[i];

}

}

Debug.LogError("Max number of players reached");

**return** **null**;

}

**public** **void** RemovePlayer(**int** PlayerID)

{

**if** (Players[PlayerID] == **null**)

{

Debug.LogError("Player does not exist");

**return**;

}

Players[PlayerID].Destroy();

Players[PlayerID] = **null**;

NumPlayers--;

}

**public** **void** RemoveAllPlayers()

{

**for** (**int** i = 0; i < Players.Length; i++)

{

Players[i].Destroy();

Players[i] = **null**;

}

NumPlayers = 0;

}

**public** **void** Destroy()

{

ClientID.Remove(EndPoint);

**for** (**int** i = 0; i < Players.Length; i++)

**if** (Players[i] != **null**)

Players[i].Destroy();

}

}

**public** **class** Player

{

**public** **byte** ID { **get**; **private** **set**; }

**private** PlayerController \_Controller;

**public** PlayerController Controller

{

**get**

{

**return** \_Controller;

}

**set**

{

\_Controller = value;

\_Controller.Owner = **this**;

**if** (Entity != **null**)

{

\_Controller.PlayerControl = Entity.Controller;

Entity.Controller.Owner = \_Controller;

}

}

}

**public** PlayerCreature Entity;

**public** Player(**byte** ID)

{

Entity = **new** PlayerCreature();

Entity.ProtectedDeletion = **true**;

**this**.ID = ID;

}

**public** **void** Destroy()

{

DZEngine.Destroy(Entity);

**if** (\_Controller != **null**)

\_Controller.Disable();

}

**public** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.Add(ID);

Data.AddRange(BitConverter.GetBytes(Entity.ID));

**return** Data.ToArray();

}

}

}

**Assets/Utility/TriggerPlate.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DZNetwork;

**using** ClientHandle;

**public** **class** TriggerPlate : AbstractWorldEntity, IUpdatable, IRenderer, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.TriggerPlate;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** SortingLayer { **get**; **set**; }

**private** GameObject Self;

**private** SpriteRenderer Renderer;

**private** GameObject Bar;

**private** SpriteRenderer BarRenderer;

**public** Vector2 Size = **new** Vector2(1, 1);

**public** **float** Value = 0;

**public** **float** Incrementer = 0;

**public** **float** MaxValue = 10;

**public** **int** RequiredNumPlayers = 0;

**public** Action OnTrigger = **null**;

**public** Action<Player> OnInteract = **null**;

**public** TriggerPlate(**ushort** ID) : **base**(ID)

{

Init(**new** Vector2(0, 0));

}

**public** TriggerPlate(Vector2 Size, Vector2 Position, **int** RequiredNumPlayers = 0, **float** MaxValue = 10)

{

**this**.Size = Size;

**this**.MaxValue = MaxValue;

**this**.RequiredNumPlayers = RequiredNumPlayers;

Init(Position);

}

**private** **void** Init(Vector2 Position)

{

Self = **new** GameObject();

Self.transform.localScale = Size;

Self.transform.position = Position;

Bar = **new** GameObject();

Bar.transform.parent = Self.transform;

Bar.transform.localPosition = **new** Vector2(-1, 0);

}

**public** **void** InitializeRenderer()

{

Renderer = Self.AddComponent<SpriteRenderer>();

Renderer.sortingLayerName = "TriggerPlates";

Renderer.sortingOrder = 0;

Renderer.sprite = Resources.Load<Sprite>("Sprites/Square");

BarRenderer = Bar.AddComponent<SpriteRenderer>();

BarRenderer.sortingLayerName = "TriggerPlates";

BarRenderer.sortingOrder = 1;

BarRenderer.sprite = Resources.Load<Sprite>("Sprites/Square");

BarRenderer.color = **new** Color(0, 0.64f, 0.9f);

}

**public** **void** Render()

{

BarRenderer.transform.localPosition = **new** Vector2(-0.5f + Value / 2, 0);

BarRenderer.transform.localScale = **new** Vector2(Value, 0.9f);

}

**public** **void** ServerUpdate()

{

}

**private** **bool** CheckBound(Vector2 Pos)

{

**return** Pos.x > Self.transform.position.x - Self.transform.localScale.x / 2 &&

Pos.x < Self.transform.position.x + Self.transform.localScale.x / 2 &&

Pos.y > Self.transform.position.y - Self.transform.localScale.y / 2 &&

Pos.y < Self.transform.position.y + Self.transform.localScale.y / 2;

}

**private** **bool** CheckInBounds(Vector2 Position, **float** Margin)

{

**return** CheckBound(**new** Vector2(Position.x - Margin, Position.y - Margin)) ||

CheckBound(**new** Vector2(Position.x + Margin, Position.y + Margin)) ||

CheckBound(**new** Vector2(Position.x - Margin, Position.y + Margin)) ||

CheckBound(**new** Vector2(Position.x + Margin, Position.y - Margin));

}

**private** **bool** Triggered = **false**;

**private** Player LastPlayerTrigger = **null**;

**private** Client LastClientTrigger = **null**;

**public** **void** Update()

{

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**int** Count = 0;

**int** TotalNumPlayers = 0;

**foreach** (Client C **in** Clients)

{

**if** (C == **null**) **continue**;

TotalNumPlayers += C.NumPlayers;

**for** (**int** i = 0; i < C.Players.Length; i++)

{

**if** (C == LastClientTrigger && LastPlayerTrigger != **null** && i == LastPlayerTrigger.ID && C.Players[i] == **null**) LastPlayerTrigger = **null**;

**if** (C.Players[i] == **null** || C.Players[i].Entity == **null**) **continue**;

PlayerCreature Entity = C.Players[i].Entity;

**if** (CheckInBounds(Entity.Position, 0.5f))

{

Count++;

**if** (Entity.Controller.Interact > 0 && LastPlayerTrigger == **null**)

{

LastPlayerTrigger = C.Players[i];

LastClientTrigger = C;

OnInteract?.Invoke(C.Players[i]);

**if** (RequiredNumPlayers < 0)

{

Incrementer ++;

**if** (Incrementer > MaxValue)

{

Incrementer = 0;

}

Value = (**float**)Incrementer / MaxValue;

}

}

**else** **if** (Entity.Controller.Interact <= 0.1f && C.Players[i] == LastPlayerTrigger)

{

LastPlayerTrigger = **null**;

}

}

}

}

**if** (TotalNumPlayers > 0)

{

**if** (RequiredNumPlayers == 0 && Count == TotalNumPlayers)

{

Value += Time.fixedDeltaTime / 3;

}

**else** **if** (RequiredNumPlayers > 0 && Count >= RequiredNumPlayers)

{

Value += Time.fixedDeltaTime / 3;

}

**else** **if** (RequiredNumPlayers >= 0)

{

Value -= Time.fixedDeltaTime \* 2;

Triggered = **false**;

}

}

**if** (Value >= 1 && Triggered == **false**)

{

Triggered = **true**;

Value = 1;

OnTrigger?.Invoke();

}

**else** **if** (Value < 0)

Value = 0;

}

**public** **void** BodyPhysicsUpdate()

{

}

**protected** **override** **void** OnDelete()

{

GameObject.Destroy(Self);

GameObject.Destroy(Bar);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Self.transform.position.x));

Data.AddRange(BitConverter.GetBytes(Self.transform.position.y));

Data.AddRange(BitConverter.GetBytes(Size.x));

Data.AddRange(BitConverter.GetBytes(Size.y));

Data.AddRange(BitConverter.GetBytes(Mathf.Min(Value, 1)));

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(Packet Data)

{

ParseSnapshot(ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** Vector2 Position;

**public** Vector2 Size;

**public** **float** Value;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Position = Self.transform.position,

Size = Size,

Value = Value

};

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Position = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

Size = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

Value = Data.ReadFloat()

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Self.transform.position = Data.Position;

Size = Data.Size;

Value = Data.Value;

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Self.transform.position = From.Position + (To.Position - From.Position) \* Time;

Size = From.Size;

Value = From.Value + (To.Value - From.Value) \* Time;

}

}

**Assets/Utility/Tilemap.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** UnityEngine.UI;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** System.Text.RegularExpressions;

/// <summary>

/// Defines a tile of a tilemap

/// </summary>

**public** **struct** Tile

{

**public** **int** NumFrames; //Number of animation frames

**public** **int** AnimationFrame; //Animation frame index

**public** **int** TileIndex; //Which tile from tile pallet

**public** **int** Blank; //Is this tile blank?

**public** **int** Render; //Is this tile being rendered?

**public** Tile(**int** Blank = 0, **int** TileIndex = 0, **int** NumFrames = 1, **int** AnimationFrame = 0, **int** Render = 1)

{

**this**.TileIndex = TileIndex;

**this**.NumFrames = NumFrames;

**this**.AnimationFrame = AnimationFrame;

**this**.Blank = Blank;

**this**.Render = Render;

}

}

/// <summary>

/// Defines a tilepallet for a tilemap

/// </summary>

**public** **class** TilePallet

{

**public** **int** NumTiles; //Number of different tiles

**public** Texture2D Pallet; //Pallet

**public** **int** TileStride; //Number of pixels between tiles

**public** **int**[] FrameCount; //Number of animation frames for each tile

}

**public** **class** Tilemap : AbstractWorldEntity, IUpdatable, IRenderer, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.Tilemap;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** SortingLayer { **get**; **set**; }

//ComputeShaders for GPU for rendering wall and floor tilemaps

**private** ComputeShader WallCompute;

**private** ComputeShader FloorCompute;

**private** **int** ComputeKernel; //Kernel index of GPU function

**protected** GameObject Self;

**public** Tile[] FloorMap;

**public** Tile[] WallMap;

// Map format is height followed by width such that (0, 0) tile is the top left of the tilemap

// x

// ----->

// | [ 0 0 0 ]

// y | [ 0 0 0 ]

// v [ 0 0 0 ]

//

// This is to make rendering easier in the compute shader

//Buffers for wall and floor for passing tilemaps to GPU

ComputeBuffer WallBuffer;

ComputeBuffer FloorBuffer;

//Components for rendering to Unity

**private** RawImage FloorRender;

**private** RawImage[] Rows;

**private** RenderTexture WallRenderTexture;

**private** RenderTexture FloorRenderTexture;

//Tile pallets for wall and floor

**public** TilePallet WallTilePalletData;

**public** TilePallet FloorTilePalletData;

**private** **float** TilesPerUnit = 1; //Size of tiles in respect to a unity unit

**private** **int** TileDimension = 32; //Pixel width and height of tile

**private** **int** WallTileHeight = 32; //Pixel height of a wall tile

**private** Vector2Int TilemapSize; //Size of tilemap

**private** Vector2 TilemapWorldSize; //Size of tilemap in unity units

**private** **const** **float** ColliderMargin = 0.02f; //Margin for colliders (shrinks collider size by this value on each side)

**private** CompositeCollider2D CompositeCollider; //Composite collider for optimizing collisions

**private** BoxCollider2D[] ColliderMap; //Layout of colliders on tilemap

**private** List<BoxCollider2D> ColliderList; //List of colliders in use

**private** Rigidbody2D RB; //Rigidbody of tilemap

**public** Tilemap(**int** TileDimension, **int** WallTileHeight, Vector2Int TilemapSize, **float** TilesPerUnit = 1)

{

**this**.TileDimension = TileDimension;

**this**.WallTileHeight = WallTileHeight;

**this**.TilemapSize = TilemapSize;

**this**.TilesPerUnit = TilesPerUnit;

FloorMap = **new** Tile[TilemapSize.x \* TilemapSize.y];

WallMap = **new** Tile[TilemapSize.x \* TilemapSize.y];

Initialize();

}

**public** Tilemap(**ushort** ID) : **base**(ID)

{

TileDimension = 32;

WallTileHeight = 32;

TilemapSize = Vector2Int.zero;

TilesPerUnit = 1;

FloorMap = **new** Tile[TilemapSize.x \* TilemapSize.y];

WallMap = **new** Tile[TilemapSize.x \* TilemapSize.y];

Initialize();

}

**public** Tilemap(**int** TileDimension, **int** WallTileHeight, Vector2Int TilemapSize, Tile[] FloorMap, Tile[] WallMap, **float** TilesPerUnit = 1)

{

**this**.TileDimension = TileDimension;

**this**.WallTileHeight = WallTileHeight;

**this**.TilemapSize = TilemapSize;

**this**.TilesPerUnit = TilesPerUnit;

**this**.FloorMap = FloorMap;

**this**.WallMap = WallMap;

Initialize();

}

**public** Tilemap(**ushort** ID, **int** TileDimension, **int** WallTileHeight, Vector2Int TilemapSize, Tile[] FloorMap, Tile[] WallMap, **float** TilesPerUnit = 1) : **base**(ID)

{

**this**.TileDimension = TileDimension;

**this**.WallTileHeight = WallTileHeight;

**this**.TilemapSize = TilemapSize;

**this**.TilesPerUnit = TilesPerUnit;

**this**.FloorMap = FloorMap;

**this**.WallMap = WallMap;

Initialize();

}

**public** Vector2 TilemapToWorldPosition(Vector2Int Position)

{

**return** **new** Vector2

(

Self.transform.position.x - TilemapSize.x / 2f / TilesPerUnit + Position.x / TilesPerUnit + TilesPerUnit / 2,

Self.transform.position.y + TilemapSize.y / 2f / TilesPerUnit - Position.y / TilesPerUnit - TilesPerUnit / 2

);

}

**public** Vector2Int WorldPositionToTilemap(Vector2 Position)

{

**return** **new** Vector2Int

(

Mathf.RoundToInt(TilesPerUnit \* (Position.x - Self.transform.position.x + TilemapSize.x / 2f / TilesPerUnit - TilesPerUnit / 2)),

Mathf.RoundToInt(TilesPerUnit \* (Self.transform.position.y + TilemapSize.y / 2f / TilesPerUnit - Position.y - TilesPerUnit / 2))

);

}

**public** Tile GetFloorTileAtPosition(Vector2Int Position)

{

**return** FloorMap[Position.y \* TilemapSize.x + Position.x];

}

**public** Tile GetWallTileAtPosition(Vector2Int Position)

{

**return** FloorMap[Position.y \* TilemapSize.x + Position.x];

}

**public** **static** Tile[] TilesFromString(**string** TilesToParse)

{

List<Tile> Tiles = **new** List<Tile>();

**string** Formatted = Regex.Replace(TilesToParse, @"[ \n\r\t]", "");

**string**[] TileArray = TilesToParse.Split('/');

**for** (**int** i = 0; i < TileArray.Length; i++)

{

**string**[] Componenets = TileArray[i].Split(',');

Tiles.Add(**new** Tile()

{

TileIndex = **int**.Parse(Componenets[0]),

AnimationFrame = **int**.Parse(Componenets[1]),

Blank = **int**.Parse(Componenets[2]),

Render = **int**.Parse(Componenets[3])

});

}

**return** Tiles.ToArray();

}

/// <summary>

/// Resize tilemap to fit a new floor and wall map

/// </summary>

**public** **void** Resize(Vector2Int NewTilemapSize, Tile[] FloorMap, Tile[] WallMap)

{

UpdateResizeOverNetwork++;

**this**.FloorMap = FloorMap;

**this**.WallMap = WallMap;

**bool** SizeChange = NewTilemapSize != TilemapSize;

**if** (SizeChange) TilemapSize = NewTilemapSize;

**if** (DZSettings.ActiveRenderers && SizeChange)

GenerateRenders();

TilemapSize = NewTilemapSize;

GenerateColliders();

}

/// <summary>

/// Releases unused memory as tilemap caches textures and objects for reuse

/// </summary>

**public** **void** ReleaseUnusedResources()

{

ColliderList.RemoveAll(I =>

{

**if** (!I.enabled)

{

GameObject.Destroy(I);

**return** **true**;

}

**return** **false**;

});

**if** (Rows != **null**)

**if** (Rows.Length > TilemapSize.y)

{

**for** (**int** i = TilemapSize.y; i < Rows.Length; i++)

{

GameObject.Destroy(Rows[i].gameObject);

}

RawImage[] Temp = Rows;

Rows = **new** RawImage[TilemapSize.y];

System.Buffer.BlockCopy(Temp, 0, Rows, 0, TilemapSize.y);

}

Resources.UnloadUnusedAssets();

}

/// <summary>

/// Initializes base tilemap

/// </summary>

**private** **void** Initialize()

{

TilemapWorldSize = (Vector2)TilemapSize / TilesPerUnit;

ColliderMap = **new** BoxCollider2D[TilemapSize.x \* TilemapSize.y];

ColliderList = **new** List<BoxCollider2D>();

//Initialize GameObject

Self = **new** GameObject();

