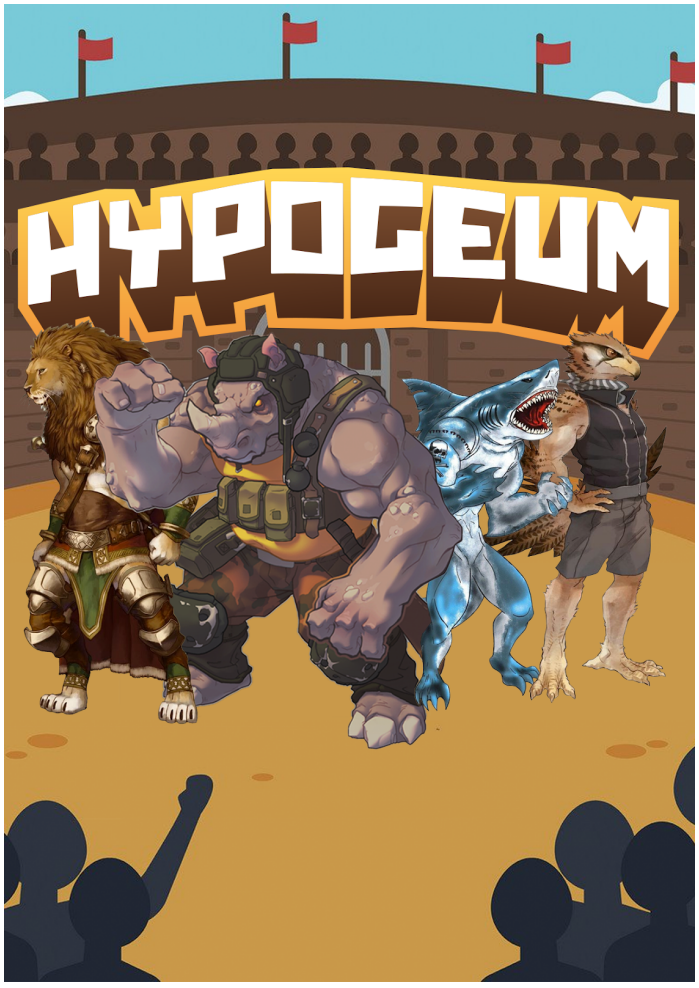
Technical design



Abstract

Since humans had left the Earth, centuries have passed and the blue Planet is now inhabited only by the animals, that have learned to manage the technology of our descendants and to create their own. From that moment, a long war among the different species has taken act, to establish which was the best one. Inspired by the ancient books on "mythology", they decided to set their battles in a huge arena: the Hypogeum. Rather than kill each other in "primitive" ways, they clashed each other using different cars, depending on the species they belong. Now, only four teams have left – Eagles, Lions, Rhinos and Sharks – and the outcome is more uncertain than ever. Who will be the audience's favorite? Who will win the war? And, most important, who will obtain the supremacy?

Team Lama

927539 - Carrarini Andrea

894173 - Cerrato Loris

939930 - De Cosmo Andrea

931468 - Maione Michele

1 Changelog

User	Date	Description
Maione	22/03/2019	Created document
Carrarini	09/04/2019	Project goal, provided services, client side
Maione	10/04/2019	Back-end
Maione	11/04/2019	Development, estimated cost
Carrarini	12/04/2019	Hardware requirements, workload estimation,
Carrarini	13/04/2019	Front-end, external services, communication
Carrarini	14/04/2019	Delivery 1
Maione	03/05/2019	Corrections to delivery 1
De Cosmo	13/05/2019	Updated sections, applied corrections to delivery 1
Maione	20/05/2019	General formatting
De Cosmo	20/05/2019	Updated sections, added cost estimations sections, applied corrections
De Cosmo	20/05/2019	Delivery 2

2 Project Goal

Hypogeum aims to provide to customers a 24/7 service to Microsoft Windows users via Steam. The game requires an Internet connection to play and does not have an offline mode.
It is designed as a client-server architecture where the players can start their client connecting to a central server over the Internet.

3 Provided Services

Since Hypogeum is a competitive game for killer players, we expect some tension and complaints about the game itself and also about connection problems. For this reason, we need to provide the players a customer support that at least let them feel that their complaints and opinions are heard.
We also want to integrate social networks (at least Facebook) in order to give the chance to the users to show their friends their statistics, their score and how good they are at the game.
An important and needful feature is a website where users can see their stats and the game state, that is which faction is winning the war, which is their position in faction leaderboards or in the general one, and so on. For more details, see section 6 Front-end.
We do not want to keep their personal data, especially password and users information, so we let Steam take care of that. We aim to provide also an in-game store, where players can buy aesthetic personalization for the cars or other in game items. To do that, Steams offers its Steam Microtransaction APIs that let us create our own in-game store without taking the responsibility of keeping personal credit cards data (that could be a huge security issue), but this requires to share with it our revenue (unfortunately).

