SWE 590 Special Topics – Cloud Computing Applications

Term Project

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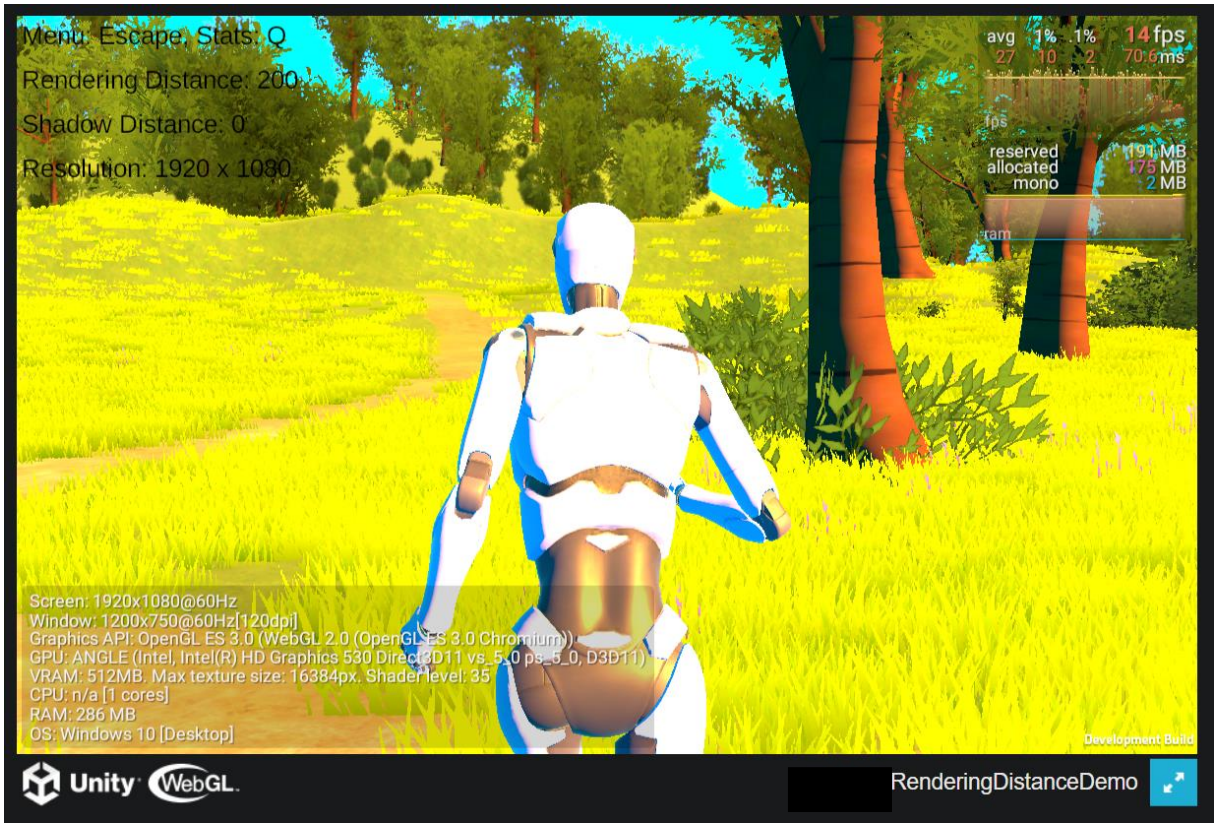
DEPLOYING OPEN-SOURCE GAME ON THE CLOUD