Self.name = "Tilemap";

//Initialize Collider objects

RB = Self.AddComponent<Rigidbody2D>();

RB.isKinematic = **true**;

CompositeCollider = Self.AddComponent<CompositeCollider2D>();

CompositeCollider.generationType = CompositeCollider2D.GenerationType.Manual;

}

**public** **void** InitializeRenderer() { }

**protected** **override** **void** OnCreate()

{

//Initialize colliders

GenerateColliders();

//Initialize renders

GenerateRenders();

}

**public** **void** ServerUpdate()

{

}

**public** **void** Update() { }

**public** **void** BodyPhysicsUpdate() { }

**private** Vector3 PrevTilePosition; //Store previous position of tilemap

**private** **void** UpdateRenderSortingLayers() //Updates the render sorting layer of each tile row

{

**if** (Rows == **null**) **return**;

PrevTilePosition = Self.transform.position;

**for** (**int** i = 0; i < TilemapSize.y; i++)

{

**float** StrideHeight = ((**float**)WallTileHeight / TileDimension) / TilesPerUnit;

**float** BaseY = Rows[i].transform.position.y - ((StrideHeight - 1 / TilesPerUnit) / 2);

Rows[i].canvas.sortingOrder = Mathf.RoundToInt(-(BaseY \* 10)) + 1;

}

}

**public** **void** Render()

{

**if** (PrevTilePosition != Self.transform.position) //Avoid updating all rows constantly has tilemaps can get quite large

UpdateRenderSortingLayers(); //Update the sorting layers for each tile row

//Generate textures to render

**if** (WallBuffer == **null** || FloorBuffer == **null** || WallCompute == **null** || FloorCompute == **null**)

**return**;

WallBuffer.SetData(WallMap);

WallCompute.Dispatch(ComputeKernel, TilemapSize.x / 4 + 1, TilemapSize.y / 4 + 1, 1);

FloorBuffer.SetData(FloorMap);

FloorCompute.Dispatch(ComputeKernel, TilemapSize.x / 4 + 1, TilemapSize.y / 4 + 1, 1);

}

/// <summary>

/// Assigns new tile pallets to tilemap

/// </summary>

**public** **void** SetTilePallet()

{

WallCompute.SetTexture(ComputeKernel, "TilePallet", WallTilePalletData.Pallet);

WallCompute.SetInt("TileStride", WallTilePalletData.TileStride);

WallCompute.SetInt("TilePalletCount", WallTilePalletData.NumTiles);

FloorCompute.SetTexture(ComputeKernel, "TilePallet", FloorTilePalletData.Pallet);

FloorCompute.SetInt("TileStride", FloorTilePalletData.TileStride);

FloorCompute.SetInt("TilePalletCount", FloorTilePalletData.NumTiles);

}

/// <summary>

/// Generates new composite colliders for a tilemap

/// </summary>

/// <param name="Truncate">If true, disposes of unused colliders</param>

**public** **virtual** **void** GenerateColliders(**bool** Truncate = **false**)

{

//Expand collider array if needed

**if** (ColliderMap.Length < TilemapSize.x \* TilemapSize.y)

ColliderMap = **new** BoxCollider2D[TilemapSize.x \* TilemapSize.y];

**int** ReuseIndex = 0; //Index of colliders to reuse

**int** FinalReuseIndex = 0; //Indicates the last collider that was reused

**int** NumCurrentColliders = ColliderList.Count; //Store the number of current colliders

**for** (**int** i = 0; i < TilemapSize.y; i++)

{

**for** (**int** j = 0; j < TilemapSize.x; j++)

{

**int** Index = i \* TilemapSize.x + j;

**if** (WallMap[Index].Blank == 0)

{

BoxCollider2D Collider = **null**;

**if** (FinalReuseIndex == 0 && ReuseIndex < NumCurrentColliders) //If there are colliders to reuse, reuse them

{

Collider = ColliderList[ReuseIndex];

ReuseIndex++;

}

**else** //Otherwise create new colliders

{

FinalReuseIndex = ReuseIndex;

Collider = Self.AddComponent<BoxCollider2D>();

ColliderList.Add(Collider);

}

//Position the colliders on the tilemap

Collider.enabled = **true**;

**float** Dimension = 1 / TilesPerUnit;

Collider.size = **new** Vector2(Dimension - ColliderMargin, Dimension - ColliderMargin);

Collider.offset = **new** Vector2(j / TilesPerUnit + Dimension / 2 - TilemapSize.x / 2f / TilesPerUnit,

-i / TilesPerUnit - Dimension / 2 + TilemapSize.y / 2f / TilesPerUnit);

Collider.usedByComposite = **true**;

ColliderMap[Index] = Collider;

}

}

}

**if** (Truncate) //If true, dispose of unused colliders

{

**for** (; ReuseIndex < NumCurrentColliders; ReuseIndex++)

{

GameObject.Destroy(ColliderList[ReuseIndex]);

}

ColliderList.RemoveRange(FinalReuseIndex, NumCurrentColliders - FinalReuseIndex);

}

**else** //Disable unused colliders but cache to reuse

**for** (; ReuseIndex < NumCurrentColliders; ReuseIndex++)

{

ColliderList[ReuseIndex].enabled = **false**;

}

CompositeCollider.GenerateGeometry();

}

/// <summary>

/// Generates new renders for rendering a different sized tilemap

/// </summary>

/// <param name="Truncate">If true, disposes of unused renders</param>

**private** **void** GenerateRenders(**bool** Truncate = **false**)

{

**if** (DZSettings.ActiveRenderers == **false**) **return**;

//Initialize Buffers

**if** (WallBuffer != **null**) WallBuffer.Dispose();

**if** (FloorBuffer != **null**) FloorBuffer.Dispose();

//Initialize compute shaders

**if** (WallCompute == **null**)

{

WallCompute = UnityEngine.Object.Instantiate(Resources.Load<ComputeShader>("ComputeShaders/TilemapComputeShader"));

ComputeKernel = WallCompute.FindKernel("TilemapRender");

}

**if** (FloorCompute == **null**)

{

FloorCompute = UnityEngine.Object.Instantiate(Resources.Load<ComputeShader>("ComputeShaders/TilemapComputeShader"));

ComputeKernel = WallCompute.FindKernel("TilemapRender");

}

//Set Tile Dimensions

WallCompute.SetInt("TileWidth", TileDimension);

WallCompute.SetInt("TileHeight", WallTileHeight);

FloorCompute.SetInt("TileWidth", TileDimension);

FloorCompute.SetInt("TileHeight", TileDimension);

//Set Map Dimensions

WallCompute.SetInt("MapWidth", TilemapSize.x);

WallCompute.SetInt("MapHeight", TilemapSize.y);

FloorCompute.SetInt("MapWidth", TilemapSize.x);

FloorCompute.SetInt("MapHeight", TilemapSize.y);

//Check TilePallets

**if** (WallTilePalletData == **null** || FloorTilePalletData == **null**)

{

Debug.LogWarning("WallTilePalletData or FloorTilePalletData is null, rendering default pallets...");

GenerateDefaultTileData();

}

//Set TilePallets

SetTilePallet();

//Set the buffers

**if** (WallBuffer != **null**)

WallBuffer.Dispose();

WallBuffer = **new** ComputeBuffer(WallMap.Length, **sizeof**(**int**) \* 5);

**if** (FloorBuffer != **null**)

FloorBuffer.Dispose();

FloorBuffer = **new** ComputeBuffer(FloorMap.Length, **sizeof**(**int**) \* 5);

WallCompute.SetBuffer(ComputeKernel, "Map", WallBuffer);

FloorCompute.SetBuffer(ComputeKernel, "Map", FloorBuffer);

//Create new textures if required

**if** (WallRenderTexture == **null**)

{

WallRenderTexture = **new** RenderTexture(TileDimension \* TilemapSize.x, WallTileHeight \* TilemapSize.y, 8)

{

enableRandomWrite = **true**,

filterMode = FilterMode.Point,

anisoLevel = 1

};

WallRenderTexture.Create();

WallCompute.SetTexture(ComputeKernel, "Result", WallRenderTexture);

}

**else** **if** (Truncate || WallRenderTexture.width < TilemapSize.x || WallRenderTexture.height < TilemapSize.y) //Truncate textures if option was true to release more memory

{

WallRenderTexture.Release();

WallRenderTexture.width = TilemapSize.x;

WallRenderTexture.height = TilemapSize.y;

WallRenderTexture.Create();

}

//Create new textures if required

**if** (FloorRenderTexture == **null**)

{

FloorRenderTexture = **new** RenderTexture(TileDimension \* TilemapSize.x, TileDimension \* TilemapSize.y, 8)

{

enableRandomWrite = **true**,

filterMode = FilterMode.Point,

anisoLevel = 1

};

FloorRenderTexture.Create();

FloorCompute.SetTexture(ComputeKernel, "Result", FloorRenderTexture);

}

**else** **if** (Truncate || FloorRenderTexture.width < TilemapSize.x || FloorRenderTexture.height < TilemapSize.y) //Truncate textures if option was true to release more memory

{

FloorRenderTexture.Release();

FloorRenderTexture.width = TilemapSize.x;

FloorRenderTexture.height = TilemapSize.y;

FloorRenderTexture.Create();

}

**if** (FloorRender == **null**) //Create a new render for the floor map if needed

{

Canvas FloorCanvas = Self.AddComponent<Canvas>();

FloorCanvas.renderMode = RenderMode.WorldSpace;

FloorCanvas.sortingLayerName = "Floor";

Self.AddComponent<CanvasScaler>();

Self.AddComponent<GraphicRaycaster>();

Self.GetComponent<RectTransform>().sizeDelta = Vector2.zero;

FloorRender = Self.AddComponent<RawImage>();

}

//Scale the floormap render

FloorRender.rectTransform.sizeDelta = **new** Vector2((**float**)TilemapSize.x / TilesPerUnit, (**float**)TilemapSize.y / TilesPerUnit);

FloorRender.material = Resources.Load<Material>("Materials/LitMaterial");

FloorRender.texture = FloorRenderTexture;

FloorRender.uvRect = **new** Rect(0, 0, (**float**)TileDimension \* TilemapSize.x / FloorRenderTexture.width, (**float**)TileDimension \* TilemapSize.y / FloorRenderTexture.height);

//Initialize row gameobjects

**int** CurrentLength = 0;

**if** (Rows == **null**)

Rows = **new** RawImage[TilemapSize.y];

**else**

CurrentLength = Rows.Length > TilemapSize.y ? TilemapSize.y : Rows.Length; //Get the number of rows to render for a given tilemap

**if** (Rows.Length < TilemapSize.y) //Resize array of rows if needed

{

RawImage[] Temp = Rows;

Rows = **new** RawImage[TilemapSize.y];

System.Buffer.BlockCopy(Temp, 0, Rows, 0, Temp.Length);

}

**int** i = 0;

**for** (; i < CurrentLength; i++) //Loop through number of rows that can be reused

{

Rows[i].rectTransform.sizeDelta = Vector2.zero;

**float** StrideHeight = ((**float**)WallTileHeight / TileDimension) / TilesPerUnit;

Rows[i].rectTransform.position = **new** Vector3(0, -TilemapSize.y / 2f / TilesPerUnit + StrideHeight / 2 + i / TilesPerUnit);

Rows[i].rectTransform.position += Self.transform.position;

Rows[i].rectTransform.sizeDelta = **new** Vector2(TilemapSize.x / TilesPerUnit, StrideHeight);

Rows[i].material = Resources.Load<Material>("Materials/LitMaterial");

Rows[i].texture = WallRenderTexture;

**float** RenderHeight = (**float**)WallTileHeight \* TilemapSize.y / WallRenderTexture.height;

Rows[i].uvRect = **new** Rect(0, i \* RenderHeight / TilemapSize.y, (**float**)TileDimension \* TilemapSize.x / WallRenderTexture.width, RenderHeight / TilemapSize.y);

}

**for** (; i < TilemapSize.y; i++) //Loop through remainder of tilemap and create new rows

{

GameObject Row = **new** GameObject();

Row.transform.parent = Self.transform;

Canvas RowCanvas = Row.AddComponent<Canvas>();

RowCanvas.renderMode = RenderMode.WorldSpace;

RowCanvas.overrideSorting = **true**;

RowCanvas.sortingOrder = 0;

RectTransform RT = Row.GetComponent<RectTransform>();

RawImage RowImage = Row.AddComponent<RawImage>();

RowImage.rectTransform.sizeDelta = Vector2.zero;

**float** StrideHeight = ((**float**)WallTileHeight / TileDimension) / TilesPerUnit;

RowImage.rectTransform.position = **new** Vector3(0, -TilemapSize.y / 2f + StrideHeight / 2 + i / TilesPerUnit);

RowImage.rectTransform.position += Self.transform.position;

RowImage.rectTransform.sizeDelta = **new** Vector2(TilemapSize.x / TilesPerUnit, StrideHeight);

RowImage.material = Resources.Load<Material>("Materials/LitMaterial");

RowImage.texture = WallRenderTexture;

**float** RenderHeight = (**float**)WallTileHeight \* TilemapSize.y / WallRenderTexture.height;

RowImage.uvRect = **new** Rect(0, i \* RenderHeight / TilemapSize.y, (**float**)TileDimension \* TilemapSize.x / WallRenderTexture.width, RenderHeight / TilemapSize.y);

Rows[i] = RowImage;

}

**for** (; i < Rows.Length; i++) //Loop through remainding rows and destroy them if truncate option was true, otherwise deactivate and cache to reuse

{

**if** (Truncate)

GameObject.Destroy(Rows[i].gameObject);

**else**

Rows[i].gameObject.SetActive(**false**);

}

**if** (Truncate && Rows.Length != TilemapSize.y) //Resize array of rows to size of tilemap if truncate option is true

{

RawImage[] Temp = Rows;

Rows = **new** RawImage[TilemapSize.y];

System.Buffer.BlockCopy(Temp, 0, Rows, 0, TilemapSize.y);

}

UpdateRenderSortingLayers();

}

/// <summary>

/// Generate default tilepallets when none are provided

/// </summary>

**private** **void** GenerateDefaultTileData()

{

**if** (WallTilePalletData == **null**)

{

WallTilePalletData = **new** TilePallet

{

Pallet = Resources.Load<Texture2D>("TilemapPallets/Default"),

NumTiles = 2,

TileStride = 64, //32 + 32

FrameCount = **new** **int**[2] { 2, 2 }

};

}

**if** (FloorTilePalletData == **null**)

{

FloorTilePalletData = **new** TilePallet

{

Pallet = Resources.Load<Texture2D>("TilemapPallets/Default"),

NumTiles = 2,

TileStride = 64, //32 + 32

FrameCount = **new** **int**[2] { 2, 2 }

};

}

}

**protected** **override** **void** OnDelete()

{

//Release buffers

**if** (WallBuffer != **null**)

WallBuffer.Dispose();

**if** (FloorBuffer != **null**)

FloorBuffer.Dispose();

//Delete Objects

**if** (Rows != **null**)

{

**for** (**int** i = 0; i < Rows.Length; i++)

{

GameObject.Destroy(Rows[i].gameObject);

}

}

GameObject.Destroy(Self);

}

**private** List<**byte**> MapCache = **new** List<**byte**>();

**private** **int** UpdateResizeOverNetwork = 1;

**private** **int** PreviousResizeOverNetwork = 0;

**public** **override** **byte**[] GetBytes()

{

**if** (UpdateResizeOverNetwork != PreviousResizeOverNetwork)

{

PreviousResizeOverNetwork = UpdateResizeOverNetwork;

**int** Volume = TilemapSize.x \* TilemapSize.y;

MapCache.Clear();

**for** (**int** i = 0; i < Volume; i++)

{

Tile T = FloorMap[i];

MapCache.AddRange(BitConverter.GetBytes(T.Blank));

**if** (T.Blank == 0)

{

MapCache.AddRange(BitConverter.GetBytes(T.Render));

MapCache.AddRange(BitConverter.GetBytes(T.TileIndex));

MapCache.AddRange(BitConverter.GetBytes(T.AnimationFrame));

}

}

**for** (**int** i = 0; i < Volume; i++)

{

Tile T = WallMap[i];

MapCache.AddRange(BitConverter.GetBytes(T.Blank));

**if** (T.Blank == 0)

{

MapCache.AddRange(BitConverter.GetBytes(T.Render));

MapCache.AddRange(BitConverter.GetBytes(T.TileIndex));

MapCache.AddRange(BitConverter.GetBytes(T.AnimationFrame));

}

}

}

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(UpdateResizeOverNetwork));

Data.AddRange(BitConverter.GetBytes(-1)); //Tilemap pallet

Data.AddRange(BitConverter.GetBytes(Self.transform.position.x)); //Tilemap position