4 Client side

In the following, there are the client-side requirements, divided in hardware minimum and recommended, and software.

4.1 Hardware requirements

4.1.1 Minimum requirements

CPU	2,4 GHz Dual core
RAM	2 GB
Video card	NVIDIA GTX 260; ATI 4850
Network	Broadband Internet connection
Connection	ADSL 10Mbps
HD	150 MB of free space
Input devices	Mouse and keyboard

4.1.2 Recommended requirements

CPU	2,5+ GHz Quad core
RAM	4 GB
Video card	NVIDIA GTX 660 or better; ATI 7950 or better
Network	Broadband Internet connection
Connection	ADSL 20Mbps
HD	150 MB of free space
Input devices	Mouse and keyboard

4.2 Software requirements

OS	Windows 7 sp1+ or newer
Connectivity	Broadband internet connection (512kbps/192kbp)
DirectX	9.0c
Other	Steam

5 Workload estimation

Our estimations foresee **20.000 players per month**, with a **daily average** of **720 players** and a **peak** of **2.100 players** during the day.
Since Hypogeum has a **season-based** mechanic, we do not expect a drastic decrease of our users after the first two months, so the curve of the graph will have a slower decrease than the average. For the same reasons, thanks to the release of **scheduled updates**, that add game elements, functionalities and personalization items, and thanks to the **season-based structure**, when our curve is in a local minimum point it can raise up, involving other players and keeping the current ones.
Since the match are for up to 8 players and since we expect a peak of 750 daily players, we have to handle about 90 concurrent matches. For more details, see chapter 8.4 Workload Capacity.
The server is in charge of saving, for each player, personal statistics, match statistics and factions ranks, with a total weight of around 200KB.

6 Front-end

We aim to provide a website where players can check their personal statistics and scores, their positions in game ranks and the game state, as the leaderboards of the different factions, the time remaining to the end of the season and so on. For these reasons we need to have a **front-end server** that fulfills these requests.

6.1 Platforms

Since the traffic volume of the front-end server is completely different form the back-end one and since we need few data to build the leaderboards or to show the players their in-game stats and the game information,

we opted for a Easy Linux Hosting Packet on Aruba S.p.A. (https://hosting.aruba.it/hosting/linux-basic.aspx). The features of the basic server, according to the Aruba documentation, are the following:

6.2 Easy Linux Hosting features

Disk space	Unlimited (Use the web space, exclusively for the publication of the website and not as a repository, ie as a tool for the mere archiving of files and/or own material and/or downloadable also from other sites.)
Traffic volume	Unlimited (The actual speed of the Internet connection depends on the degree of congestion of the network, on the quality of the access network and of the Customer's plants, therefore Aruba is not able to guarantee the effective achievement of the nominal speed.)
Bandwidth	2 Gb/s - best effort
Database	5 MySQL DB
DB space	1 GB on SSD (we can improve up to 10GB, with an additional annual cost of 7.00€ for each GB)
Backup	✔
Year price	50.00€ (+ IVA)

6.2.1 Scalability and Extensibility

If the game will have great success we might need to change to a better plan of hosting. In that case, we will keep our Easy Linux Hosting Packet (https://hosting.aruba.it/hosting/linux-easy.aspx) and add other database space. If this will not be enough, since our game data are in the back-end database and in the front-end we just need to show them to the players, we could evaluate the option to buy a Basic Linux Hosting Packet (https://hosting.aruba.it/hosting/linux-basic.aspx), that has the database as an optional feature. This is an advantage since the bottleneck in our game is not represented by the storage (so probably we will not need to add other storage space), but by the maximum number of clients connected simultaneously.

6.2.1.1 Basic Linux Hosting features

Disk space	Unlimited (same as for the previous)
Traffic volume	Unlimited (same as for the previous)
Bandwidth	2 Gb/s - best effort
Database	optional
DB space	1 GB on SSD
Backup	✔
Year price	24.99€ (+ IVA)

7 Back-end

7.1 Platforms

The project will be hosted on the Cloud. The value for money of the Cloud of Aruba S.p.A. (https://www.cloud.it/cloud-computing/cloud-pro.aspx), led us to select this type of solution. Thanks to this choice, we can also manage the natural abandonment of the game users over time, decreasing the virtual resources of the Cloud and, with them, the costs.

