UE17CS352: Cloud Computing

Final Class Project: Rideshare

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345	May 10, 2020, 1:49 p.m.	10.0	DB Clear Success. Initial container count is 5. Load Balancer working. DB get APIs successfully called Auto scale successful, final container count is 6. Successfully retrieved workers list. Crash slave API successfully returned 200 OK. Called worker list after new slave is spawned New worker started. Old slave worker stopped. DB get APIs successfully called after new slave creation

Introduction

In this report, we present our team's approach to the final project of the Cloud Computing Course (UE17CS352). The final project built upon our learnings from the previous 3 assignments. This project reinforced our learnings on multiple concepts:

- REST paradigm
- Microservice architecture
- Python Flask to serve API endpoints
- PostgreSQL Database to store persistent data
- AWS Instances, Load Balancers, Elastic IPs, Virtual Machines, Target Groups, etc.
- Docker Containerization
- RabbitMQ as an AMQP message broker (Python Pika library)
- Apache Zookeeper to maintain centralized information in distributed systems (Python Kazoo library)

In the assignments, we built a Database as a service cloud server that could serve "User" requests and "Ride" requests from different IP addresses using a Load balancer to distribute traffic. The "User" and "Ride" instances ran Flask and Postgresql DB using internal docker containers. Until Assignment 3, the "Rides" and "User" containers used their own separate databases.

In the project, we improve upon the microservice design further. The "Users" and "Rides" microservices will no longer be using their own databases and will instead use the "DBaaS service". The DBaaS service to be built has to be scalable, fault-tolerant and highly available.

Related work and References

Kazoo and Zookeeper Resources:

- https://kazoo.readthedocs.io/en/latest/
- https://readthedocs.org/projects/kazoo/downloads/pdf/2.5.0/

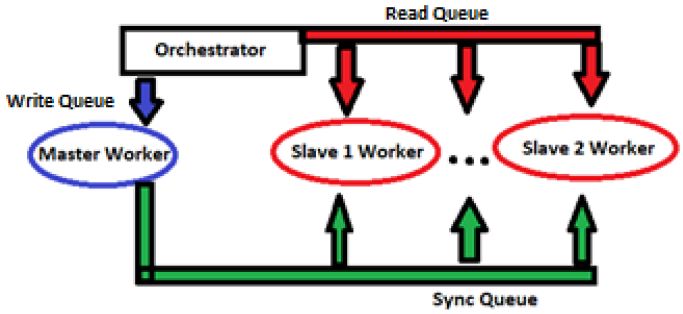
RabbitMQ Resources:

- https://www.rabbitmq.com/getstarted.html
- https://levelup.gitconnected.com/rabbitmq-with-docker-on-windows-in-30-minutes-172e88bb0808

- https://github.com/cagrias/django-rabbitmq-celery-docker-example
- https://medium.com/@tonywangcn/how-to-build-docker-cluster-with-celery-and-rabbitmq-in-10-minutes-13fc74d21730

Algorithm and Design

- ### Pika Rabbit MQ Queues Setup:



There are 3 queues; Read. Write and Sync. All 3 queues use Remote Procedure Calls (RPCs) to send and receive information from the workers. Fanout exchange is used in Sync queue to send sync messages to all slaves. I used the Python library "Pika" to setup all the RabbitMQ message brokering and queue connections. We first load all the input parameters of the request to "byte" data type using the "Pickle" python library. Read requests are sent to the Slave queue. Write requests are sent to the Master queue. When a write message response is returned from the master worker, the same message is also sent to the Sync queue, so that there is data consistency between the slave and master workers.

- ### Worker configuration:

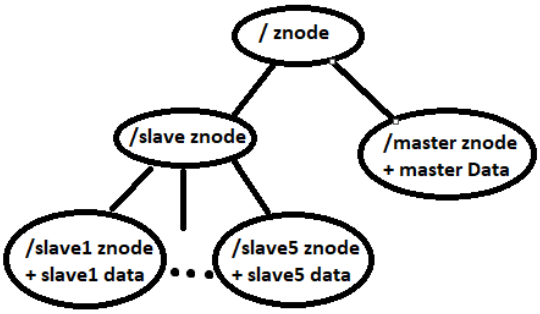
Each worker is a docker container containing all the Python dependencies. There are 2 types of workers: masters and slaves. The master worker handles write requests only and maintains a connection to only the Write queue. There are multiple slaves that are updated using the "eventual consistency" model. The slave worker maintains a connection to both the Read queue and the Sync queue. The Read queue services read requests, while the Sync queue helps to maintain data consistency between the master and slave workers. The worker code in "rpc_server_databse.py" contains code for both master and slave. If the file is run with command line argument flag as 0, worker runs master code. If flag is 1, worker runs as slave code.