Data.AddRange(BitConverter.GetBytes(Self.transform.position.y));

Data.AddRange(BitConverter.GetBytes(TilemapSize.x));

Data.AddRange(BitConverter.GetBytes(TilemapSize.y));

Data.AddRange(BitConverter.GetBytes(TilesPerUnit));

Data.AddRange(BitConverter.GetBytes(WallTileHeight));

Data.AddRange(BitConverter.GetBytes(MapCache.Count));

Data.AddRange(MapCache);

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

Data D = (Data)ParseBytesToSnapshot(Data);

ParseSnapshot(D);

}

**public** **struct** Data

{

**public** **int** UpdateResizeOverNetwork;

**public** **int** TilePalletIndex;

**public** Vector2 Position;

**public** Vector2Int TilemapSize;

**public** **float** TilesPerUnit;

**public** **int** WallTileHeight;

**public** Tile[] FloorMap;

**public** Tile[] WallMap;

}

**public** **override** **object** GetSnapshot()

{

Data Snapshot = **new** Data()

{

UpdateResizeOverNetwork = UpdateResizeOverNetwork,

TilePalletIndex = -1,

Position = Self.transform.position,

TilemapSize = TilemapSize,

TilesPerUnit = TilesPerUnit,

WallTileHeight = WallTileHeight,

FloorMap = **new** Tile[FloorMap.Length],

WallMap = **new** Tile[WallMap.Length]

};

System.Buffer.BlockCopy(FloorMap, 0, Snapshot.FloorMap, 0, FloorMap.Length);

System.Buffer.BlockCopy(WallMap, 0, Snapshot.WallMap, 0, WallMap.Length);

**return** Snapshot;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

Data D = **new** Data()

{

UpdateResizeOverNetwork = Data.ReadInt(),

TilePalletIndex = Data.ReadInt(),

Position = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

TilemapSize = **new** Vector2Int(Data.ReadInt(), Data.ReadInt()),

TilesPerUnit = Data.ReadFloat(),

WallTileHeight = Data.ReadInt()

};

**int** NumBytes = Data.ReadInt();

**int** Volume = D.TilemapSize.x \* D.TilemapSize.y;

D.FloorMap = **new** Tile[Volume];

**for** (**int** i = 0; i < Volume; i++)

{

**int** Blank = Data.ReadInt();

D.FloorMap[i].Blank = Blank;

**if** (Blank == 1)

**continue**;

D.FloorMap[i].Render = Data.ReadInt();

D.FloorMap[i].TileIndex = Data.ReadInt();

D.FloorMap[i].AnimationFrame = Data.ReadInt();

}

D.WallMap = **new** Tile[Volume];

**for** (**int** i = 0; i < Volume; i++)

{

**int** Blank = Data.ReadInt();

D.WallMap[i].Blank = Blank;

**if** (Blank == 1)

**continue**;

D.WallMap[i].Render = Data.ReadInt();

D.WallMap[i].TileIndex = Data.ReadInt();

D.WallMap[i].AnimationFrame = Data.ReadInt();

}

**return** D;

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

UpdateResizeOverNetwork = Data.UpdateResizeOverNetwork;

**int** TilePalletIndex = Data.TilePalletIndex;

**if** (TilePalletIndex == -1)

GenerateDefaultTileData();

Self.transform.position = Data.Position;

TilesPerUnit = Data.TilesPerUnit;

WallTileHeight = Data.WallTileHeight;

**if** (PreviousResizeOverNetwork != UpdateResizeOverNetwork)

{

PreviousResizeOverNetwork = UpdateResizeOverNetwork;

Resize(Data.TilemapSize, Data.FloorMap, Data.WallMap);

}

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

**return**;

}

}

**Assets/World/AbstractWorld.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**public** **class** AbstractWorld : MonoBehaviour

{

[SerializeField]

**public** DZSettings.EntityType Type;

**public** **object** Self;

**public** **object** Context;

}

**Assets/DZScript.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** UnityEngine;

**using** DZNetwork;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Controllers;

//Unity Script to update DZEngine

**public** **class** DZScript : MonoBehaviour

{

**public** **void** Start()

{

ServerHandler.Start();

DZEngine.Initialize();

Main.Start();

}

**public** **void** FixedUpdate()

{

ServerHandle.FixedUpdate();

DZEngine.FixedUpdate();

Game.FixedUpdate();

Main.FixedUpdate();

}

**private** **void** OnApplicationQuit()

{

DZEngine.ReleaseResources();

}

}

**Client/Assets/DZSettings.cs**

using System;

using System.Collections.Generic;

using System.Linq;

using System.Text;

using System.Threading.Tasks;

public static class DZSettings

{

public enum EntityType

{

Null,

PlayerCreature,

Tilemap,

TriggerPlate,

BulletEntity,

EnemyCreature,

Turret,

CoinEntity,

CrystalEntity

}

public static int NumPhysicsIterations = 10;

public static bool ActiveRenderers = true;

public static bool ActiveControllers = true;

public static bool ClientSidePrediction = true;

public static bool Client = true;

}

**Client/Assets/Game.cs**

**using** ClientHandle;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Controllers;

**using** DeadZoneEngine.Entities;

**using** DZNetwork;

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** UnityEngine;

**public** **class** Game

{

**public** **static** Client Client;

**public** **static** DZEngine.ManagedList<IServerSendable> ServerItems = **new** DZEngine.ManagedList<IServerSendable>();

**public** **static** **int** ServerTickRate = 60;

**public** **static** **int** ClientTickRate = 60;

**public** **static** **ulong** ClientTicks = 0;

**public** **static** **ulong** ClientTickAsServerTick = 0;

**public** **static** **bool** Initialized = **false**;

**public** **class** ServerSnapshot

{

**public** **struct** Object

{

**public** DZSettings.EntityType Type;

**public** **bool** FlaggedToDelete;

**public** **object** Data;

}

**public** **ulong** ServerTick;

**public** Dictionary<**ushort**, Object> Data = **new** Dictionary<**ushort**, Object>();

}

**public** **static** **ulong** InterpolationRatio = 2;

**public** **static** **ulong** TargetInterpolationRatio = 2;

**public** **static** **ulong** LowerInterpolationRatioMargin = 1;

**public** **static** **ulong** UpperInterpolationRatioMargin = 5;

**public** **static** **ulong** IterpolationCap = 30;

**private** **static** JitterBuffer<ServerSnapshot> Histogram = **new** JitterBuffer<ServerSnapshot>();

**private** **static** ServerSnapshot CurrentLoaded = **null**;

**public** **static** **void** FixedUpdate()

{

Loader.Socket.FixedUpdate();

**float** ServerToClientTick = (**float**)ClientTickRate / ServerTickRate;

**float** ClientToServerTick = (**float**)ServerTickRate / ClientTickRate;

ClientTickAsServerTick = (**ulong**)(ClientTicks \* ClientToServerTick);

**if** (Initialized == **false** && Histogram.Count > 1)

{

**ulong** NumServerTicksPassed = Histogram.Last.ServerTick - Histogram.First.ServerTick;

**if** (NumServerTicksPassed >= InterpolationRatio)

{

ClientTicks = (**ulong**)((Histogram.Last.ServerTick - InterpolationRatio) \* ServerToClientTick);

Initialized = **true**;

}

}

DZEngine.FixedUpdate();

SendData();

Interp = 0;

ClientTicks++;

}

**private** **static** **float** Interp = 0;

**public** **static** **void** Update()

{

**float** ServerToClientTick = (**float**)ClientTickRate / ServerTickRate;

**float** ClientToServerTick = (**float**)ServerTickRate / ClientTickRate;

**if** (Initialized == **true**)

{

ServerSnapshot From = **null**;

ServerSnapshot To = **null**;

Histogram.Iterate(S =>

{

**if** (S.Value.ServerTick >= ClientTickAsServerTick)

{

From = S.Value;

**if** (S.Next != **null**)

To = S.Next.Value;

}

}, S => S.Value.ServerTick >= ClientTickAsServerTick);

**if** (From != **null**)

{

Histogram.Dequeue(From);

**if** (To != **null**)

{

**if** (CurrentLoaded != From)

{

LoadSnapshot(From, **false**);

CurrentLoaded = From;

**int** LargestHistogram = 0;

**for** (**int** i = 0; i < Client.Players.Length; i++)

{

**if** (Client.Players[i] != **null**)

{

Client.Players[i].Entity.StartClientPrediction(From);

**if** (Client.Players[i].Entity.Histogram.Count > LargestHistogram)

LargestHistogram = Client.Players[i].Entity.Histogram.Count;

}

}

**for** (**int** j = 0; j < LargestHistogram; j++)

{

**for** (**int** i = 0; i < Client.Players.Length; i++)

{

**if** (Client.Players[i] != **null**)

{

Client.Players[i].Entity.ClientPrediction();

}

}

DZEngine.PhysicsUpdate();

}

**for** (**int** i = 0; i < Client.Players.Length; i++)

{

**if** (Client.Players[i] != **null**)

{

Client.Players[i].Entity.EndClientPrediction();

}

}

}

**float** FromTick = (From.ServerTick \* ServerToClientTick);

**float** Origin = (ClientTicks - FromTick);

**float** Time = Origin / ((To.ServerTick \* ServerToClientTick) - FromTick) + Interp;

Interpolate(From, To, Time);

}

**else**

{

LoadSnapshot(From, **true**);

**float** Time = (ClientTicks - From.ServerTick \* ServerToClientTick) / ClientTickRate;

Extrapolate(From, Time);

}

}

**else**

{

Histogram.Dequeue(Histogram.Last);

}

**if** ((**ulong**)Histogram.Count - 1 < TargetInterpolationRatio - LowerInterpolationRatioMargin)

{

InterpolationRatio += 1;

ClientTicks = (**ulong**)((Histogram.Last.ServerTick - InterpolationRatio) \* ServerToClientTick);

}

**else** **if** ((**ulong**)Histogram.Count - 1 > TargetInterpolationRatio + UpperInterpolationRatioMargin)

{

**if** (InterpolationRatio != 0)

InterpolationRatio -= 1;

ClientTicks = (**ulong**)((Histogram.Last.ServerTick - InterpolationRatio) \* ServerToClientTick);

}

**if** (InterpolationRatio > IterpolationCap) InterpolationRatio = IterpolationCap;

Interp += Time.deltaTime;

}

}

**private** **static** **void** Interpolate(ServerSnapshot From, ServerSnapshot To, **float** Time)

{

List<**ushort**> IDs = To.Data.Keys.ToList();

**foreach** (**ushort** ID **in** IDs)

{

**if** (!From.Data.ContainsKey(ID))

**continue**;

\_IInstantiatableDeletable Item = EntityID.GetObject(ID);

ServerSnapshot.Object ToData = To.Data[ID];

ServerSnapshot.Object FromData = From.Data[ID];

IServerSendable ServerItem = Item **as** IServerSendable;

DZSettings.EntityType ToType = ToData.Type;

DZSettings.EntityType FromType = FromData.Type;

**if** (ToData.Data == **null** || FromData.Data == **null** || ToType != FromType || (**int**)ToType != ServerItem.ServerObjectType || (**int**)FromType != ServerItem.ServerObjectType)

**continue**;

**if** (ServerItem == **null**)

**continue**;

ServerItem.Interpolate(FromData.Data, ToData.Data, Time);

}

}

**private** **static** **void** Extrapolate(ServerSnapshot From, **float** Time)

{

List<**ushort**> IDs = From.Data.Keys.ToList();

**foreach** (**ushort** ID **in** IDs)

{

**if** (!From.Data.ContainsKey(ID))

**continue**;

\_IInstantiatableDeletable Item = EntityID.GetObject(ID);

ServerSnapshot.Object FromData = From.Data[ID];

IServerSendable ServerItem = Item **as** IServerSendable;

DZSettings.EntityType FromType = FromData.Type;

**if** (FromData.Data == **null** || (**int**)FromType != ServerItem.ServerObjectType)

**continue**;

**if** (ServerItem == **null**)

**continue**;

ServerItem.Extrapolate(FromData.Data, Time);

}

}

**public** **static** **void** SendData()

{

**if** (Loader.Socket.SocketConnected)

SendSnapshot();

**if** (!Loader.Socket.Connected)

**return**;

}

**private** **static** **void** SendSnapshot()

{

Packet Setup = **new** Packet();

Setup.Write(Client.NumPlayers);

Loader.Socket.Send(Setup, ServerCode.SyncPlayers);

Packet SnapshotPacket = **new** Packet();

SnapshotPacket.Write(Client.NumPlayers);

SnapshotPacket.Write(InputMapping.GetBytes());

Loader.Socket.Send(SnapshotPacket, ServerCode.ClientSnapshot);

}

**public** **static** **void** SyncClient(DZUDPSocket.RecievePacketWrapper Packet)

{

**int** NumPlayers = Packet.Data.ReadByte();

**if** (NumPlayers != Client.NumPlayers)

{

Debug.LogWarning("Sync failed due to inconsistent player count");

**return**;

}

**ushort** CID = Packet.Data.ReadUShort();

**if** (Client.ID != CID)

Client.ID.ChangeID(CID);

**for** (**int** i = 0; i < NumPlayers; i++)

{

**int** ID = Packet.Data.ReadByte();

**if** (ID == **byte**.MaxValue)

**continue**;

**ushort** PlayerEntityID = Packet.Data.ReadUShort();

**if** (Client.Players[i].Entity.ID != PlayerEntityID)

Client.Players[i].Entity.ID.ChangeID(PlayerEntityID, **true**);

}

}

**public** **static** **void** UnWrapSnapshot(DZUDPSocket.RecievePacketWrapper Packet)

{

**if** (Client == **null**) **return**;

**int** CheckSum = Packet.Data.ReadInt();

ServerTickRate = Packet.Data.ReadInt();

**ulong** ServerTick = Packet.Data.ReadULong();

Main.LifeForce[0] = Packet.Data.ReadInt();

Main.LifeForce[1] = Packet.Data.ReadInt();

Main.LifeForce[2] = Packet.Data.ReadInt();

Main.Money = Packet.Data.ReadInt();

**if** (ServerTick <= (Histogram.Count == 0 ? 0 : Histogram.Last.ServerTick))

{

Debug.LogWarning("Received a late packet");

**return**;

}

ServerSnapshot Snapshot = **new** ServerSnapshot();

Snapshot.ServerTick = ServerTick;

**int** NumSnapshotItems = Packet.Data.ReadInt();

**for** (**int** i = 0; i < NumSnapshotItems; i++)

{

ServerSnapshot.Object Object = **new** ServerSnapshot.Object();

**ushort** ID = Packet.Data.ReadUShort();

**bool** FlaggedToDelete = Packet.Data.ReadBool();

Object.FlaggedToDelete = FlaggedToDelete;

**if** (FlaggedToDelete)

{

Snapshot.Data.Add(ID, Object);

**continue**;

}

DZSettings.EntityType Type = (DZSettings.EntityType)Packet.Data.ReadInt();

Object.Type = Type;

**object** ServerItem = Parse(Type, Packet.Data);

**if** (ServerItem == **null**)

{

Debug.LogWarning("Unable to Parse item from server snapshot");

**return**;

}

Object.Data = ServerItem;

Snapshot.Data.Add(ID, Object);

}

Histogram.Add(Snapshot);

}

**private** **static** **void** LoadSnapshot(ServerSnapshot Snapshot, **bool** ParseData = **true**)

{

List<**ushort**> IDs = Snapshot.Data.Keys.ToList();

**foreach** (**ushort** ID **in** IDs)

{

\_IInstantiatableDeletable Item = EntityID.GetObject(ID);

ServerSnapshot.Object Object = Snapshot.Data[ID];

**bool** FlaggedToDelete = Object.FlaggedToDelete;

**if** (FlaggedToDelete)

{

**if** (Item != **null**)

DZEngine.Destroy(Item);

**continue**;

}

IServerSendable ServerItem = Item **as** IServerSendable;

DZSettings.EntityType Type = Object.Type;

**if** (ServerItem == **null**)

ServerItem = Parse(ID, Type);

**if** (ServerItem == **null**)

{

Debug.LogWarning("Unable to Parse item from server snapshot");

**return**;

}

**if** ((DZSettings.EntityType)ServerItem.ServerObjectType != Type)

{

Debug.LogWarning("Entity Types of ID " + ID + " do not match... (ServerID = " + Type + ", LocalID = " + (DZSettings.EntityType)ServerItem.ServerObjectType + ") resetting IDs and re-parsing");

ServerItem.ID.ChangeID();

Item = EntityID.GetObject(ID);

ServerItem = Item **as** IServerSendable;