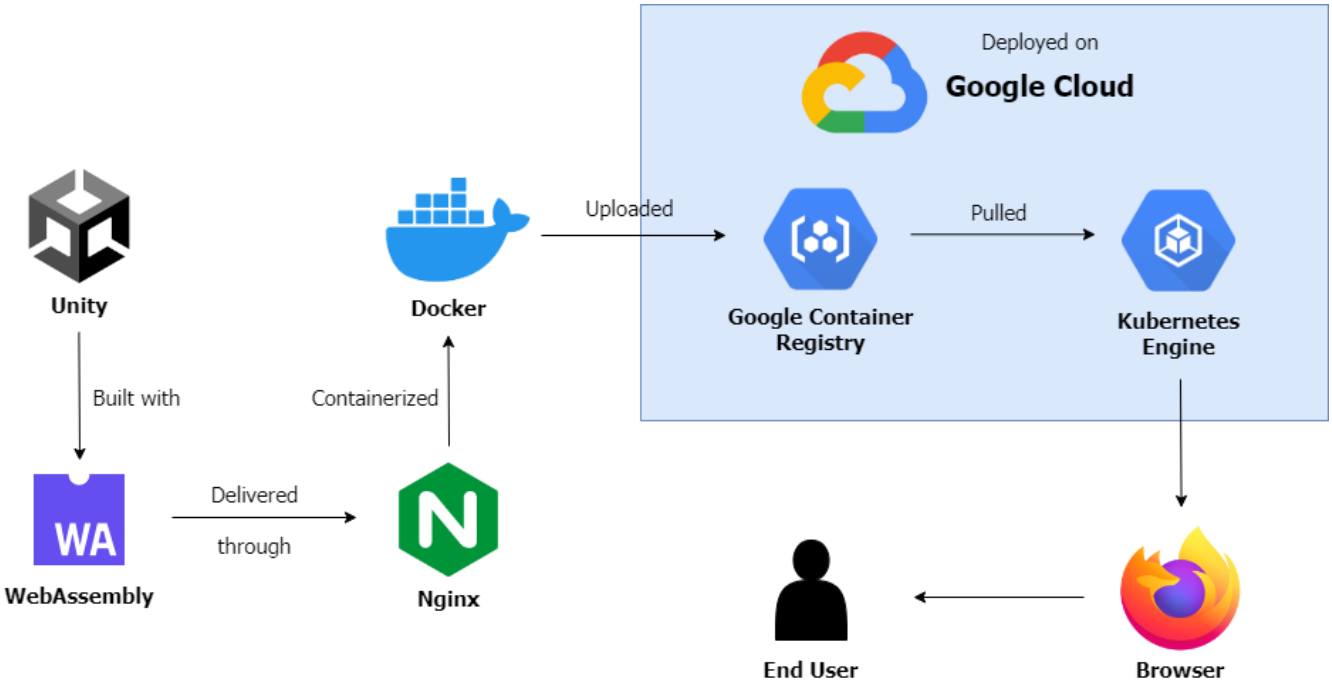


This project aims to deploy a WebAssembly build of a 3D game made in Unity, on Google Cloud using the Kubernetes Engine. The game is an open-source tech demo made for the SWE585 Game Programming course in the previous semester as a term project. The technologies employed are as follows, in order of use:

- Game made with Unity (WebAssembly build)
- Delivered through NGINX server

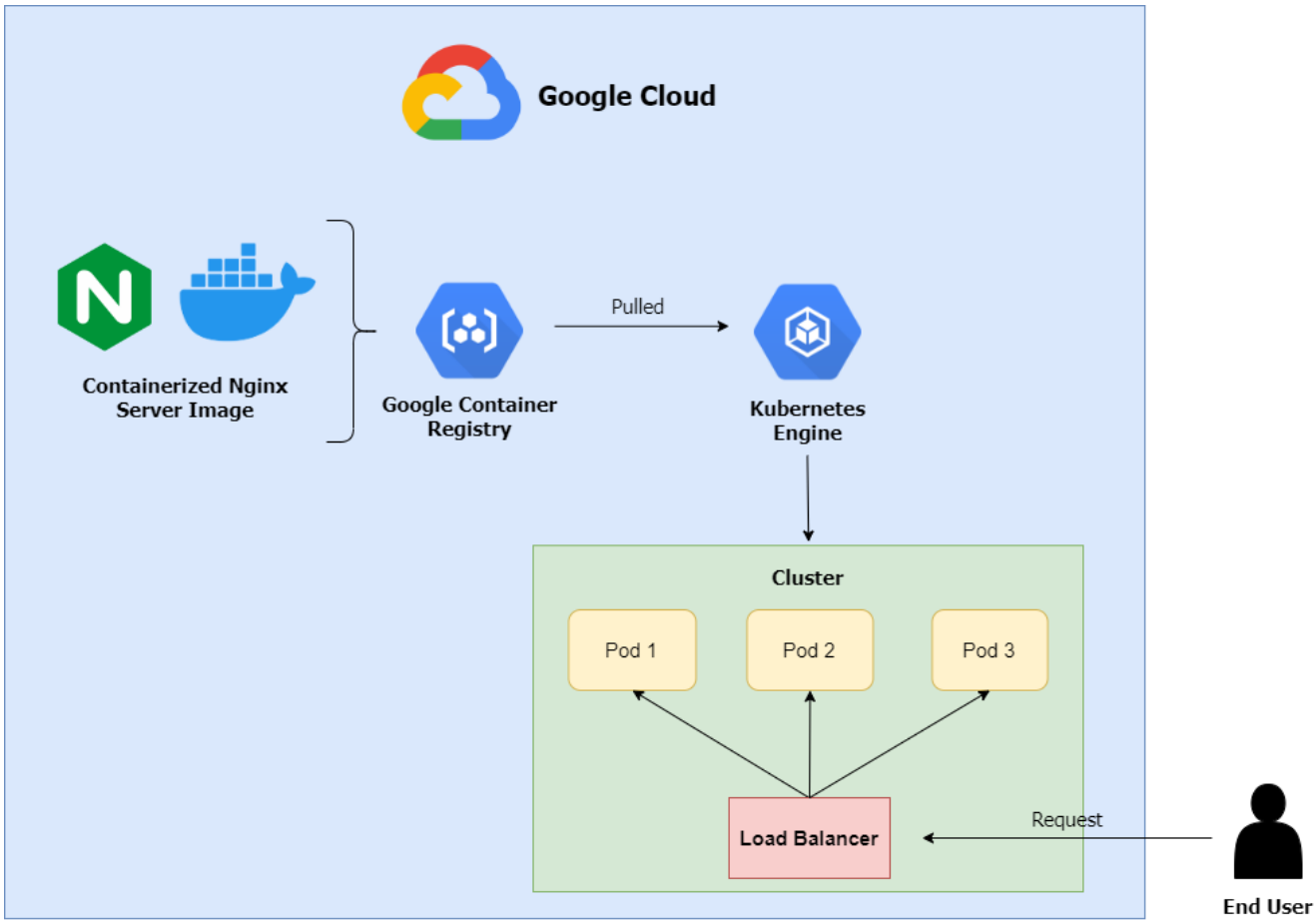
- Containerized with Docker (Alpine image)
- Pushed to Google Cloud Container Registry
- Deployed on Kubernetes cluster with load balancer service

The following diagram illustrates the workflow and how the content is delivered to the end user.



Architecture

The docker container built with the light-weight alpine image is deployed on a public Kubernetes cluster with 3 pods, employing the engine's load-balancing service. This cluster uses the autopilot feature, allowing the engine to take care of scaling. The server image can be delivered to end users through each pod, which serves as a form of load balancing. The architecture is illustrated in the following diagram.



Testing & Metrics

Testing was carried out using the Locust framework. The following tables illustrate the results for five tests, with increasing numbers of maximum concurrent users, leading to increasing numbers of requests. As expected, larger numbers of requests lead to increasing response times. However, the response times are within acceptable ranges, so the cluster performs well. Locust also provides output for failures, but they were not included here as failure never occurred. Pushing the server to such an extent would have likely triggered the autopilot's scaling, leading to budget problems.

Users	# Requests	Average (ms)	Min (ms)	Max (ms)	RPS
1	310	81	72	156	12.2
10	3623	76	68	158	112.6
50	23069	85	69	422	516.5
200	43438	228	68	1436	754.2
500	35882	546	72	3752	732.9

Users	50%ile (ms)	70%ile (ms)	90%ile (ms)	95%ile (ms)	99%ile (ms)	100%ile (ms)
1	78	84	96	100	120	160
10	74	76	82	90	110	160
50	82	87	100	110	140	420
200	220	240	290	340	470	1400
500	540	630	770	870	1200	3800

Below are additional metrics taken from the Google Cloud monitoring dashboard, from a one-hour span of server idling.

Name	Location	CPU Utilization	Memory Utilization	Disk Utilization
autopilot-cluster-swe590	europe-central2	49.77% of 2.12 CPU	43.35% of 4.84 GiB	0% of 3.73 TiB