7.2 Hardware

This is a list of the chosen Cloud hardware features:

7.2.1 Cloud server

Component	Description
Server manufacturer	DELL
Storage manufacturer	EqualLogic
O.S.	Ubuntu Server 18.04 LTS 64 bit
CPU	Intel Xeon 5600 - 3,46 GHz - L3 cache 12 MB - 130 W
HDD	Redundant and replicated SSD storage in sync; Dual controller enterprise storage, hardware RAID aggregation and replication on twin storage.
Network	3 Network cards; 1 Gbit/s full duplex
Network load	Maximum number of concurrent HTTP sessions (active) 40.000 (estimate to reach 90% of system load)

7.2.1.1 Monthly price

Component	Price
+10 GB HD	1,44€
+1 vCpu	11,52€
+1 GB RAM	3,60€

7.2.1.2 Monthly forecast quantity-use

	Launch	Growth	Maximum	Decline	Minimum
vCpu	1	8	8	4	1
RAM (GB)	1	8	32	8	1
HDD (GB)	10	20	30	30	30
Price/month	**16,56€**	**123,84€**	**211,68€**	**79,20€**	**19,44€**

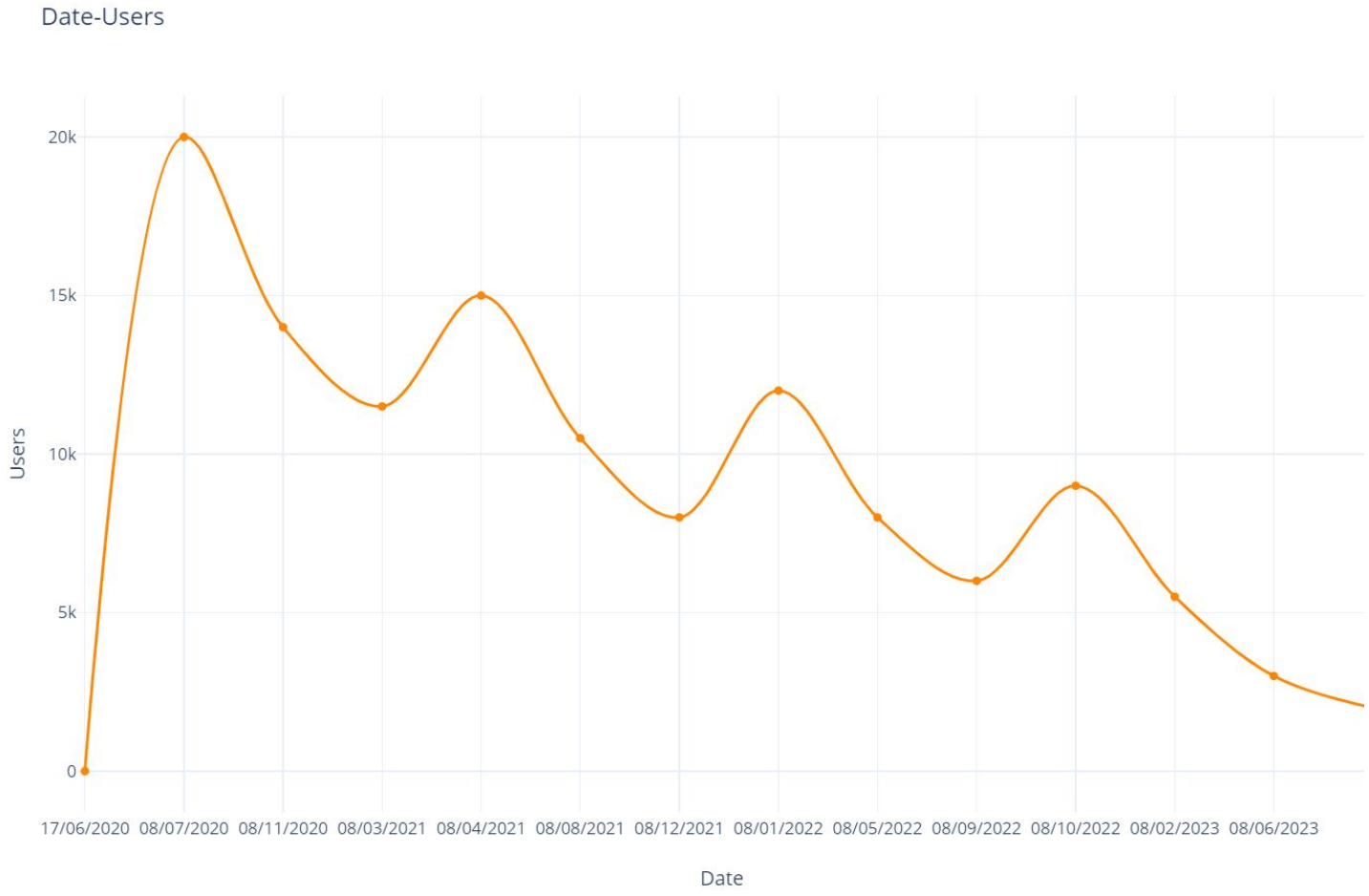
7.3 Software

Since the project will be implemented with Unity and then in C#, on top of the **mono framework**, the game server will be implemented in C# with the same framework. This is another reason why we have chosen an Ubuntu server. For more information refer to 8.3 Software.