**if** (ServerItem == **null**)

ServerItem = Parse(ID, Type);

**if** (ServerItem == **null**)

{

Debug.LogWarning("Unable to Parse item from server snapshot");

**return**;

}

}

**if** (ParseData)

ServerItem.ParseSnapshot(Object.Data);

ServerItem.RecentlyUpdated = **true**;

}

**foreach** (IServerSendable Item **in** ServerItems)

{

**if** (!Item.ProtectedDeletion && !Item.RecentlyUpdated)

{

DZEngine.Destroy(Item);

Debug.LogWarning("An Item was destroyed as it was not updated by the server");

}

}

}

**private** **static** **object** Parse(DZSettings.EntityType Type, Packet Data)

{

**switch** (Type)

{

**case** DZSettings.EntityType.PlayerCreature: **return** PlayerCreature.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.Tilemap: **return** Tilemap.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.TriggerPlate: **return** TriggerPlate.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.BulletEntity: **return** BulletEntity.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.EnemyCreature: **return** EnemyCreature.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.Turret: **return** Turret.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.CoinEntity: **return** CoinEntity.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.CrystalEntity: **return** CrystalEntity.ParseBytesToSnapshot(Data);

**case** DZSettings.EntityType.Null: **return** **null**;

**default**: Debug.LogWarning("Parsing unknown entity type"); **return** **null**;

}

}

**private** **static** IServerSendable Parse(**ushort** ID, DZSettings.EntityType Type)

{

**switch** (Type)

{

**case** DZSettings.EntityType.PlayerCreature: **return** **new** PlayerCreature(ID);

**case** DZSettings.EntityType.Tilemap: **return** **new** Tilemap(ID);

**case** DZSettings.EntityType.TriggerPlate: **return** **new** TriggerPlate(ID);

**case** DZSettings.EntityType.BulletEntity: **return** **new** BulletEntity(ID);

**case** DZSettings.EntityType.EnemyCreature: **return** **new** EnemyCreature(ID);

**case** DZSettings.EntityType.Turret: **return** **new** Turret(ID);

**case** DZSettings.EntityType.CoinEntity: **return** **new** CoinEntity(ID);

**case** DZSettings.EntityType.CrystalEntity: **return** **new** CrystalEntity(ID);

**case** DZSettings.EntityType.Null: **return** **null**;

**default**: Debug.LogWarning("Parsing unknown entity type"); **return** **null**;

}

}

**public** **static** **void** Connected()

{

Debug.Log("Client Connected");

}

**public** **static** **void** Disconnected()

{

Debug.Log("Client Disconnected");

Initialized = **false**;

Histogram.Clear();

}

}

**Client/Assets/InputManager.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine.InputSystem;

**using** UnityEngine;

**using** DeadZoneEngine.Controllers;

**using** ClientHandle;

**using** **static** DeadZoneEngine.Controllers.InputMapping;

**using** DZNetwork;

**public** **class** PlayerController : Controller

{

**public** Player Owner;

**public** PlayerCreature.Control PlayerControl;

**public** PlayerController(Player Owner, PlayerCreature.Control PlayerControl) : **base**()

{

**this**.Owner = Owner;

**this**.PlayerControl = PlayerControl;

}

**private** InputAction Interact;

**public** PlayerController(InputDevice Device, DeviceController DC) : **base**(Device, DC)

{

InputAction Movement = ActionMap.AddAction("Movement", InputActionType.PassThrough);

Interact = ActionMap.AddAction("Interact");

**if** (Device **is** Keyboard)

{

Movement.AddCompositeBinding("2DVector(mode=2)")

.With("Up", Device.path + "/w")

.With("Down", Device.path + "/s")

.With("Left", Device.path + "/a")

.With("Right", Device.path + "/d");

Interact.AddBinding(Device.path + "/space");

}

**else**

{

Movement.AddCompositeBinding("2DVector(mode=2)")

.With("Up", Device.path + "/stick/up")

.With("Down", Device.path + "/stick/down")

.With("Left", Device.path + "/stick/left")

.With("Right", Device.path + "/stick/right");

Interact.AddBinding(Device.path + "/trigger");

}

Movement.performed += MoveAction;

}

**protected** **override** **void** SetType()

{

Type = ControllerType.PlayerController;

}

**public** **override** **void** OnInput(UnityEngine.InputSystem.Controls.ButtonControl Control)

{

**if** (Owner != **null** || (IsKeyboard && Control.name != "enter"))

**return**;

Player P = Game.Client.AddPlayer();

P.Controller = **this**;

DC.Enable();

}

**private** Vector2 MovementDirection;

**public** **void** MoveAction(InputAction.CallbackContext Context)

{

MovementDirection = Context.ReadValue<Vector2>();

}

**public** **override** **void** Tick()

{

**if** (PlayerControl == **null**) **return**;

PlayerControl.MovementDirection = MovementDirection;

PlayerControl.Interact = Interact.ReadValue<**float**>();

}

**public** **override** **void** ParseBytes(Packet Data)

{

PlayerControl.InputID = Data.ReadULong();

PlayerControl.Interact = Data.ReadFloat();

PlayerControl.MovementDirection = **new** Vector2(Data.ReadFloat(), Data.ReadFloat());

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.Add(Owner.ID);

Data.AddRange(BitConverter.GetBytes(PlayerControl.InputID));

Data.AddRange(BitConverter.GetBytes(PlayerControl.Interact));

Data.AddRange(BitConverter.GetBytes(PlayerControl.MovementDirection.x));

Data.AddRange(BitConverter.GetBytes(PlayerControl.MovementDirection.y));

**return** Data.ToArray();

}

}

**public** **static** **class** InputManager

{

**public** **static** **void** Initialize()

{

InputMapping.OnDeviceAdd += OnDeviceAdd;

InputMapping.OnDeviceDisconnect += OnDeviceDisconnect;

InputMapping.OnDeviceReconnect += OnDeviceReconnect;

InputMapping.OnDeviceRemove += OnDeviceRemove;

}

**public** **static** **void** OnDeviceAdd(InputDevice Device)

{

InputMapping.Devices[Device].Controllers.Add(**new** PlayerController(Device, InputMapping.Devices[Device]));

}

**public** **static** **void** OnDeviceDisconnect(InputDevice Device)

{

}

**public** **static** **void** OnDeviceReconnect(InputDevice Device)

{

}

**public** **static** **void** OnDeviceRemove(InputDevice Device)

{

}

}

**Client/Assets/Loader.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** System.Net;

**using** UnityEngine;

**using** UnityEngine.UI;

**using** DZNetwork;

**using** System;

**public** **class** Loader

{

**public** **static** DZClient Socket = **new** DZClient();

**public** **static** **string** ServerIP = "192.168.2.26"; //"172.16.6.165";//"192.168.2.51"; //"192.168.2.26"; //"172.16.6.165";

**public** **static** **int** ServerPort = 26950;

**public** **static** InputField IPAddressField;

**public** **static** Text StatusText;

[RuntimeInitializeOnLoadMethod]

**private** **static** **void** Start()

{

Physics2D.queriesStartInColliders = **false**;

Application.quitting += Dispose;

Time.fixedDeltaTime = 1f / Game.ClientTickRate;

Physics2D.simulationMode = SimulationMode2D.Script;

IPAddressField = GameObject.FindGameObjectWithTag("IPInput").GetComponent<InputField>();

IPAddressField.text = ServerIP + ":" + ServerPort;

IPAddressField.onValueChanged.AddListener(**delegate** { Connect(); });

StatusText = GameObject.FindGameObjectWithTag("StatusBox").GetComponent<Text>();

StatusText.text = "";

//Remove later

Socket.ConnectHandle += Game.Connected;

Socket.DisconnectHandle += Game.Disconnected;

Socket.PacketHandle += ServerHandle.ProcessPacket;

Socket.PacketLostHandle += ServerHandle.HandleLostPacket;

Socket.Connect(ServerIP, ServerPort);

}

**private** **static** **void** Connect()

{

**string**[] IPPort = IPAddressField.text.Split(':');

**if** (IPPort.Length != 2)

{

StatusText.text = "Please enter IP in the correct format";

}

**try**

{

Socket.Connect(IPPort[0], **int**.Parse(IPPort[1]));

}

**catch** (Exception E)

{

StatusText.text = "Failed to parse IP";

}

}

**private** **static** **void** Dispose()

{

Socket.Dispose();

}

}

**Client/Assets/Main.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** ClientHandle;

**using** System.Linq;

**public** **static** **class** Main

{

//Sorting layers for rendering

**public** **enum** SortingLayers

{

Default

}

**private** **static** DZEngine.ManagedList<IRenderer<SpriteRenderer>> SpriteRenderers = **new** DZEngine.ManagedList<IRenderer<SpriteRenderer>>(); //List of SpriteRenderers

**public** **static** Tilemap Tilemap;

**private** **static** TriggerPlate StartPlate;

**public** **static** **bool** GameStarted = **false**;

// Start is called before the first frame update

**public** **static** **void** Start()

{

LoadMenu();

}

**const** **string** MenuFloorMap =

@"

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1

            ";

**const** **string** MenuWallMap =

@"

            1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1

            ";

**private** **static** **void** LoadMenu()

{

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**foreach** (Client C **in** Clients)

{

**if** (C == **null** || C.Players == **null**)

**continue**;

**for** (**int** i = 0; i < C.Players.Length; i++)

{

**if** (C.Players[i] == **null** || C.Players[i].Entity == **null**) **continue**;

C.Players[i].Entity.Position = **new** Vector2(UnityEngine.Random.Range(-8f, 8f), UnityEngine.Random.Range(-8f, 8f));

C.Players[i].Entity.Out = **false**;

}

}

**if** (Tilemap == **null**)

{

Tilemap = (Tilemap)**new** Tilemap(32, 64, **new** Vector2Int(20, 20), Tilemap.TilesFromString(MenuFloorMap), Tilemap.TilesFromString(MenuWallMap)).Create();

}

**else**

{

Tilemap.Resize(**new** Vector2Int(20, 20), Tilemap.TilesFromString(MenuFloorMap), Tilemap.TilesFromString(MenuWallMap));

Tilemap.ReleaseUnusedResources();

}

StartPlate = **new** TriggerPlate(**new** Vector2(4, 2), **new** Vector2(0, -3));

StartPlate.OnTrigger = StartGame;

}

**private** **static** EnemyCreature.Path GeneratePath(**int** Height, **int** Width)

{

List<EnemyCreature.WayPoint> Path = **new** List<EnemyCreature.WayPoint>();

**int** NumTurns = UnityEngine.Random.Range(6, 10);

**string**[] Tiles = **null**;

**bool** ValidPath = **false**;

**while** (!ValidPath)

{

Path.Clear();

Tiles = MenuFloorMap.Split('/');

Vector2Int StartPosition = **new** Vector2Int(1, UnityEngine.Random.Range(1, Height - 1));

**float** Chance = UnityEngine.Random.Range(0f, 1f);

**if** (Chance > 0.25)

StartPosition = **new** Vector2Int(Width - 2, UnityEngine.Random.Range(1, Height - 1));

**else** **if** (Chance > 0.5)

StartPosition = **new** Vector2Int(UnityEngine.Random.Range(1, Width - 1), 1);

**else** **if** (Chance > 0.75)

StartPosition = **new** Vector2Int(UnityEngine.Random.Range(1, Width - 1), Height - 2);

**int** Direction = 1;

**if** (Chance > 0.25)

Direction = 3;

**else** **if** (Chance > 0.5)

Direction = 0;

**else** **if** (Chance > 0.75)

Direction = 2;

Path.Add(**new** EnemyCreature.WayPoint()

{

Direction = Direction,

Position = StartPosition

});

**for** (**int** i = 0; i < NumTurns; i++)

{

**int** CurrentDirection = Direction;

**int** Length = UnityEngine.Random.Range(3, 8);

**if** (i == NumTurns - 1)

{

**switch** (Direction)

{

**case** 0: Length = Height - StartPosition.y; **break**;

**case** 1: Length = Width - StartPosition.x; **break**;

**case** 2: Length = StartPosition.y; **break**;

**case** 3: Length = StartPosition.x; **break**;

}

}

**for** (**int** j = 0; j < Length; j++)

{

Tiles[StartPosition.y \* Width + StartPosition.x] = "0,2,0,1";

Vector2Int NewPosition = StartPosition;

**switch** (Direction)

{

**case** 0: NewPosition.y++; **break**;

**case** 1: NewPosition.x++; **break**;

**case** 2: NewPosition.y--; **break**;

**case** 3: NewPosition.x--; **break**;

}

**if** (NewPosition.x < 1 || NewPosition.x > Width - 2 || NewPosition.y < 1 || (NewPosition.y > Height - 3 && Direction == 0))

{

**break**;

}

StartPosition = NewPosition;

}

**bool** ValidDirection = **true**;

**do**

{

Direction = (Direction + (UnityEngine.Random.Range(0f, 1f) > 0.5 ? 1 : -1)) % 4;

**if** (Direction < 0) Direction += 4;

Vector2Int NewPosition = StartPosition;

**switch** (Direction)

{

**case** 0: NewPosition.y++; **break**;

**case** 1: NewPosition.x++; **break**;

**case** 2: NewPosition.y--; **break**;

**case** 3: NewPosition.x--; **break**;

}

**if** (NewPosition.x < 1 || NewPosition.x > Width - 1 || NewPosition.y < 1 || NewPosition.y > Height - 2)

{

ValidDirection = **false**;

}

**else** **if** (Tiles[NewPosition.y \* Width + NewPosition.x] == "0,2,0,1")

{

ValidDirection = **false**;

}

}

**while** (CurrentDirection == Direction && !ValidDirection);

Path.Add(**new** EnemyCreature.WayPoint()

{

Direction = CurrentDirection,

Position = StartPosition

});

}

**bool** TopLeftQuadrant = **false**;

**bool** TopRightQuadrant = **false**;

**bool** BottomLeftQuadrant = **false**;

**bool** BottomRightQuadrant = **false**;

**for** (**int** i = 0; i < Path.Count; i++)

{

**if** (Path[i].Position.x < Width / 2)

{

**if** (Path[i].Position.y < Height / 2)

{

BottomLeftQuadrant = **true**;

}

**else**

{

TopLeftQuadrant = **true**;

}

}

**else**

{

**if** (Path[i].Position.y < Height / 2)

{

BottomRightQuadrant = **true**;

}

**else**

{

TopRightQuadrant = **true**;

}

}

}

ValidPath = TopLeftQuadrant && TopRightQuadrant && BottomLeftQuadrant && BottomRightQuadrant;

}

**return** **new** EnemyCreature.Path()

{

Map = **string**.Join("/", Tiles),

Traversal = Path

};

}

**private** **static** EnemyCreature.Path CurrentPath;

**public** **static** **void** StartGame()

{

CurrentPath = GeneratePath(20, 20);

Tilemap.Resize(**new** Vector2Int(20, 20), Tilemap.TilesFromString(CurrentPath.Map), Tilemap.TilesFromString(MenuWallMap));

GameStarted = **true**;

DZEngine.Destroy(StartPlate);

}

**public** **static** **int**[] LifeForce = **new** **int**[3] { 10, 10, 10 };

**private** **static** **float** WaveTimer = 5;

**private** **static** **int** WaveSize = 10;

**private** **static** **int** WaveMaxSize = 10;

**private** **static** **int** WaveHealth = 1;

**private** **static** **int** Wave = 0;

**private** **static** **float** WaveSpacing = 0.3f;

**private** **static** **float** WaveSpacingMax = 1;

**private** **static** **int** EnemiesToSpawn = 5;

**private** **static** **float** SpawnTimer = 0;

**public** **static** **int** Money = 40;

**public** **static** **float** Drain = 0;

**private** **static** List<EnemyCreature> Enemies = **new** List<EnemyCreature>();

**public** **static** List<Turret> Towers = **new** List<Turret>();

**public** **static** **void** TakeLifeForce()

{

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] > 0)

{

LifeForce[i]--;

**break**;

}

}

}

**public** **static** **void** GainLifeForce(**int** Health)

{

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] != 0)

{

LifeForce[i] += Health;

**if** (LifeForce[i] > 10)

LifeForce[i] = 10;

**break**;

}

}

}

**private** **static** **void** Reset()

{

Money = 40;

**for** (**int** i = 0; i < Enemies.Count; i++)

{

DZEngine.Destroy(Enemies[i]);

}

Enemies.Clear();

**for** (**int** i = 0; i < Towers.Count; i++)

{

DZEngine.Destroy(Towers[i]);

}

Towers.Clear();

LifeForce = **new** **int**[3] { 10, 10, 10 };

GameStarted = **false**;

LoadMenu();