- ### Auto scale of workers:

The number of slave workers servicing Read requests is directly proportional to the number of Read requests. Every additional 20 requests every 2 minutes require an additional slave worker. Similarly, the number of workers needed can reduce if the

rate of requests reduces. Addition/Deletion of slave workers requires addition/deletion of children in the "/slave" znode and starting/stopping slave docker containers.

- ## Kazoo Zookeeper Znode Structure:



The Python library "Kazoo" is used to handle the zookeeper nodes running on the orchestrator instance. There is 1 znode "/master" to store data on the master worker. This contains information about the master worker PID, worker container ID and worker container name. There is also a "/slave" znode that is a parent node to all the running Slave workers. Each child of the "/slave" node contains information about that particular slave's PID, container ID and name. The children of "/slave" znode are dynamically added/deleted when slave workers are started/stopped.

- ## Master Leader Election:

A Zookeeper Data Watch is placed on the "/master" znode. Whenever the "/crash/master" API purposely stops a master worker, the master data watch is triggered. This triggers a function that reads all the slave data from the children of "/slave". It finds the slave with the lowest PID and converts that to master by restarting the Python process with o flag. "/master" data is updated with the new master's info. Another new Slave container is spawned to take up the newly converted master's place.

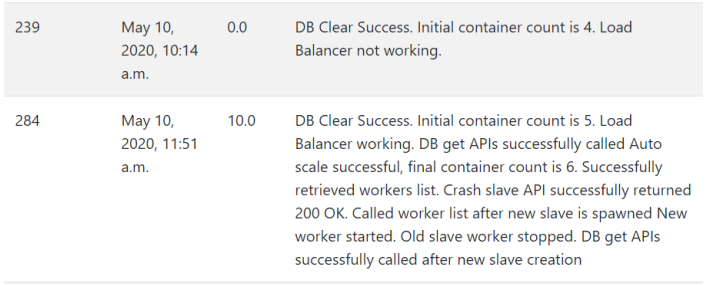
- ## Slave Leader Election:

A Zookeeper Children Watch is placed on the "/slave" znode. Whenever the "/crash/slave" API is called, all the children of the slave znode are scanned to check for the highest PID. Then, the highest PID slave container is stopped and the corresponding slave child znode is deleted. A new slave worker and znode is brought up to replace the crashed slave.

Testing Issues

- Since Kazoo Zookeeper uses asynchronous calls, some of the lengthy function calls used to finish in unpredictable timings. This caused issues with the next code instructions running even though the function calls didn't end. We fixed this by adding sleep timers in the Python code, so that the code did not go to the next step until we were sure that the asynchronous call finished.

- Initially the Automated testing gave us a score of 0, citing a "Load Balancer not working". However, the load balancer worked upon sending POSTMAN requests. The issue was fixed by deleting the old Load Balancers, Target Groups and Rules, and then creating a fresh new set of Load Balancers, Target Groups and Rules. Upon doing this, we immediately received a **10 score** on the automated testing.



239	May 10, 2020, 10:14 a.m.	0.0	DB Clear Success. Initial container count is 4. Load Balancer not working.
284	May 10, 2020, 11:51 a.m.	10.0	DB Clear Success. Initial container count is 5. Load Balancer working. DB get APIs successfully called Auto scale successful, final container count is 6. Successfully retrieved workers list. Crash slave API successfully returned 200 OK. Called worker list after new slave is spawned New worker started. Old slave worker stopped. DB get APIs successfully called after new slave creation

Challenges

- Poor documentation for the Python Kazoo library used for Zookeeper setup.

- Majority of Apache Zookeeper tutorials used JAVA, while we used Python.
Contributions

Name	USN	Contribution
Madhav Mahesh Kashyap	PES1201700227	Orchestrator, RabbitMQ queue, Zookeeper setup, Worker code, AWS Instance and Load balancers
Sangam Kedilaya	PES1201701139	Worker code, AWS Instance and Load balancers
K Sachin Nayak	PES1201701123	Worker code, AWS Instance and Load balancers
Anirudh Avadhani	PES1201701526	Worker code, AWS Instance and Load balancers

Checklist

SNo	Item	Status
1	Source code documented	Done
2	Source code uploaded to private GitHub repository (gave access to the evaluators)	Done (https://github.com/madhavmk/Cloud-Computing-Course)
3	Instructions for building and running the code (must be usable out of the box)	Done (Present in the README file of the repository)