7.4 Workload Capacity

Users	Process (users ÷ 8)	RAM (MB) / process	CPU (MHz) / process	Network (Mbit/s) / process
720	90	88	307	11,11
1.000	125	64	221	8,00
1.600	200	40	138	5,00
2.400	300	27	92	3,33

7.4.1 Estimate of users



8 Development

8.1 Platforms

The project will be developed on Windows 10 Professional, whereas the artists will work on macOS Mojave.

8.2 Hardware

Development computers were chosen on Amazon. The technical specifications are:

Tag	Price	Type	Description
Developer PC	1670,18€	Desktop PC - Dell XPS Tower 8930	Processor: 6-core 8th-generation Intel Core i7-8700 (Turbo Boost up to 4.6GHz) Memory: 16GB 2666 MHz DDR4 memory Graphic card: Nvidia GeForce GTX 1070 with 8GB GDDR5 memory Storage: x4 256GB SSD M.2 PCIe + 2TB HDD 7.200 rpm OS: Windows 10 Pro
	0,00€	Keyboard	Multimedia keyboard Dell-KB216, included with the computer
	0,00€	Mouse	Wired mouse Dell Primax Sapphire MS116, included with the computer
	309,58€	Monitor	Monitor Dell 27 InfintyEdge | S2719H da 27”
Graphic PC	3.059,00€	iMac 21,5”	Processor: 3.2GHz 6-core 8th-generation Intel Core i7 (Turbo Boost up to 4.6GHz) Memory: 16GB 2666MHz DDR4 Memory Graphic card: Radeon Pro Vega 20 with 4GB of HBM2 memory Storage: 512GB SSD Monitor: 21.5 inch with retina 4K OS: macOS Mojave
	0,00€	Mouse	Magic Mouse 2, included with the iMac
	50,00	Keyboard	Magic Keyboard with Numeric Keypad
Additional graphic hardware	599,90€	Graphic tablet	Wacom Intuos Pro large paper edition with digital workflow
	0,00€	Pen	Wacom Pro Pen 2, included with the Graphic tablet
	18,43€	Glove	SmudgeGuard for two fingers

8.3 Project roles

Symbol	Description
D	Game and Level designer
A	Artist
P	Programmer
M	Musician

8.4 Software

Group	Roles	File type	Extension	Software	Price/Month
Environment	D, A, P, M	O.S.		Windows 10 Pro macOS Mojave	0,00€ (included in the pc) 0,00€ (included in the iMac)
Organization	D, A, P, M	Issue tracking		Pivotal Tracker (online)	0,00€
		Version control	.git	Git 2.19	0,00€
		Flowchart	.xml	Draw.io Desktop 8.8.0	0,00€
		Office suite		Google Docs	0,00€
		Document presentation	.pdf	Adobe Acrobat Reader DC 2019	0,00€
Asset editing	D, A	Raster image	.png; .jpg; .tiff	GIMP 2.10	0,00€
	D, A	Vector image	.svg	Inkscape 0.91	0,00€
	D, M	Music and sounds	.mp3	FL Studio 20	0,00€
	A	3D models	.blend; .fbx	Blender 2.79	0,00€
General editing	D, A, P, M	Other text file		Notepad++ 7.5.9	0,00€
Prototyping	D, A	Tiled map	.tmx	Tiled 1.2.0	0,00€
Development	P	C# project	.sln	Visual Studio 2017 Community	0,00€
	D, P	Unity project	.unity	Unity Personal 2018.3 Unity Pro	0,00€ (if revenue/funding in the last fiscal year < 100.000$)

					125,00€/month
	P	Web		PhpStorm	19,99€/month
Graphics	A	Photoshop	.psd; .psb	Adobe Photoshop	24.99€/month
	A	Illustrator	.ai	Adobe Illustrator	24.99€/month
	A	InDesign	.indd	Adobe InDesign	24.99€/month
	A	After Effects	.aep	Adobe After Effects	24.99€/month
	A	Premiere	.prproj	Adobe Premiere	24.99€/month

8.5 Major Software Development Tasks

The main steps of the game development that have been identified are:

- Preliminary phase;
- Game design;
- Graphics;
- Audio;
- Game development;
- Release.