}

// Update is called once per frame

**public** **static** **void** FixedUpdate()

{

**if** (DZSettings.ActiveRenderers == **true**)

**foreach** (IRenderer<SpriteRenderer> Renderer **in** SpriteRenderers)

{

**if** (Renderer.SortingLayer == (**int**)SortingLayers.Default)

Renderer.RenderObject.sortingOrder = Mathf.RoundToInt(-Renderer.RenderObject.transform.parent.position.y \* 10);

}

**if** (GameStarted)

{

**if** (Drain <= 0)

{

Drain = 5;

TakeLifeForce();

}

**else** Drain -= Time.fixedDeltaTime;

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**int** TotalNumPlayers = 0;

**foreach** (Client C **in** Clients)

{

**if** (C == **null**) **continue**;

**if** (C.Players == **null**) **continue**;

**for** (**int** i = 0; i < C.Players.Length; i++)

{

**if** (C.Players[i] == **null**) **continue**;

**if** (C.Players[i].Entity == **null**) **continue**;

TotalNumPlayers++;

}

}

**if** (TotalNumPlayers == 0)

{

Reset();

}

**bool** Alive = **false**;

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] > 0)

Alive = **true**;

}

**if** (WaveTimer > 0)

{

WaveTimer -= Time.fixedDeltaTime;

}

**else**

{

WaveTimer = Random.Range(4f, 10f);

Wave++;

EnemiesToSpawn = Random.Range(10, WaveMaxSize);

WaveHealth++;

WaveSpacing = Random.Range(0.1f, WaveSpacingMax);

WaveSpacingMax += Random.Range(-0.5f, 0.5f);

**if** (Random.Range(0f, 1f) < 0.3)

{

WaveSpacing = 0.3f;

}

**if** (WaveSpacing < 0.3)

WaveSpacing = 0.3f;

}

SpawnTimer += Time.fixedDeltaTime;

**if** (WaveTimer <= 0 && EnemiesToSpawn > 0 && SpawnTimer > WaveSpacing)

{

EnemiesToSpawn--;

SpawnTimer = 0;

EnemyCreature EC = **new** EnemyCreature();

EC.Position = Tilemap.TilemapToWorldPosition(CurrentPath.Traversal[0].Position);

EC.Health = WaveHealth;

EC.Traversal = CurrentPath;

Enemies.Add(EC);

}

**if** (Alive == **false**)

{

Reset();

}

}

}

}

**Client/Assets/ServerHandler.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** System.Net;

**using** UnityEngine;

**using** DZNetwork;

**public** **enum** ServerCode

{

Null,

SyncPlayers,

ClientSnapshot,

ServerSnapshot

}

**public** **class** ServerHandler

{

**public** **static** **void** Start()

{

ServerHandle.PacketHandle = (Packet) =>

{

ServerCode Job = (ServerCode)Packet.Data.ReadInt();

PerformServerAction(Packet, Job);

};

ServerHandle.LostPacketHandle = (SentPacketWrapper) =>

{

HandleLostPacket(SentPacketWrapper.Code);

};

}

**private** **static** **void** HandleLostPacket(ServerCode Job)

{

//If socket is not connected and packets are lost well.. theres a good reason why packets are lost

**if** (!Loader.Socket.Connected)

**return**;

**switch** (Job)

{

**case** ServerCode.Null:

**break**;

**default**:

Debug.LogWarning("Unknown ServerCode: " + Job);

**break**;

}

}

**private** **static** **void** PerformServerAction(DZUDPSocket.RecievePacketWrapper Packet, ServerCode Job)

{

**switch** (Job)

{

**case** ServerCode.SyncPlayers:

Game.SyncClient(Packet);

**break**;

**case** ServerCode.ServerSnapshot:

Game.UnWrapSnapshot(Packet);

**break**;

**default**:

Debug.LogWarning("Unknown ServerCode: " + Job);

**break**;

}

}

}

**Server/Assets/Scripts/Creatures/BulletEntity.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DZNetwork;

**using** ClientHandle;

**using** DeadZoneEngine;

**public** **class** BulletEntity : AbstractWorldEntity, IPhysicsUpdatable, IRenderer, IServerSendable

{

**public** **int** SortingLayer { **get**; **set**; }

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.BulletEntity;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

BodyChunk Bolt;

**public** **float** Speed = 5;

**public** **int** NumBounces = 10;

**public** Vector2 Direction = Vector2.up;

**public** BulletEntity(**ushort** ID) : **base**(ID)

{

Init();

}

**public** BulletEntity() : **base**()

{

Init();

}

**public** **void** Init()

{

Bolt = **new** BodyChunk();

Bolt.Context = **this**;

Bolt.ContextType = DZSettings.EntityType.BulletEntity;

Bolt.Collider.radius = 0.1f;

Bolt.Kinematic = **true**;

}

**public** Vector2 Position

{

**get**

{

**if** (Bolt != **null**)

**return** Bolt.Position;

**return** Vector2.zero;

}

**set**

{

**if** (Bolt != **null**)

Bolt.Position = value;

}

}

**public** **void** InitializeRenderer()

{

}

**public** **void** Render()

{

Bolt.RenderObject.transform.localScale = **new** Vector2(0.2f, 0.2f);

Bolt.RenderObject.color = Color.red;

}

**public** **void** ServerUpdate()

{

}

**private** RaycastHit2D[] RayCasts = **new** RaycastHit2D[6];

**public** **void** FixedUpdate()

{

**float** ScaledSpeed = Speed \* Time.fixedDeltaTime;

Vector2 NormalDirection = Vector2.Perpendicular(Direction).normalized \* (Bolt.Collider.radius + 0.01f);

RayCasts[0] = Physics2D.Raycast(Bolt.Position, Direction, ScaledSpeed);

RayCasts[1] = Physics2D.Raycast(Bolt.Position + NormalDirection, Direction, ScaledSpeed);

RayCasts[2] = Physics2D.Raycast(Bolt.Position - NormalDirection, Direction, ScaledSpeed);

Vector2 End = Bolt.Position + Direction \* ScaledSpeed;

RayCasts[3] = Physics2D.Raycast(End, -Direction, ScaledSpeed - Bolt.Collider.radius - 0.1f);

RayCasts[4] = Physics2D.Raycast(End + NormalDirection, -Direction, ScaledSpeed);

RayCasts[5] = Physics2D.Raycast(End - NormalDirection, -Direction, ScaledSpeed);

**bool** FoundHit = **false**;

**int** Index = 0;

**for** (**int** i = 0; i < RayCasts.Length; i++)

{

**if** (RayCasts[i].collider != **null** && Vector2.Dot(RayCasts[i].normal, Direction) < 0)

{

FoundHit = **true**;

Index = i;

**break**;

}

}

**if** (FoundHit)

{

**if** (Main.GameStarted)

{

RaycastHit2D Hit = RayCasts[Index];

**float** Distance = Mathf.Abs((Hit.point - Bolt.Position).magnitude) - Bolt.Collider.radius;

Vector2 NewPosition = Bolt.Position + Direction \* Distance;

AbstractWorld WorldContext = Hit.collider.gameObject.GetComponent<AbstractWorld>();

Direction = Vector2.Reflect(Direction, Hit.normal).normalized;

CheckContext(WorldContext);

}

DZEngine.Destroy(**this**);

}

**else**

{

**int** NumContacts = Bolt.GetContacts();

**if** (NumContacts > 0)

{

**for** (**int** i = 0; i < NumContacts; i++)

{

AbstractWorld WorldContext = Bolt.Contacts[i].otherCollider.gameObject.GetComponent<AbstractWorld>();

Direction = Vector2.Reflect(Direction, Vector2.Perpendicular((Vector2)Bolt.Contacts[i].otherCollider.transform.position - Position)).normalized;

CheckContext(WorldContext);

}

}

Bolt.Position += Direction \* ScaledSpeed;

}

}

**private** **void** CheckContext(AbstractWorld WorldContext)

{

**if** (WorldContext != **null**)

{

**if** (WorldContext.Type == DZSettings.EntityType.PlayerCreature)

{

PlayerCreature Player = (PlayerCreature)WorldContext.Context;

Main.TakeLifeForce();

}

**else** **if** (WorldContext.Type == DZSettings.EntityType.EnemyCreature)

{

EnemyCreature Enemy = (EnemyCreature)WorldContext.Context;

Enemy.ApplyVelocity(-Direction, 10);

Enemy.Health--;

**if** (Enemy.State == EnemyCreature.BodyState.Limp)

{

**if** (NumBounces > 0)

{

NumBounces--;

**return**;

}

}

}

**else** **if** (WorldContext.Type == DZSettings.EntityType.Turret)

{

((Turret)WorldContext.Context).LifeTime -= 1;

**if** (NumBounces > 0)

{

NumBounces--;

**return**;

}

}

**else** **if** (WorldContext.Type == DZSettings.EntityType.BulletEntity)

{

((BulletEntity)WorldContext.Context).Direction = -Direction;

**if** (NumBounces > 0)

{

NumBounces--;

**return**;

}

}

}

}

**public** **void** IsolateVelocity() { }

**public** **void** RestoreVelocity() { }

**protected** **override** **void** OnDelete()

{

DZEngine.Destroy(Bolt);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Speed));

Data.AddRange(BitConverter.GetBytes(Direction.x));

Data.AddRange(BitConverter.GetBytes(Direction.y));

Data.AddRange(Bolt.GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(Packet Data)

{

ParseSnapshot(ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **float** Speed;

**public** Vector2 Direction;

**public** BodyChunk.Data Bolt;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Speed = Speed,

Direction = Direction,

Bolt = (BodyChunk.Data)Bolt.GetSnapshot()

};

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Speed = Data.ReadFloat(),

Direction = **new** Vector2(Data.ReadFloat(), Data.ReadFloat()),

Bolt = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Speed = Data.Speed;

Direction = Data.Direction;

Bolt.ParseSnapshot(Data.Bolt);

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Direction = From.Direction;

Speed = From.Speed;

Bolt.Interpolate(From.Bolt, To.Bolt, Time);

}

}

**Server/Assets/Scripts/Creatures/CoinEntity.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DZNetwork;

**public** **class** CoinEntity : AbstractWorldEntity, IUpdatable, IRenderer, IServerSendable

{

**public** **int** SortingLayer { **get**; **set**; }

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.CoinEntity;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** Money = 1;

**public** **int** Health = 0;

**public** BodyChunk Coin;

**public** **float** Decay = 10;

**public** CoinEntity(**ushort** ID) : **base**(ID)

{

Init();

}

**public** CoinEntity() : **base**()

{

Init();

}

**public** **void** Init()

{

Coin = **new** BodyChunk();

Coin.Context = **this**;

Coin.ContextType = DZSettings.EntityType.CoinEntity;

Coin.Collider.radius = 0.01f;

Coin.Velocity = **new** Vector2(UnityEngine.Random.Range(-5f, 5f), UnityEngine.Random.Range(-5f, 5f));

}

**public** Vector2 Position

{

**get**

{

**if** (Coin != **null**)

**return** Coin.Position;

**return** Vector2.zero;

}

**set**

{

**if** (Coin != **null**)

Coin.Position = value;

}

}

**public** **void** InitializeRenderer()

{

}

**public** **void** Render()

{

Coin.RenderObject.transform.localScale = **new** Vector2(0.2f, 0.2f);

**if** (Health > 0)

Coin.RenderColor = Color.red;

**else**

Coin.RenderColor = Color.magenta;

}

**public** **void** ServerUpdate()

{

}

**public** **void** Update()

{

Decay -= Time.fixedDeltaTime;

**if** (Decay < 0)

{

DZEngine.Destroy(**this**);

}

Collider2D[] C = Physics2D.OverlapCircleAll(Position, 1f);

List<PlayerCreature> NearbyCreatures = **new** List<PlayerCreature>();

**for** (**int** i = 0; i < C.Length; i++)

{

**if** (C[i] != **null**)

{

AbstractWorld AW = C[i].GetComponent<AbstractWorld>();

**if** (AW != **null** && AW.Type == DZSettings.EntityType.PlayerCreature)

{

NearbyCreatures.Add((PlayerCreature)AW.Context);

}

}

}

**for** (**int** i = 0; i < NearbyCreatures.Count; i++)

{

Vector2 Dir = NearbyCreatures[i].Position - Coin.Position;

**if** (Dir.magnitude < 0.3f)

{

Main.Money += Money;

Main.GainLifeForce(Health);

DZEngine.Destroy(**this**);

}

**float** Speed = 10;

Coin.Velocity += Dir.normalized \* Speed \* Time.fixedDeltaTime;

}

Coin.Velocity \*= 0.9f;

}

**public** **void** BodyPhysicsUpdate() { }

**public** **void** IsolateVelocity() { }

**public** **void** RestoreVelocity() { }

**protected** **override** **void** OnDelete()

{

DZEngine.Destroy(Coin);

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Money));

Data.AddRange(BitConverter.GetBytes(Health));

Data.AddRange(Coin.GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(Packet Data)

{

ParseSnapshot(ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **int** Money;

**public** **int** Health;

**public** BodyChunk.Data Coin;

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

Money = Money,

Health = Health,

Coin = (BodyChunk.Data)Coin.GetSnapshot()

};

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

Money = Data.ReadInt(),

Health = Data.ReadInt(),

Coin = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

Money = Data.Money;

Health = Data.Health;

Coin.ParseSnapshot(Data.Coin);

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

Money = From.Money;

Health = From.Health;

Coin.Interpolate(From.Coin, To.Coin, Time);

}

}

**Server/Assets/Scripts/Creatures/EnemyCreature.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DeadZoneEngine;

**public** **class** EnemyCreature : AbstractCreature, IServerSendable

{

**public** **struct** WayPoint

{

**public** **int** Direction;

**public** Vector2Int Position;

}

**public** **struct** Path

{

**public** List<WayPoint> Traversal;

**public** **string** Map;

}

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.EnemyCreature;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **int** CurrentWayPoint = 0;

**public** Path Traversal;

**public** **float** DecayTimer = 5;

**public** **int** CorpseHP = 5;

**public** **int** Health = 5;

**public** **float** Speed = 1;

**private** **float**[] DynamicRunSpeed;

**public** BodyState State;

**public** **enum** BodyState

{

Standing,

Limp

}

**public** EnemyCreature(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** EnemyCreature()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

BodyChunks[1].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

**if** (State == BodyState.Limp) BodyColor = Color.grey;

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

Color BodyColor;

**private** **void** Initialize()

{

BodyChunks = **new** BodyChunk[2];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[1] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.25f;

BodyChunks[1].Collider.radius = 0.25f;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.EnemyCreature;

BodyChunks[1].Context = **this**;

BodyChunks[1].ContextType = DZSettings.EntityType.EnemyCreature;

SetGravity(0f);

BodyChunkConnections = **new** DistanceJoint[1];

BodyChunkConnections[0] = **new** DistanceJoint();

BodyChunkConnections[0].Set(**new** DistanceJointData(BodyChunks[0], BodyChunks[1], 0.5f, Vector2.zero));

BodyChunkConnections[0].Active = **false**;

Physics2D.IgnoreCollision(BodyChunks[0].Collider, BodyChunks[1].Collider, **true**); //Ignore collisions between body parts

DynamicRunSpeed = **new** **float**[2];

BodyColor = **new** Color(0, 1, 0);

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

**if** (BodyChunks[1] != **null**)

BodyChunks[1].Position = value;

}

}

**public** **void** ApplyVelocity(Vector2 Direction, **float** Force)

{

BodyChunks[0].Velocity += Direction \* Force;

}

**public** **void** ApplyVelocity(Vector2 Vel)

{

BodyChunks[0].Velocity += Vel;

}

**public** **void** ServerUpdate()

{

}

**public** Func<Tilemap, WayPoint, Vector2, Vector2> PathingAlgorithm = (Map, WP, Position) =>

{

Vector2 WPActualPosition = Main.Tilemap.TilemapToWorldPosition(WP.Position);

**return** (WPActualPosition - Position).normalized;

};

**private** **bool** Death = **false**;

**public** **override** **void** Update()

{

**if** (Health < 0)

{

State = BodyState.Limp;

**if** (DecayTimer > 0)

DecayTimer -= Time.fixedDeltaTime;

**else**

{

DecayTimer = 5;

Health--;

}

**if** (!Death)

{

Death = **true**;

**int** Count = UnityEngine.Random.Range(1, 4);

**for** (**int** i = 0; i < Count; i++)

{

CoinEntity CE = **new** CoinEntity();

CE.Money = 1;

CE.Position = Position;

CE.Health = UnityEngine.Random.Range(0f, 1f) < 0.25f ? 1 : 0;

}

}

}

**if** (Health < -CorpseHP)

{

DZEngine.Destroy(**this**);