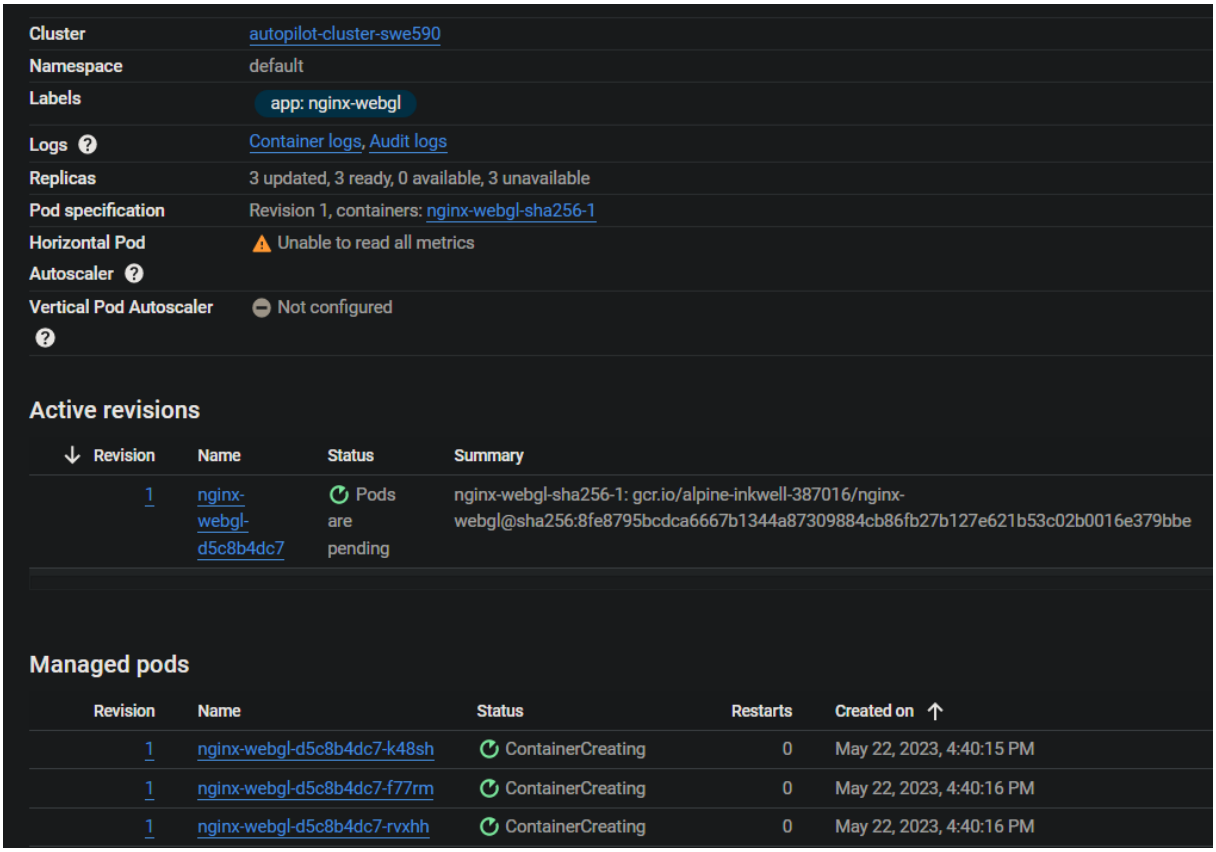
Budget

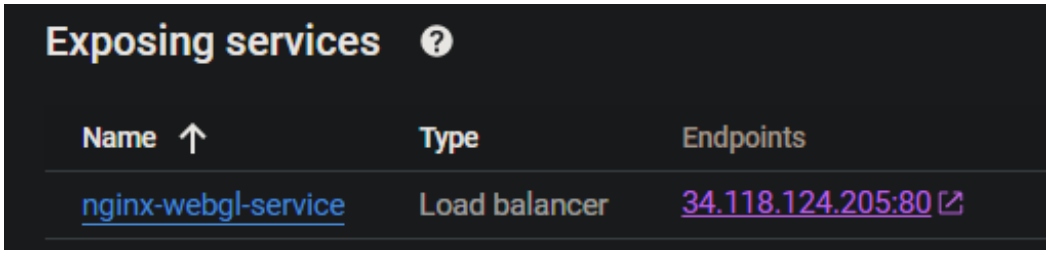
All the software used in the making of the project was either free or offered free trials. Deployment on Google Cloud was also within the limits of the free trial. As such, the project

was implemented completely free of charge. More aggressive testing was avoided to not risk triggering additional charges.

Resources

The deployed image can be accessed and the game can be played on a browser through the following link: http://34.118.124.205/. Note that there might be rendering and gameplay-related bugs depending on browser configuration, entering and exiting fullscreen fixes the bug in most cases.





The code and related project files can be found on the GitHub repository. The repository also contains more detailed test results.

A video demonstration can be found on YouTube.