A more detailed description of the tasks performed in each step, the estimations about their starting and ending date (and so their duration) are described in the following Gantt chart.

8.5.1 Development GANTT

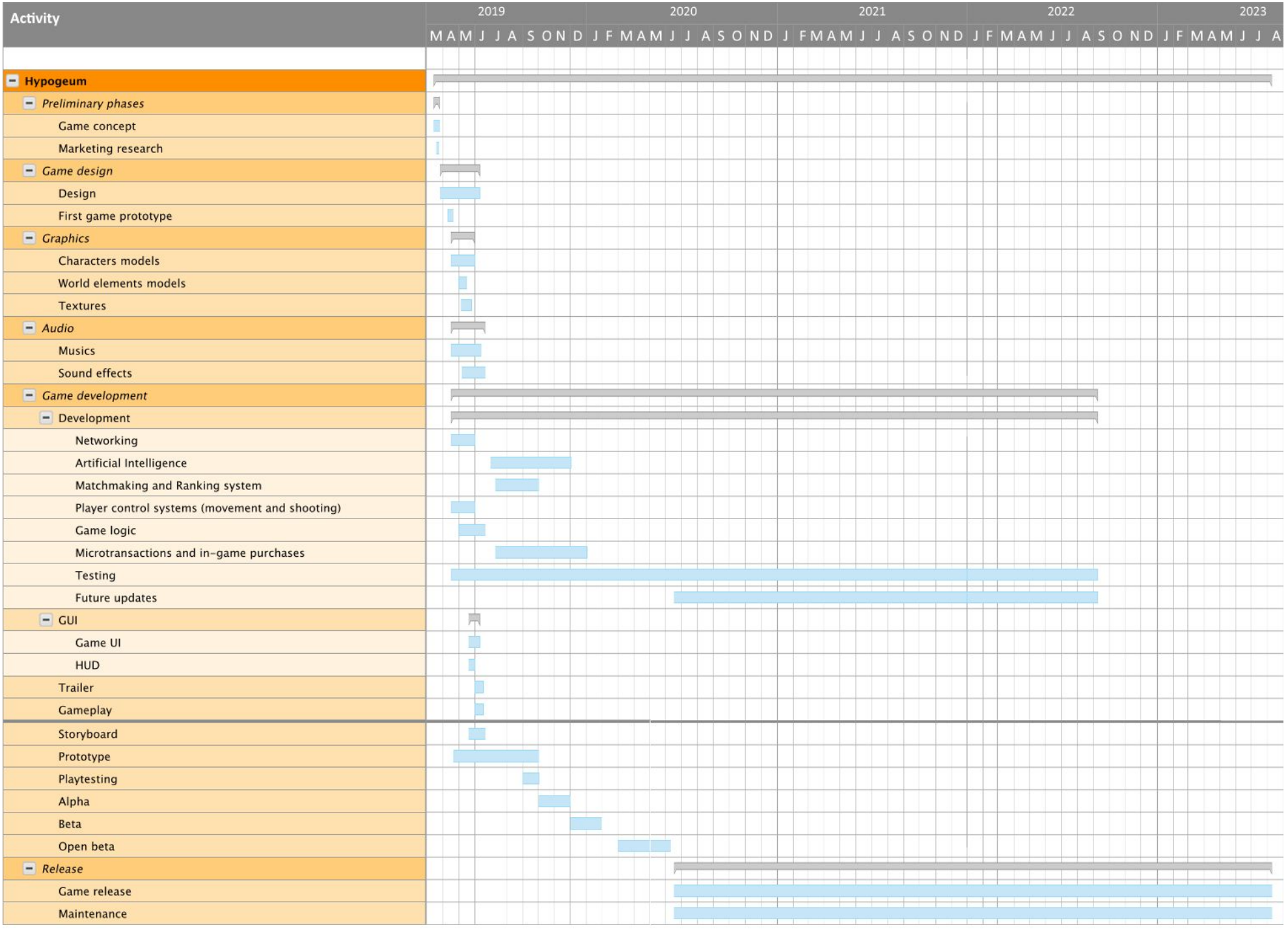
In this section we present 2 tables:

- The scheduling of the main activities and their sub-tasks;
- The Gantt chart representing the tasks performed between 01/01/2019 and 31/12/2023.