}

**if** (CurrentWayPoint < Traversal.Traversal.Count)

{

WayPoint WP = Traversal.Traversal[CurrentWayPoint];

Vector2 WPActualPosition = Main.Tilemap.TilemapToWorldPosition(WP.Position);

MovementDirection = PathingAlgorithm(Main.Tilemap, WP, Position);

**if** ((Position.x < WPActualPosition.x + 0.5 && Position.x > WPActualPosition.x - 0.5) &&

(Position.y < WPActualPosition.y + 0.5 && Position.y > WPActualPosition.y - 0.5))

CurrentWayPoint++;

}

**else**

{

Main.TakeLifeForce();

DZEngine.Destroy(**this**);

}

UpdateBodyState();

UpdateMovement();

}

**private** **void** UpdateBodyState()

{

}

**private** Vector2 MovementDirection;

**private** **void** UpdateMovement()

{

**switch** (State)

{

**case** BodyState.Limp:

{

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**break**;

**case** BodyState.Standing:

{

DynamicRunSpeed[0] = 1f;

DynamicRunSpeed[1] = 1.5f;

BodyChunks[0].Velocity += **new** Vector2(Speed \* DynamicRunSpeed[0] \* MovementDirection.x, Speed \* DynamicRunSpeed[0] \* MovementDirection.y);

BodyChunks[1].Velocity += **new** Vector2(Speed \* DynamicRunSpeed[1] \* MovementDirection.x, Speed \* DynamicRunSpeed[1] \* MovementDirection.y);

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**break**;

}

}

**public** **override** **void** BodyPhysicsUpdate()

{

**switch** (State)

{

**case** BodyState.Limp:

{

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, Vector2.zero, 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **true**;

}

**break**;

**case** BodyState.Standing:

{

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, **new** Vector2(0, 0.3f), 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **false**;

**float** Dist = Vector2.Distance(BodyChunks[0].Position, BodyChunks[1].Position);

Vector2 Dir = (BodyChunks[0].Position - BodyChunks[1].Position).normalized;

BodyChunks[1].Position += Dist \* Dir \* 0.8f;

BodyChunks[1].Velocity += Dist \* Dir \* 0.8f;

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**break**;

}

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

BodyChunks[1].Gravity = Gravity;

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

BodyChunks[1].Delete();

BodyChunkConnections[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes((**int**)State));

Data.AddRange(BodyChunks[0].GetBytes());

Data.AddRange(BodyChunks[1].GetBytes());

Data.AddRange(BodyChunkConnections[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** BodyState State;

**public** BodyChunk.Data BodyChunk0;

**public** BodyChunk.Data BodyChunk1;

**public** DistanceJoint.Data BodyChunkConnections0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

State = (BodyState)Data.ReadInt(),

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunk1 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunkConnections0 = (DistanceJoint.Data)DistanceJoint.ParseBytesToData(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

State = Data.State;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

BodyChunks[1].ParseSnapshot(Data.BodyChunk1);

BodyChunkConnections[0].ParseSnapshot(Data.BodyChunkConnections0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

State = State,

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot(),

BodyChunk1 = (BodyChunk.Data)BodyChunks[1].GetSnapshot(),

BodyChunkConnections0 = (DistanceJoint.Data)BodyChunkConnections[0].GetSnapshot()

};

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

BodyChunks[1].Interpolate(From.BodyChunk1, To.BodyChunk1, Time);

BodyChunkConnections[0].Interpolate(From.BodyChunkConnections0, To.BodyChunkConnections0, Time);

}

}

**Server/Assets/Scripts/Creatures/PlayerCreature.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** ClientHandle;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**public** **class** PlayerCreature : AbstractCreature, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.PlayerCreature;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **bool** Out;

**public** **float** RunSpeed;

**public** **class** Control

{

**public** PlayerController Owner;

**public** Vector2 MovementDirection;

**public** Vector2 ShieldVector;

**public** **float** Interact;

**public** **struct** Snapshot

{

**public** **ulong** InputID;

**public** Vector2 MovementDirection;

}

**public** **ulong** InputID;

**public** Snapshot GetSnapshot()

{

**return** **new** Snapshot()

{

InputID = InputID++,

MovementDirection = MovementDirection

};

}

**public** **void** ParseSnapshot(Snapshot Snapshot)

{

MovementDirection = Snapshot.MovementDirection;

}

}

**public** Control Controller { **get**; **private** **set**; } //Controller for player movement

**private** **float**[] DynamicRunSpeed; //Controls Speed of each bodychunk

**public** PlayerCreature(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** PlayerCreature()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

BodyChunks[1].RenderObject.gameObject.transform.localScale = **new** Vector2(0.5f, 0.5f);

}

Color BodyColor;

**private** **void** Initialize()

{

**if** (DZSettings.ClientSidePrediction)

Histogram = **new** DZNetwork.JitterBuffer<PlayerSnapshot>();

Controller = **new** Control();

RunSpeed = 2f;

BodyChunks = **new** BodyChunk[2];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[1] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.25f;

BodyChunks[1].Collider.radius = 0.25f;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.PlayerCreature;

BodyChunks[1].Context = **this**;

BodyChunks[1].ContextType = DZSettings.EntityType.PlayerCreature;

SetGravity(0f);

BodyChunkConnections = **new** DistanceJoint[1];

BodyChunkConnections[0] = **new** DistanceJoint();

BodyChunkConnections[0].Set(**new** DistanceJointData(BodyChunks[0], BodyChunks[1], 0.5f, Vector2.zero));

BodyChunkConnections[0].Active = **false**;

Physics2D.IgnoreCollision(BodyChunks[0].Collider, BodyChunks[1].Collider, **true**); //Ignore collisions between body parts

DynamicRunSpeed = **new** **float**[2];

BodyColor = **new** Color(UnityEngine.Random.Range(0f, 1f), UnityEngine.Random.Range(0f, 1f), UnityEngine.Random.Range(0f, 1f));

BodyChunks[0].RenderColor = BodyColor;

BodyChunks[1].RenderColor = BodyColor;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

**if** (BodyChunks[1] != **null**)

BodyChunks[1].Position = value;

}

}

**public** **void** ApplyVelocity(Vector2 Direction, **float** Force)

{

BodyChunks[0].Velocity += Direction \* Force;

}

**public** **void** ApplyVelocity(Vector2 Vel)

{

BodyChunks[0].Velocity += Vel;

}

**public** **void** ServerUpdate()

{

**if** (Controller.Owner == **null** || DZSettings.ClientSidePrediction == **false**) **return**;

UpdateReconcilliation();

LerpReconcilleError();

BodyChunks[0].PhysicallyActive = **true**;

BodyChunks[1].PhysicallyActive = **true**;

BodyChunkConnections[0].PhysicallyActive = **true**;

BodyChunks[0].Kinematic = **false**;

BodyChunks[1].Kinematic = **false**;

}

**bool** Placed = **false**;

**public** **override** **void** Update()

{

**if** (Main.GameStarted)

{

**if** (Controller.Interact > 0 && !Placed)

{

Placed = **true**;

Vector2Int PlacePositionBounds0 = Main.Tilemap.WorldPositionToTilemap(Position + **new** Vector2(0.3f, 0.3f));

Vector2Int PlacePositionBounds1 = Main.Tilemap.WorldPositionToTilemap(Position + **new** Vector2(0.3f, -0.3f));

Vector2Int PlacePositionBounds2 = Main.Tilemap.WorldPositionToTilemap(Position + **new** Vector2(-0.3f, 0.3f));

Vector2Int PlacePositionBounds3 = Main.Tilemap.WorldPositionToTilemap(Position + **new** Vector2(-0.3f, -0.3f));

**if** (Main.Tilemap.GetFloorTileAtPosition(PlacePositionBounds0).AnimationFrame != 2 &&

Main.Tilemap.GetFloorTileAtPosition(PlacePositionBounds1).AnimationFrame != 2 &&

Main.Tilemap.GetFloorTileAtPosition(PlacePositionBounds2).AnimationFrame != 2 &&

Main.Tilemap.GetFloorTileAtPosition(PlacePositionBounds3).AnimationFrame != 2 &&

Main.Tilemap.GetWallTileAtPosition(PlacePositionBounds0).Blank != 1 &&

Main.Tilemap.GetWallTileAtPosition(PlacePositionBounds1).Blank != 1 &&

Main.Tilemap.GetWallTileAtPosition(PlacePositionBounds2).Blank != 1 &&

Main.Tilemap.GetWallTileAtPosition(PlacePositionBounds3).Blank != 1)

{

Collider2D[] C = Physics2D.OverlapCircleAll(Position, 0.5f);

**bool** ValidPlace = **true**;

**for** (**int** i = 0; i < C.Length; i++)

{

**if** (C[i] != **null**)

{

AbstractWorld AW = C[i].GetComponent<AbstractWorld>();

**if** (AW == **null** || (AW != **null** && AW.Type != DZSettings.EntityType.PlayerCreature))

{

ValidPlace = **false**;

}

}

}

**if** (ValidPlace && Main.Money >= 10)

{

Main.Money -= 10;

Turret T = **new** Turret();

T.Position = Position;

Main.Towers.Add(T);

}

}

}

**else** **if** (Controller.Interact <= 0)

{

Placed = **false**;

}

}

UpdateBodyState();

UpdateMovement();

}

**private** **void** UpdateBodyState()

{

}

**private** **void** UpdateMovement()

{

DynamicRunSpeed[0] = 1f;

DynamicRunSpeed[1] = 1.5f;

**if** (Controller != **null**)

{

BodyChunks[0].Velocity += **new** Vector2(RunSpeed \* DynamicRunSpeed[0] \* Controller.MovementDirection.x, RunSpeed \* DynamicRunSpeed[0] \* Controller.MovementDirection.y);

BodyChunks[1].Velocity += **new** Vector2(RunSpeed \* DynamicRunSpeed[1] \* Controller.MovementDirection.x, RunSpeed \* DynamicRunSpeed[1] \* Controller.MovementDirection.y);

}

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**public** **override** **void** BodyPhysicsUpdate()

{

BodyChunks[0].Kinematic = **false**;

BodyChunks[1].Kinematic = **false**;

SetGravity(0f);

BodyChunks[1].SpriteOffset = Vector2.Lerp(BodyChunks[1].SpriteOffset, **new** Vector2(0, 0.3f), 4 \* Time.fixedDeltaTime);

BodyChunkConnections[0].Active = **false**;

**float** Dist = Vector2.Distance(BodyChunks[0].Position, BodyChunks[1].Position);

Vector2 Dir = (BodyChunks[0].Position - BodyChunks[1].Position).normalized;

BodyChunks[1].Position += Dist \* Dir \* 0.8f;

BodyChunks[1].Velocity += Dist \* Dir \* 0.8f;

BodyChunks[0].Velocity \*= 0.8f;

BodyChunks[1].Velocity \*= 0.8f;

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

BodyChunks[1].Gravity = Gravity;

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

BodyChunks[1].Delete();

BodyChunkConnections[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BitConverter.GetBytes(Controller.InputID));

Data.AddRange(BodyChunks[0].GetBytes());

Data.AddRange(BodyChunks[1].GetBytes());

Data.AddRange(BodyChunkConnections[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** **ulong** InputID;

**public** BodyChunk.Data BodyChunk0;

**public** BodyChunk.Data BodyChunk1;

**public** DistanceJoint.Data BodyChunkConnections0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

InputID = Data.ReadULong(),

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunk1 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data),

BodyChunkConnections0 = (DistanceJoint.Data)DistanceJoint.ParseBytesToData(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

**if** (Controller.Owner != **null** && DZSettings.ClientSidePrediction && !Reconcille)

**return**;

Data Data = (Data)ObjectData;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

BodyChunks[1].ParseSnapshot(Data.BodyChunk1);

BodyChunkConnections[0].ParseSnapshot(Data.BodyChunkConnections0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

InputID = Controller.InputID,

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot(),

BodyChunk1 = (BodyChunk.Data)BodyChunks[1].GetSnapshot(),

BodyChunkConnections0 = (DistanceJoint.Data)BodyChunkConnections[0].GetSnapshot()

};

}

**public** **class** PlayerSnapshot

{

**public** Data Snapshot;

**public** Control.Snapshot Controls;

}

**public** DZNetwork.JitterBuffer<PlayerSnapshot> Histogram = **null**;

**private** **void** UpdateReconcilliation()

{

Histogram.Add(**new** PlayerSnapshot()

{

Snapshot = (Data)GetSnapshot(),

Controls = Controller.GetSnapshot()

});

}

**private** **void** LerpReconcilleError()

{

**const** **float** Amount = 4f;

**float** Error = (ReconcilledSelf.BodyChunk0.Position - BodyChunks[0].Position).SqrMagnitude();

**if** (Error < 1)

{

BodyChunks[0].Position = Vector3.Lerp(BodyChunks[0].Position, ReconcilledSelf.BodyChunk0.Position, Amount \* Time.fixedDeltaTime);

BodyChunks[1].Position = Vector3.Lerp(BodyChunks[1].Position, ReconcilledSelf.BodyChunk1.Position, Amount \* Time.fixedDeltaTime);

}

**else**

{

BodyChunks[0].Position = ReconcilledSelf.BodyChunk0.Position;

BodyChunks[1].Position = ReconcilledSelf.BodyChunk1.Position;

}

}

**private** PlayerSnapshot Current = **null**;

**public** Data CurrentSelf;

**private** **bool** ValidPredictPass;

**private** **bool** FinishedPredict;

**public** **void** StartClientPrediction(Game.ServerSnapshot FromData)

{

ValidPredictPass = FromData.Data.ContainsKey(ID);

CurrentSelf = (Data)GetSnapshot();

Reconcille = **true**;

**if** (!ValidPredictPass) **return**;

Data ClientPredictBaseline = (Data)FromData.Data[ID].Data;

**if** (LastReconcilled >= ClientPredictBaseline.InputID)

{

ValidPredictPass = **false**;

**return**;

}

LastReconcilled = ClientPredictBaseline.InputID;

Histogram.Iterate(S =>

{

**if** (S.Value.Controls.InputID >= ClientPredictBaseline.InputID)

{

Current = S.Value;

}

}, S => S.Value.Controls.InputID >= ClientPredictBaseline.InputID);

**if** (Current != **null**)

{

Histogram.Dequeue(Current);

ParseSnapshot(ClientPredictBaseline);

FinishedPredict = **false**;

CurrentKey = Histogram.FirstKey;

}

**else**

{

Histogram.Clear();

ValidPredictPass = **false**;

}

}

**private** DZNetwork.JitterBuffer<PlayerSnapshot>.Key CurrentKey;

**public** **void** ClientPrediction()

{

**if** (!ValidPredictPass) **return**;

**if** (CurrentKey != **null**)

{

Controller.ParseSnapshot(CurrentKey.Value.Controls);

**if** (!FinishedPredict && CurrentKey.Next == **null**)

{

FinishedPredict = **true**;

ReconcilledSelf = (Data)GetSnapshot();

}

CurrentKey = CurrentKey.Next;

}

}

**public** **void** EndClientPrediction()

{

ParseSnapshot(CurrentSelf);

Reconcille = **false**;

}

**private** Data ReconcilledSelf;

**private** **bool** Reconcille = **false**;

**private** **ulong** LastReconcilled = 0;

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

**if** (Controller.Owner != **null** && DZSettings.ClientSidePrediction)

**return**;

Data From = (Data)FromData;

Data To = (Data)ToData;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

BodyChunks[1].Interpolate(From.BodyChunk1, To.BodyChunk1, Time);

BodyChunkConnections[0].Interpolate(From.BodyChunkConnections0, To.BodyChunkConnections0, Time);

}

}

**Server/Assets/Scripts/Creatures/Turret.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine.Entities;

**using** DeadZoneEngine.Entities.Components;

**using** DeadZoneEngine;

**public** **class** Turret : AbstractCreature, IServerSendable

{

**public** **int** ServerObjectType { **get**; **set**; } = (**int**)DZSettings.EntityType.Turret;

**public** **bool** RecentlyUpdated { **get**; **set**; } = **false**;

**public** **bool** ProtectedDeletion { **get**; **set**; } = **false**;

**public** **float** Timer = 0;

**public** **float** FireRate = 2;

**public** **float** LifeTime = 150;

**public** Turret(**ushort** ID) : **base**(ID)

{

Initialize();

}

**public** Turret()

{

Initialize();

}

**public** **override** **void** Render()

{

BodyChunks[0].RenderObject.gameObject.transform.localScale = **new** Vector2(0.7f, 0.7f);

}

Color BodyColor;

**private** **void** Initialize()

{

BodyChunks = **new** BodyChunk[1];

BodyChunks[0] = **new** BodyChunk(**this**);

BodyChunks[0].Collider.radius = 0.35f;

BodyChunks[0].Kinematic = **true**;

BodyChunks[0].Context = **this**;

BodyChunks[0].ContextType = DZSettings.EntityType.Turret;

SetGravity(0f);

BodyColor = **new** Color(0.56f, 0.56f, 0.56f);

BodyChunks[0].RenderColor = BodyColor;

}

**public** **void** SetGravity(**float** Gravity)

{

BodyChunks[0].Gravity = Gravity;

}

**public** Vector2 Position

{

**get**

{

**if** (BodyChunks[0] != **null**)

**return** BodyChunks[0].Position;

**return** Vector2.zero;

}

**set**

{

**if** (BodyChunks[0] != **null**)

BodyChunks[0].Position = value;

}

}

**public** **void** ServerUpdate()

{

}

Action<Turret> PerformFireAction = (Turret Self) =>

{

Vector2[] Directions = **new** Vector2[]

{

**new** Vector2(0, 1),

**new** Vector2(0, -1),

**new** Vector2(1, 0),

**new** Vector2(-1, 0),

**new** Vector2(1, 1),

**new** Vector2(1, -1),

**new** Vector2(-1, 1),

**new** Vector2(-1, -1)

};

**for** (**int** i = 0; i < Directions.Length; i++)

{

BulletEntity Shot = **new** BulletEntity();

Shot.Position = Self.Position;

Shot.Direction = Directions[i].normalized;

Shot.Speed = 2f;

}

};

**public** **override** **void** Update()

{

LifeTime -= Time.fixedDeltaTime;

**if** (LifeTime < 0)

{

DZEngine.Destroy(**this**);

}

Timer += Time.fixedDeltaTime;

**if** (Timer >= FireRate)

{

Timer = 0;

PerformFireAction?.Invoke(**this**);

}

}

**private** **void** UpdateBodyState()

{

}

**protected** **override** **void** OnDelete()

{

BodyChunks[0].Delete();

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.AddRange(BodyChunks[0].GetBytes());

**return** Data.ToArray();

}

**public** **override** **void** ParseBytes(DZNetwork.Packet Data)

{

ParseSnapshot((Data)ParseBytesToSnapshot(Data));

}

**public** **struct** Data

{

**public** BodyChunk.Data BodyChunk0;

}

**public** **static** **object** ParseBytesToSnapshot(DZNetwork.Packet Data)

{

**return** **new** Data()

{

BodyChunk0 = (BodyChunk.Data)BodyChunk.ParseBytesToSnapshot(Data)

};

}

**public** **override** **void** ParseSnapshot(**object** ObjectData)

{

Data Data = (Data)ObjectData;

BodyChunks[0].ParseSnapshot(Data.BodyChunk0);

}

**public** **override** **object** GetSnapshot()

{

**return** **new** Data()

{

BodyChunk0 = (BodyChunk.Data)BodyChunks[0].GetSnapshot()

};

}

**public** **override** **void** Interpolate(**object** FromData, **object** ToData, **float** Time)

{

Data From = (Data)FromData;

Data To = (Data)ToData;

BodyChunks[0].Interpolate(From.BodyChunk0, To.BodyChunk0, Time);

}

}

**Server/Assets/Scripts/Creatures/DZSettings.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**public** **static** **class** DZSettings

{

**public** **enum** EntityType

{

Null,

PlayerCreature,

Tilemap,

TriggerPlate,

BulletEntity,

EnemyCreature,

Turret,

CoinEntity,

CrystalEntity

}

**public** **static** **int** NumPhysicsIterations = 10;

**public** **static** **bool** ActiveRenderers = **true**;

**public** **static** **bool** ActiveControllers = **false**;

**public** **static** **bool** ClientSidePrediction = **false**;

**public** **static** **bool** Client = **false**;

}

**Server/Assets/Scripts/Creatures/Game.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** ClientHandle;

**using** DZNetwork;

**using** DeadZoneEngine.Entities;

**using** System.Net;

**using** DeadZoneEngine.Controllers;

/// <summary>

/// Manages the server connection and game functionality

/// </summary>

**public** **class** Game

{

**public** **class** ServerSnapshot

{

**public** **struct** Object

{

**public** DZSettings.EntityType Type;

**public** **bool** FlaggedToDelete;

**public** **object** Data;

}

**public** **ulong** ServerTick;

**public** Dictionary<**ushort**, Object> Data = **new** Dictionary<**ushort**, Object>();

}

**public** **static** **ulong** ServerTicks = 0;

**public** **static** **int** ServerTickRate = 60;

/// <summary>

/// Called once a frame

/// </summary>

**public** **static** **void** FixedUpdate()

{

Loader.Socket.FixedUpdate();

UpdateClients();

SendSnapshot();

ServerTicks++;

}

**private** **static** **void** UpdateClients()

{

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**foreach** (Client C **in** Clients)

{

**if** (C != **null**)

**if** (C.LostConnection)

{

**if** (C.TicksSinceConnectionLoss > Client.TicksToTimeout)

C.Destroy();

C.TicksSinceConnectionLoss++;

}

**else**

C.TicksSinceConnectionLoss = 0;

}

}

**private** **static** **void** SendSnapshot() //Sends world snapshot to given client

{

Packet SnapshotPacket = **new** Packet();

SnapshotPacket.Write(ServerTickRate);

SnapshotPacket.Write(ServerTicks);

SnapshotPacket.Write(Main.LifeForce[0]);

SnapshotPacket.Write(Main.LifeForce[1]);

SnapshotPacket.Write(Main.LifeForce[2]);

SnapshotPacket.Write(Main.Money);

SnapshotPacket.Write(DZEngine.ServerSendableObjects.Count);

**for** (**int** i = 0; i < DZEngine.ServerSendableObjects.Count; i++)

{

SnapshotPacket.Write(DZEngine.GetBytes(DZEngine.ServerSendableObjects[i]));

}

SnapshotPacket.InsertCheckSum(**sizeof**(**int**) + **sizeof**(**ulong**));

Loader.Socket.Send(SnapshotPacket, ServerCode.ServerSnapshot);

}

**public** **static** Client SyncPlayers(DZUDPSocket.RecievePacketWrapper Packet)

{

Client C = Client.GetClient(Packet.Client);

**byte** NumPlayers = Packet.Data.ReadByte();

**if** (C.NumPlayers != NumPlayers)

{

**while** (C.NumPlayers < NumPlayers)

C.AddPlayer();

}

Packet SyncPacket = **new** Packet();

SyncPacket.Write(NumPlayers);

SyncPacket.Write(C.ID);

**for** (**int** i = 0; i < C.NumPlayers; i++)

{

**if** (C.Players[i] == **null**)

SyncPacket.Write(**byte**.MaxValue);

**else**

SyncPacket.Write(C.Players[i].GetBytes());

}

Loader.Socket.SendTo(SyncPacket, ServerCode.SyncPlayers, Packet.Client);

**return** C;

}

**public** **static** **void** UnWrapSnapshot(DZUDPSocket.RecievePacketWrapper Packet)

{

Client C = SyncPlayers(Packet);

InputMapping.ParseBytes(Packet.Data, C);

}

**public** **static** **void** AddConnection(IPEndPoint EndPoint)

{

Debug.Log("Client Connected: " + EndPoint.Address + ":" + EndPoint.Port);

Client ConnectedClient = Client.GetClient(EndPoint);

ConnectedClient.LostConnection = **false**;

}

**public** **static** **void** RemoveConnection(IPEndPoint EndPoint)

{

Debug.Log("Client Disconnected: " + EndPoint.Address + ":" + EndPoint.Port);

Client DisconnectedClient = Client.GetClient(EndPoint);

DisconnectedClient.LostConnection = **true**;

}

}

**Server/Assets/Scripts/Creatures/InputManager.cs**

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**using** UnityEngine.InputSystem;

**using** UnityEngine;

**using** DeadZoneEngine.Controllers;

**using** ClientHandle;

**using** **static** DeadZoneEngine.Controllers.InputMapping;

**using** DZNetwork;

**public** **class** PlayerController : Controller

{

**public** Player Owner;

**public** PlayerCreature.Control PlayerControl;

**public** PlayerController(Player Owner, PlayerCreature.Control PlayerControl) : **base**()

{

**this**.Owner = Owner;

**this**.PlayerControl = PlayerControl;

}

**public** PlayerController(InputDevice Device, DeviceController DC) : **base**(Device, DC)

{

InputAction Movement = ActionMap.AddAction("Movement", InputActionType.PassThrough);

InputAction Interact = ActionMap.AddAction("Interact", InputActionType.Button);

**if** (Device **is** Keyboard)

{

Movement.AddCompositeBinding("2DVector(mode=2)")

.With("Up", Device.path + "/w")

.With("Down", Device.path + "/s")

.With("Left", Device.path + "/a")

.With("Right", Device.path + "/d");

Interact.AddBinding(Device.path + "/space");

}

**else**

{

Movement.AddCompositeBinding("2DVector(mode=2)")

.With("Up", Device.path + "/stick/up")

.With("Down", Device.path + "/stick/down")

.With("Left", Device.path + "/stick/left")

.With("Right", Device.path + "/stick/right");

Interact.AddBinding(Device.path + "/dpad/up");

}

Movement.performed += MoveAction;

Interact.performed += InteractAction;

}

**protected** **override** **void** SetType()

{

Type = ControllerType.PlayerController;

}

**public** **override** **void** OnInput(UnityEngine.InputSystem.Controls.ButtonControl Control)

{

}

**private** Vector2 MovementDirection;

**private** **float** Interact;

**public** **void** MoveAction(InputAction.CallbackContext Context)

{

MovementDirection = Context.ReadValue<Vector2>();

}

**public** **void** InteractAction(InputAction.CallbackContext Context)

{

Interact = Context.ReadValue<**float**>();

}

**public** **override** **void** Tick()

{

**if** (PlayerControl == **null**) **return**;

PlayerControl.MovementDirection = MovementDirection;

PlayerControl.Interact = Interact;

}

**public** **override** **void** ParseBytes(Packet Data)

{

PlayerControl.InputID = Data.ReadULong();

PlayerControl.Interact = Data.ReadFloat();

PlayerControl.MovementDirection = **new** Vector2(Data.ReadFloat(), Data.ReadFloat());

}

**public** **override** **byte**[] GetBytes()

{

List<**byte**> Data = **new** List<**byte**>();

Data.Add(Owner.ID);

Data.AddRange(BitConverter.GetBytes(PlayerControl.InputID));

Data.AddRange(BitConverter.GetBytes(PlayerControl.Interact));

Data.AddRange(BitConverter.GetBytes(PlayerControl.MovementDirection.x));

Data.AddRange(BitConverter.GetBytes(PlayerControl.MovementDirection.y));

**return** Data.ToArray();

}

}

**public** **static** **class** InputManager

{

**public** **static** **void** Initialize()

{

InputMapping.OnDeviceAdd += OnDeviceAdd;

InputMapping.OnDeviceDisconnect += OnDeviceDisconnect;

InputMapping.OnDeviceReconnect += OnDeviceReconnect;

InputMapping.OnDeviceRemove += OnDeviceRemove;

}

**public** **static** **void** OnDeviceAdd(InputDevice Device)

{

}

**public** **static** **void** OnDeviceDisconnect(InputDevice Device)

{

}

**public** **static** **void** OnDeviceReconnect(InputDevice Device)

{

}

**public** **static** **void** OnDeviceRemove(InputDevice Device)

{

}

}

**Server/Assets/Scripts/Creatures/Loader.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** UnityEngine;

**using** System.IO;

**using** DZNetwork;

**using** System;

**using** System.Text.RegularExpressions;

**public** **class** Loader

{

**public** **static** DZServer Socket = **new** DZServer();

[RuntimeInitializeOnLoadMethod] //Runs on application start

**private** **static** **void** Start()

{

Physics2D.queriesStartInColliders = **false**;

Application.quitting += Dispose; //Setup dispose to call when game is closed

Application.targetFrameRate = Game.ServerTickRate; //Limit server tick rate / frame rate

Time.fixedDeltaTime = 1f / Game.ServerTickRate; //Fixed physics update rate

QualitySettings.vSyncCount = 0; //Turn off vsync

Physics2D.simulationMode = SimulationMode2D.Script; //My program controls when unity updates

Socket.ConnectHandle += Game.AddConnection;

Socket.DisconnectHandle += Game.RemoveConnection;

Socket.PacketHandle += ServerHandle.ProcessPacket;

**int** Port = 26950;

**try**

{

**string** Text = Regex.Replace(File.ReadAllText(@"Server.cfg"), @"[ \n\r\t]", "");

Port = **int**.Parse(Text.Split(':')[1]);

}

**catch** (Exception E)

{

Port = 26950;

}

Socket.Connect(Port); //Startup server

}

**private** **static** **void** Dispose()

{

Socket.Dispose();

}

}

**Server/Assets/Scripts/Creatures/Main.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** UnityEngine;

**using** DeadZoneEngine;

**using** DeadZoneEngine.Entities;

**using** ClientHandle;

**using** System.Linq;

**public** **static** **class** Main

{

//Sorting layers for rendering

**public** **enum** SortingLayers

{

Default

}

**private** **static** DZEngine.ManagedList<IRenderer<SpriteRenderer>> SpriteRenderers = **new** DZEngine.ManagedList<IRenderer<SpriteRenderer>>(); //List of SpriteRenderers

**public** **static** Tilemap Tilemap;

**private** **static** TriggerPlate StartPlate;

**public** **static** **bool** GameStarted = **false**;

// Start is called before the first frame update

**public** **static** **void** Start()

{

LoadMenu();

}

**const** **string** MenuFloorMap =

@"

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/

            0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1/0,0,0,1

            ";

**const** **string** MenuWallMap =

@"

            1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/0,0,1,0/1,1,0,1/

            1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1/1,1,0,1

            ";

**private** **static** **void** LoadMenu()

{

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**foreach** (Client C **in** Clients)

{

**if** (C == **null** || C.Players == **null**)

**continue**;

**for** (**int** i = 0; i < C.Players.Length; i++)

{

**if** (C.Players[i] == **null** || C.Players[i].Entity == **null**) **continue**;

C.Players[i].Entity.Position = **new** Vector2(UnityEngine.Random.Range(-8f, 8f), UnityEngine.Random.Range(-8f, 8f));

C.Players[i].Entity.Out = **false**;

}

}

**if** (Tilemap == **null**)

{

Tilemap = (Tilemap)**new** Tilemap(32, 64, **new** Vector2Int(20, 20), Tilemap.TilesFromString(MenuFloorMap), Tilemap.TilesFromString(MenuWallMap)).Create();

}

**else**

{

Tilemap.Resize(**new** Vector2Int(20, 20), Tilemap.TilesFromString(MenuFloorMap), Tilemap.TilesFromString(MenuWallMap));

Tilemap.ReleaseUnusedResources();

}

StartPlate = **new** TriggerPlate(**new** Vector2(4, 2), **new** Vector2(0, -3));

StartPlate.OnTrigger = StartGame;

}

**private** **static** EnemyCreature.Path GeneratePath(**int** Height, **int** Width)

{

List<EnemyCreature.WayPoint> Path = **new** List<EnemyCreature.WayPoint>();

**int** NumTurns = UnityEngine.Random.Range(6, 10);

**string**[] Tiles = **null**;

**bool** ValidPath = **false**;

**while** (!ValidPath)

{

Path.Clear();

Tiles = MenuFloorMap.Split('/');

Vector2Int StartPosition = **new** Vector2Int(1, UnityEngine.Random.Range(1, Height - 1));

**float** Chance = UnityEngine.Random.Range(0f, 1f);

**if** (Chance > 0.25)

StartPosition = **new** Vector2Int(Width - 2, UnityEngine.Random.Range(1, Height - 1));

**else** **if** (Chance > 0.5)

StartPosition = **new** Vector2Int(UnityEngine.Random.Range(1, Width - 1), 1);

**else** **if** (Chance > 0.75)

StartPosition = **new** Vector2Int(UnityEngine.Random.Range(1, Width - 1), Height - 2);

**int** Direction = 1;

**if** (Chance > 0.25)

Direction = 3;

**else** **if** (Chance > 0.5)

Direction = 0;

**else** **if** (Chance > 0.75)

Direction = 2;

Path.Add(**new** EnemyCreature.WayPoint()

{

Direction = Direction,

Position = StartPosition

});