(An high resolution version here: http://www.maionemiky.it/public/Hypogeum/Gantt.png)

Activity name	Starting	Ending	Duration
Hypogeum	**14/03/19**	**08/08/23**	**1609g**
Preliminary phases	14/03/19	25/03/19	12g
Game concept	14/03/19	25/03/19	12g
Marketing research	19/03/19	23/03/19	5g
Game design	26/03/19	10/06/19	77g
Design	26/03/19	10/06/19	77g
First game prototype	10/04/19	20/04/19	11g
Graphics	16/04/19	31/05/19	46g
Characters models	16/04/19	31/05/19	46g
World elements models	01/05/19	15/05/19	15g
Textures	05/05/19	25/05/19	21g
Audio	16/04/19	20/06/19	66g
Musics	16/04/19	12/06/19	58g
Sound effects	07/05/19	20/06/19	45g
Game development	16/04/19	08/09/22	1242g
Development	16/04/19	08/09/22	1242g
Networking	16/04/19	31/05/19	46g
Artificial Intelligence	01/07/19	01/12/19	154g
Matchmaking and Ranking system	10/07/19	30/09/19	83g
Player control systems (movement and shooting)	16/04/19	31/05/19	46g
Game logic	01/05/19	20/06/19	51g
Microtransactions and in-game purchases	10/07/19	01/01/20	176g
Testing	16/04/19	08/09/22	1242g
Future updates	17/06/20	08/09/22	814g
GUI	20/05/19	10/06/19	22g
Game UI	20/05/19	10/06/19	22g
HUD	20/05/19	31/05/19	12g
Trailer	01/06/19	16/06/19	16g
Gameplay	01/06/19	16/06/19	16g
Storyboard	20/05/19	20/06/19	32g
Prototype	21/04/19	30/09/19	163g
Playtesting	01/09/19	01/10/19	31g
Alpha	01/10/19	30/11/19	61g
Beta	01/12/19	29/01/20	60g
Open beta	01/03/20	10/06/20	102g
Release	17/06/20	08/08/23	1148g
Game release	17/06/20	08/08/23	1148g
Maintenance	17/06/20	08/08/23	1148g

Scheduling of the main activities



Gantt chart (01/01/2019 - 31/12/2023).

9 External Services

In this section, we describe the two external services we require for our game: **customer care** and **payments**.

9.1 Customer care

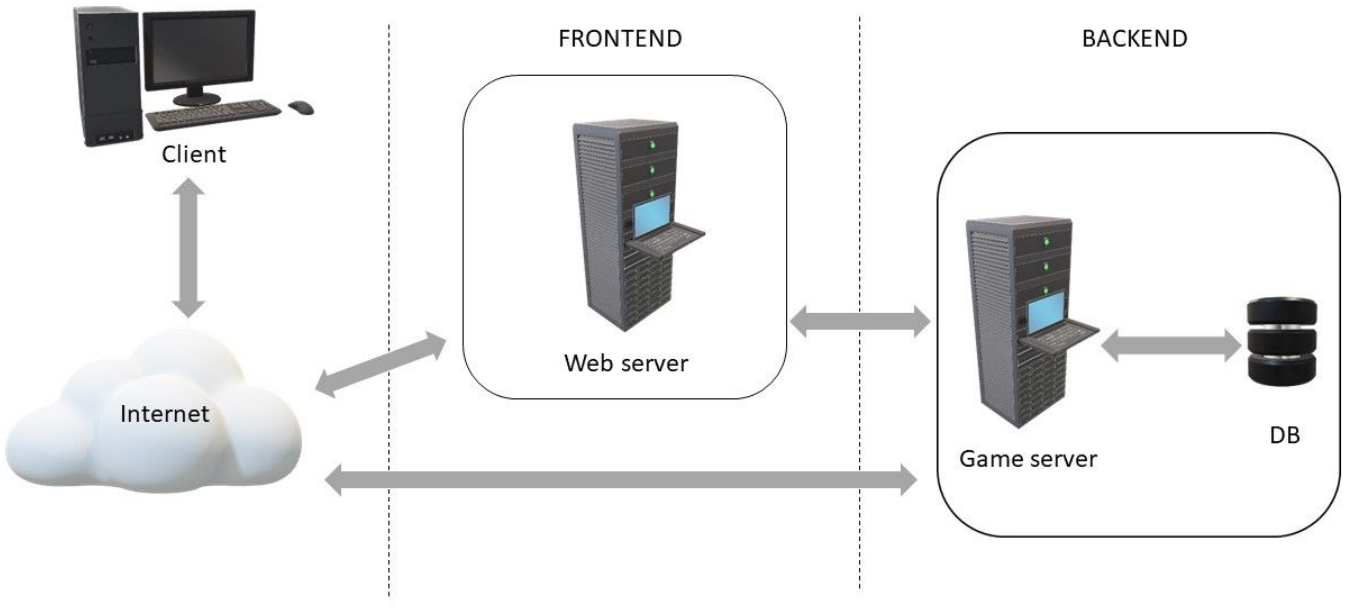
Since Hypogeum is designed both as a collaborative multiplayer and a competitive player-versus-player game, with killer players as target audience, the probability of receiving complaints is quite high. For these reasons, to provide to our users the best customer care and to help them with the issues they could encounter, we decided to delegate this service to a third-part company: 5CA. As described on the company's website (https://www.5ca.com/customer-support-expertise/video-game-support-services/), it offers video game support through different channels (phone, social media, e-mail, communities, chat, ecc.) and about different topics (game experience, hardware issues, billings and payments, etc.) that is is a huge advantage since this allows our users to get help in many different ways. Actually, the company collaborates with Epic Games, 2K games, Razer, Psyonix, and many others.
Since the company's pricing-philosophy is "pay what you use", we can not foresee in advantage the total cost, even because it depends directly on our player base dimensions.