**for** (**int** i = 0; i < NumTurns; i++)

{

**int** CurrentDirection = Direction;

**int** Length = UnityEngine.Random.Range(3, 8);

**if** (i == NumTurns - 1)

{

**switch** (Direction)

{

**case** 0: Length = Height - StartPosition.y; **break**;

**case** 1: Length = Width - StartPosition.x; **break**;

**case** 2: Length = StartPosition.y; **break**;

**case** 3: Length = StartPosition.x; **break**;

}

}

**for** (**int** j = 0; j < Length; j++)

{

Tiles[StartPosition.y \* Width + StartPosition.x] = "0,2,0,1";

Vector2Int NewPosition = StartPosition;

**switch** (Direction)

{

**case** 0: NewPosition.y++; **break**;

**case** 1: NewPosition.x++; **break**;

**case** 2: NewPosition.y--; **break**;

**case** 3: NewPosition.x--; **break**;

}

**if** (NewPosition.x < 1 || NewPosition.x > Width - 2 || NewPosition.y < 1 || (NewPosition.y > Height - 3 && Direction == 0))

{

**break**;

}

StartPosition = NewPosition;

}

**bool** ValidDirection = **true**;

**do**

{

Direction = (Direction + (UnityEngine.Random.Range(0f, 1f) > 0.5 ? 1 : -1)) % 4;

**if** (Direction < 0) Direction += 4;

Vector2Int NewPosition = StartPosition;

**switch** (Direction)

{

**case** 0: NewPosition.y++; **break**;

**case** 1: NewPosition.x++; **break**;

**case** 2: NewPosition.y--; **break**;

**case** 3: NewPosition.x--; **break**;

}

**if** (NewPosition.x < 1 || NewPosition.x > Width - 1 || NewPosition.y < 1 || NewPosition.y > Height - 2)

{

ValidDirection = **false**;

}

**else** **if** (Tiles[NewPosition.y \* Width + NewPosition.x] == "0,2,0,1")

{

ValidDirection = **false**;

}

}

**while** (CurrentDirection == Direction && !ValidDirection);

Path.Add(**new** EnemyCreature.WayPoint()

{

Direction = CurrentDirection,

Position = StartPosition

});

}

**bool** TopLeftQuadrant = **false**;

**bool** TopRightQuadrant = **false**;

**bool** BottomLeftQuadrant = **false**;

**bool** BottomRightQuadrant = **false**;

**for** (**int** i = 0; i < Path.Count; i++)

{

**if** (Path[i].Position.x < Width / 2)

{

**if** (Path[i].Position.y < Height / 2)

{

BottomLeftQuadrant = **true**;

}

**else**

{

TopLeftQuadrant = **true**;

}

}

**else**

{

**if** (Path[i].Position.y < Height / 2)

{

BottomRightQuadrant = **true**;

}

**else**

{

TopRightQuadrant = **true**;

}

}

}

ValidPath = TopLeftQuadrant && TopRightQuadrant && BottomLeftQuadrant && BottomRightQuadrant;

}

**return** **new** EnemyCreature.Path()

{

Map = **string**.Join("/", Tiles),

Traversal = Path

};

}

**private** **static** EnemyCreature.Path CurrentPath;

**public** **static** **void** StartGame()

{

CurrentPath = GeneratePath(20, 20);

Tilemap.Resize(**new** Vector2Int(20, 20), Tilemap.TilesFromString(CurrentPath.Map), Tilemap.TilesFromString(MenuWallMap));

GameStarted = **true**;

DZEngine.Destroy(StartPlate);

}

**public** **static** **int**[] LifeForce = **new** **int**[3] { 10, 10, 10 };

**private** **static** **float** WaveTimer = 5;

**private** **static** **int** WaveSize = 10;

**private** **static** **int** WaveMaxSize = 10;

**private** **static** **int** WaveHealth = 1;

**private** **static** **int** Wave = 0;

**private** **static** **float** WaveSpacing = 0.3f;

**private** **static** **float** WaveSpacingMax = 1;

**private** **static** **int** EnemiesToSpawn = 5;

**private** **static** **float** SpawnTimer = 0;

**public** **static** **int** Money = 40;

**public** **static** **float** Drain = 0;

**private** **static** List<EnemyCreature> Enemies = **new** List<EnemyCreature>();

**public** **static** List<Turret> Towers = **new** List<Turret>();

**public** **static** **void** TakeLifeForce()

{

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] > 0)

{

LifeForce[i]--;

**break**;

}

}

}

**public** **static** **void** GainLifeForce(**int** Health)

{

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] != 0)

{

LifeForce[i] += Health;

**if** (LifeForce[i] > 10)

LifeForce[i] = 10;

**break**;

}

}

}

**private** **static** **void** Reset()

{

Money = 40;

**for** (**int** i = 0; i < Enemies.Count; i++)

{

DZEngine.Destroy(Enemies[i]);

}

Enemies.Clear();

**for** (**int** i = 0; i < Towers.Count; i++)

{

DZEngine.Destroy(Towers[i]);

}

Towers.Clear();

LifeForce = **new** **int**[3] { 10, 10, 10 };

GameStarted = **false**;

LoadMenu();

}

// Update is called once per frame

**public** **static** **void** FixedUpdate()

{

**if** (DZSettings.ActiveRenderers == **true**)

**foreach** (IRenderer<SpriteRenderer> Renderer **in** SpriteRenderers)

{

**if** (Renderer.SortingLayer == (**int**)SortingLayers.Default)

Renderer.RenderObject.sortingOrder = Mathf.RoundToInt(-Renderer.RenderObject.transform.parent.position.y \* 10);

}

**if** (GameStarted)

{

**if** (Drain <= 0)

{

Drain = 5;

TakeLifeForce();

}

**else** Drain -= Time.fixedDeltaTime;

List<Client> Clients = ClientID.ConnectedClients.Values.ToList();

**int** TotalNumPlayers = 0;

**foreach** (Client C **in** Clients)

{

**if** (C == **null**) **continue**;

**if** (C.Players == **null**) **continue**;

**for** (**int** i = 0; i < C.Players.Length; i++)

{

**if** (C.Players[i] == **null**) **continue**;

**if** (C.Players[i].Entity == **null**) **continue**;

TotalNumPlayers++;

}

}

**if** (TotalNumPlayers == 0)

{

Reset();

}

**bool** Alive = **false**;

**for** (**int** i = 0; i < LifeForce.Length; i++)

{

**if** (LifeForce[i] > 0)

Alive = **true**;

}

**if** (WaveTimer > 0)

{

WaveTimer -= Time.fixedDeltaTime;

}

**else**

{

WaveTimer = Random.Range(4f, 10f);

Wave++;

EnemiesToSpawn = Random.Range(10, WaveMaxSize);

WaveHealth++;

WaveSpacing = Random.Range(0.1f, WaveSpacingMax);

WaveSpacingMax += Random.Range(-0.5f, 0.5f);

**if** (Random.Range(0f, 1f) < 0.3)

{

WaveSpacing = 0.3f;

}

**if** (WaveSpacing < 0.3)

WaveSpacing = 0.3f;

}

SpawnTimer += Time.fixedDeltaTime;

**if** (WaveTimer <= 0 && EnemiesToSpawn > 0 && SpawnTimer > WaveSpacing)

{

EnemiesToSpawn--;

SpawnTimer = 0;

EnemyCreature EC = **new** EnemyCreature();

EC.Position = Tilemap.TilemapToWorldPosition(CurrentPath.Traversal[0].Position);

EC.Health = WaveHealth;

EC.Traversal = CurrentPath;

Enemies.Add(EC);

}

**if** (Alive == **false**)

{

Reset();

}

}

}

}

**Server/Assets/Scripts/Creatures/ServerHandler.cs**

**using** System.Collections;

**using** System.Collections.Generic;

**using** System.Net;

**using** UnityEngine;

**using** DZNetwork;

**public** **enum** ServerCode

{

Null,

SyncPlayers,

ClientSnapshot,

ServerSnapshot

}

**public** **class** ServerHandler

{

// Start is called before the first frame update

**public** **static** **void** Start()

{

ServerHandle.PacketHandle = (Packet) =>

{

ServerCode Job = (ServerCode)Packet.Data.ReadInt();

PerformServerAction(Packet, Job);

};

ServerHandle.LostPacketHandle = (SentPacketWrapper) =>

{

HandleLostPacket(SentPacketWrapper.Code);

};

}

**private** **static** **void** HandleLostPacket(ServerCode Job)

{

**switch** (Job)

{

**case** ServerCode.Null:

**break**;

**default**:

Debug.LogWarning("Unknown ServerCode: " + Job);

**break**;

}

}

**private** **static** **void** PerformServerAction(DZUDPSocket.RecievePacketWrapper Packet, ServerCode Job)

{

**switch**(Job)

{

**case** ServerCode.SyncPlayers:

Game.SyncPlayers(Packet);

**break**;

**case** ServerCode.ClientSnapshot:

Game.UnWrapSnapshot(Packet);

**break**;

**default**:

Debug.LogWarning("Unknown ServerCode: " + Job);

**break**;

}

}

}

**Testing**

Video of me testing out the main gameplay: <https://bit.ly/3tHSWuU>

**Revisiting objectives:**

## The server should:

1. Establish a connection between multiple clients

*The server can handle more than one connection and multiple players on one client.*

* 1. Allow the means for 2-way communication between the server and client

*This has been achieved clearly as shown in testing as the server and client both sync their state.*

* 1. A standardised packet format will be designed in the design section of the project

*As discussed above, a standard packet format for my protocol has been designed.*

* 1. The server should adjust for packet loss and handle high ping / delayed packets appropriately for both incoming, and outgoing data

*As shown in testing the server can adjust for packet loss and handle a high ping from the client, including packet tampering, loss and duplication.*

1. Authorise the clients incoming data about position and client state
   1. If the server disagrees with the client, the server takes priority for server-authoritative control

*As shown in testing, when the client disagrees with the server the positions are snapped back as shown by the rubber banding effect.*

1. Constantly broadcast a snapshot of its current world state to its clients

*As shown in the testing video a constant stream of world snapshots are being sent to the client in order for it to render the game world.*

* 1. Snapshots should be small, and only contain relevant data towards its respective client to reduce bandwidth usage
     + Such as only the area of the world that a client can see

*This is not very relevant to my context as I only need a single tile map for my game.*

* 1. Snapshots are sent once every server tick

1. Calculate physics of entities

*As can be clearly seen in the video, entities are fully simulated and have the appropriate physics.*

* 1. Players are user-controlled entities that act on standard physics that can be controlled by commands sent via the clients

*As can be clearly seen in the testing video, the player is a user-controlled entity and acts on normal physics*

1. Receive packets relating to player controls from clients
   1. The server should account for ping and delay from the clients when performing actions (if the player is 200ms behind, handle the packet with the world rolled back 200ms)

*This is not very relevant for my context as the players don’t perform any other time critical actions other than movement*

1. Read from a configuration file which allows the user to set the server port

*There is a Server.cfg file of which the server reads from to open a connection from*

## The client should:

1. Provide a GUI for the user
   1. This should be usable by a naïve user

*The GUI is self-explanatory for how to connect simply by inputting the IP address and Port into the top right. It can definitely be improved as I don’t give a tutorial or any information as to how to play the game or start it.*

1. Host a server on the client pc with given settings / options that the user provides

*The server can be hosted on the client pc with the provided options in the Server.cfg file*

1. Handle more than one player on a device and tell the server accordingly to allow for local play to work over multiplayer as well

*As shown by the testing video more than one player can be used per client device*

1. Connect to a server with the IP address and port a user provides

*As shown by the testing video the server can be connected to via an IP address and Port*

1. Receive packets from the server

*As shown by the testing video the program clearly receives packets and unwraps them for the game world.*

* 1. Unwrap the packets and generate the snapshot client side for the user
  2. The client should account for the server tick rate and interpolate between snapshots sent to ensure smooth physics client side despite the slower tick rate of the server

*The client interpolates the server snapshots very well as shown in the testing video*

* 1. The client should account for lost snapshots / high ping and correct for disagreements in position with the server in a smooth fashion to increase quality for the user

*The client accounts for lost packets and high ping and corrects for disagreements smoothly as shown by the video.*

1. Display / Render the player and world onto the screen

*As clearly shown in the testing video the player is rendered onto the screen*

## Stage Minimum Viable Product (Create core gameplay)

1. The game should have a lobby showing the players that are playing.

*As shown at the beginning of the testing video all players are visible in the lobby and can start the game by standing on the starting square.*

1. Each playthrough should be procedurally generated.

*Every time a new game is started a new randomly generated path is made.*

1. Upon entering a level, the game should:
   1. Display the layout of the path the enemies will take.

*As clearly shown in the testing video a clear path is shown.*

* 1. Allow players to move around the level.

*As clearly shown in the testing video all the players can move around in the level*

* 1. Have enemies spawn in waves that follow the path.

*As clearly shown in the testing video the enemies spawn in waves and follow the yellow path.*

* 1. Abide by standard tower defence rules:
     1. Enemies spawn at one end of the path and upon reaching the end the player loses (either entirely or some form of health system).

*As shown in the testing video, enemies spawn at one end of the path and make their way to the end. Upon reaching the end the player looses life.*

* + 1. Players can kill enemies using towers.

*Towers can shoot the enemies as shown in the testing video.*

* + 1. Enemies drop a collectable resource used in creating towers.

*Enemies drop coins that the player can pick up to spend on making more towers*

* 1. Tower shots can hurt the players as well.

*As shown in the testing video getting hit by a tower does damage and can lead to a game over*

* 1. Towers self-destruct at the end of their lifetime.

*After 150 seconds a tower will destroy itself.*

## Stage 2: Enemy variation

1. When generating each level, the game will also define what enemy types will appear in each level and for which waves.

*Unfortunately there is only 1 enemy type that has been implemented.*

1. Enemy variation through different game mechanics or wave formats.

*As clearly shown in the testing video there are various enemy formations with tightly packed waves to very spread out enemies.*

* 1. Enemies that enter in a tightly packed wave.
  2. Enemies that are spread out.
  3. Enemies that move faster / in odd patterns.

1. Possible enemy variation through different behaviour.

*Unfortunately I never got round to implementing various enemy behaviours.*

* 1. Enemies may stagger and stall in “safe areas” along the path where bullets do not cross and hastily cross “dangerous areas” filled with bullets.
  2. Enemies may move quickly in a straight line but slowly along turns.
  3. Enemies may wait for other enemies in “safe areas” and stick together before proceeding.

## Stage 3: Quality of life:

1. Settings to customize the gameplay:

*Unfortunately I never got round to implementing quality of life options.*

* 1. Ability to disable of certain enemy types.
  2. Game modifiers:
     1. Slow motion / Bullet time.
     2. All homing bullets.
     3. Enemies getting through the path instantly cause a loss.
  3. Ability to disable permanent death.
  4. Ability to disable different tower types.
  5. Slow down default game speed.

## Stage 4: Polish:

1. Entity ragdolls (physics-based corpses)

*As clearly shown in the testing video, upon death enemies drop dead as a corpse.*

1. Particles and effects.
2. Character animations.

*Characters are lightly animated through physics*

* 1. Inverse Kinematics

**Evaluation – Potential Extensions and Improvements**

I have a few suggestions for potential improvements and extensions that could be made to my project:

1. Transition into WAN networks through updating my network protocol to better handle congestion.
2. Implementation for security as currently my packets are sent completely bare and are subject for being impersonated or altered over the network. This is not really a problem as my game will not be global and is just used locally, but it would be an improvement to encrypt my packets.
3. Implementing more enemy and tower variations with new mechanics.
4. Implementing a level designer for custom.
5. Implementing a modding API.
6. Graphics overhaul, upgrading the graphics such as using better fonts and symbols for representing health and improving sprite graphics.
7. A proper game over screen rather than just reloading into the lobby.
8. Implementing a text chat system

1. <https://www.vg247.com/2019/04/18/into-the-breach-making-of/> <https://www.gdcvault.com/play/1025772/-Into-the-Breach-Design> [↑](#footnote-ref-1)
2. <http://twvideo01.ubm-us.net/o1/vault/GD_Mag_Archives/GDM_December_2012.pdf> [↑](#footnote-ref-2)
3. [https://www.isoc.org/inet97/proceedings/F3/F3\_1.HTM](https://web.archive.org/web/20160103125117/https://www.isoc.org/inet97/proceedings/F3/F3_1.HTM) [↑](#footnote-ref-3)
4. <https://developer.valvesoftware.com/wiki/Source_Multiplayer_Networking#Lag_compensation> [↑](#footnote-ref-4)
5. https://box2d.org/files/ErinCatto\_SequentialImpulses\_GDC2006.pdf [↑](#footnote-ref-5)
6. <https://ubm-twvideo01.s3.amazonaws.com/o1/vault/gdc09/slides/04-GDC09_Catto_Erin_Solver.pdf> [↑](#footnote-ref-6)