9.2 Payments

Since our business model is based on a **freemium** paradigm, we decided to release the game as a **free-to-play** game on Steam, with an **in-game store** where our users can buy aesthetic personalization, additional weapons, cars, and so on and a mechanism based on **season-pass** contents. To do so, we use the Steam Microtransactions APIs, that help us also in the management of the payments using the users' Steam Wallet.

10 Communication

10.1 Global Infrastructure Outline



The 3-tier infrastructure for the front-end.

10.2 Network Requirements

On server-side, we will have an Internet connection that, by contract, is 2Gbps for the frontend and 1Gbps full-duplex for the backend. Our escape plan anticipates that, if the situation arrives where we can not satisfy the users' requests, we will reinforce the network architecture foreseen adding at least another server both for the frontend and the backend (in this last one we evaluate a mirroring of the MySQL database). The execution of this plan depends on our player base and on the level of success that our game will reach.
For what concerns client-side, since Hypogeum is a real time driving-shooter game, thought for collaborative-competitive multiplayer mode, the latency is a big deal, but theoretically a normal Internet connection should be enough to play (it is rather obvious that faster connections are better).

10.3 Network Hardware

We opted for a Cloud solution, so we do not need to manage the hardware directly.

11 Delivery

11.1 Estimated Delivery Time

According to the GANTT chart (8.6 Development GANTT), the game will be released in the second half of June 2020. According to our business model, we will release, through all the game life, several updates that will give to the players additional contents (such as new maps, species, weapons and so on) that will enrich their game experience and fun.

11.2 Delivery Platform

Actually, we will publish our game on Steam, where the users can download and install it on their PCs.

11.3 Delivery Methodology

We expect to deliver:

- a closed beta a couple of months later than the presentation of the prototype, to get the first feedbacks and suggestions about possible improvements;
- an open beta six months later than the presentation of the prototype, to understand what is the general idea that players have about our game.

12 Staff

12.1 For Infrastructure Setup

We need, for few days, one person for DevOps, who is in charge of configuring the Cloud server, install the program, configure the DB and so on.

12.2 For Infrastructure Management

Our team needs one person that takes care of the maintenance of the system, with occasional checks, and solves problems in case of "disaster recovery".

13 Cost of the project

This section describes the estimations we made about the costs required for the realization of the project. It is divided in 2 parts:

- the first one concerns the first four months of the development, from March 2019 to June 2019, and considers the 200.000€ assigned to us as starting budget;
- the second one concerns, instead, the following months, starting from July 2019 and going on through the whole game life.

13.1 First phase

In this section we present, in detail, which are the costs we encounter during the first four months (March 2019 - June 2019) of the development, with an overall starting budget of **200.000€**.

13.1.1 Team

The table below describes the costs for the salary of each team member, excluding the Team Lama ones:

Team element	Cost/Phase	One-off
3D/2D Artist	12.000€	
Junior Programmer	14.000€	
Senior Programmer	20.000€	
Tester	6.000€	
Web Developer	16.000€	
Music Artist		7.500€
Professional Social Media Manager	3.000€	
Legal support		20.000€
Column Total	**71.000€**	**27.500€**
Total		**98.500,00€**

13.1.2 Building

In this section we analyse the costs we have to face for the building where our offices are set:

Building	Notes:	Cost/Phase
Regus Co-Working room (x10) - Porta Venezia, Milan	The co-working contract includes: ● Fast Internet connection; ● Telecommunication services; ● Office cleanings; ● Receptionist	15.120€
Total		**15.120,00€**

13.1.3 Hardware

In this section we describe which is the hardware we require for the first development phase, both for the team than for the server:

Hardware:	Cost/Phase	One-off
Developer PC (x8) (table section 8.2)		15.838,08€
Graphic PC (x2) (table section 8.2)		6.218,00€
Additional graphic hardware (x2) (table section 8.2)		1.236,66€
Frontend hardware	50,00€	
Backend hardware	66,24€	
Column total	**116,24€**	**23.292,74€**
Total		**23.408,98€**

13.1.4 Software

In this section, we present the costs of the software required for the development in the first phase:

Software:	Notes:	Cost/Phase
Adobe Suite (x2)	It contains: • Acrobat Reader DC • After Effects • Illustrator • InDesign • Photoshop • Premiere	999,60€
Unity Pro (x7)		3500,00€
Visual Studio Community 2017		0,00€
PhpStorm		79,60€
Blender 2.79		0,00€
GIMP 2.10		0,00€
Inkscape 0.91		0,00€
Draw.io Desktop 8.8.0		0,00€
Tiled 1.2.0		0,00€
FL Studio 20		0,00€
Git 2.19		0,00€
Google G Suite (online)		0,00€
Pivotal Tracker (online)		0,00€
Trello (online)		0,00€
Windows 10 Pro	Included with the PC	0,00€

macOs Mojave	Included with the iMac	0,00€
Total		**4.579,20€**

13.1.5 Summing up

Summing up, in the first four months of the development process, the total expenses will be:

Area:	Cost
Team	98.500,00€
Building	15.120,00€
Hardware	23.408,98€
Software	4.579,20€
Total	**141.608,18€**

13.2 Second phase

In this section we present, in a more detailed way, the costs we foresee to encounter during the second phase of the game development, that goes from July 2019 on, taking care to do not evaluate the expenses that have already been made in the first one.

13.2.1 Team

In this section, we describe the cost per year for each team element involved in the second phase of the development process:

Team element	Notes:	Cost/Year	One-off
Team Lama member (x4)	For this estimation we considered 3.500 €/month (like a junior developer)	168.000€	
3D/2D Artist (x2)		72.000€	
Screenwriter		42.000€	
Junior Programmer (x3)		126.000€	
Senior Programmer (x2)		120.000€	
Tester (x3)		54.000€	
Security Manager		48.000€	
Web Developer (x2)		96.000€	
5CA Video Game Support	Policy: “Pay what you use”	variable	
Music Artist	Paid in the first phase		0,00€
Professional Social Media Manager		36.000€	
Accountant		5.500€	

Legal Support	Paid in the first phase		0,00€
Column Total		**767.500€ + variable**	**0,00€**
Total / Year			**767.500,00€ + variable**

13.2.2 Building

The following table shows which are the costs connected to the rent of offices and what they are comprehensive of:

Building	Notes:	Cost/Year
Regus Co-Working room (x19) - Porta Venezia, Milan	The co-working contract includes: ● Fast Internet connection; ● Telecommunication services; ● Office cleanings; ● Receptionist	87.381€
Total		**87.381,00€**

13.2.3 Hardware

The following table shows which are the costs of the hardware used for the development:

Hardware:	Notes	Cost/Year	One-off
Developer PC (x16) (table section 8.2)	x8 already bought		15.838,08€
Graphic PC (x3) (table section 8.2)	x2 already bought		3.109,00€
Additional graphic hardware (x3) (table section 8.2)	x2 already bought		618,33€
Frontend hardware		50,00€	
Backend hardware	Used Launch version (table 7.2.1.2)	198,72€	
Column total		**248,72€**	**19.565,41€**
Total			**19.814,13€**

13.2.4 Software

The following table resumes the costs of the software used by the team for the development:

Software:	Notes:	Cost/Year
Adobe Suite (x3)	It contains: ● Acrobat Reader DC ● After Effects ● Illustrator ● InDesign ● Photoshop ● Premiere	4.498,20€
Unity Pro (x11)		16.500,00€

Visual Studio Community 2017		0,00€
PhpStorm (x2)		398,00€
Blender 2.79		0,00€
GIMP 2.10		0,00€
Inkscape 0.91		0,00€
Draw.io Desktop 8.8.0		0,00€
Tiled 1.2.0		0,00€
FL Studio 20		0,00€
Git 2.19		0,00€
Google G Suite (online)		0,00€
Pivotal Tracker (online)		0,00€
Trello (online)		0,00€
Windows 10 Pro	Included with the PC	0,00€
macOs Mojave	Included with the iMac	0,00€
Total		**21.396,20€**

13.2.5 Summing up

To sum up, the development process starting from July 2019 will have the following total cost per year:

Area:	Cost/Year
Team	**767.500,00€ + variable**
Building	**87.381,00€**
Hardware	**19.814,13€**
Software	**21.396,30€**
Total	**896.091,43€ + variable**