

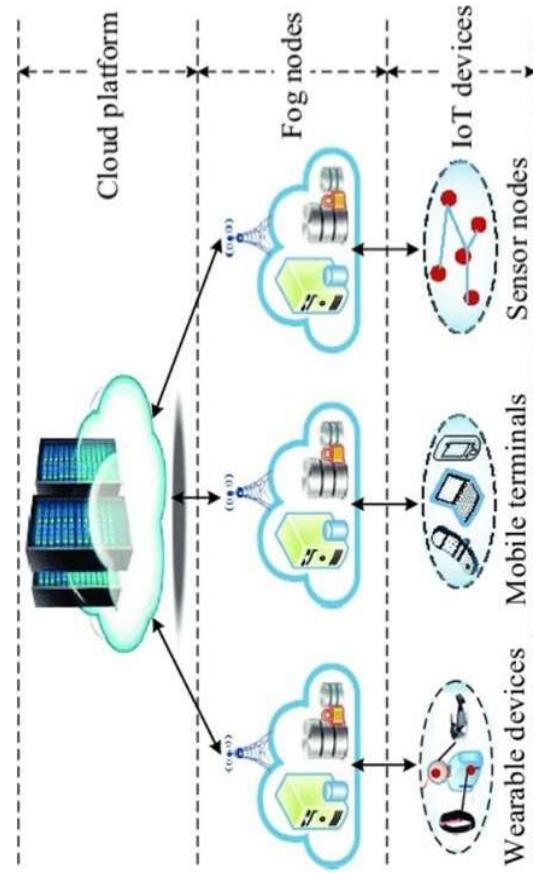


**ECEN 404 Final Presentation
Team 21: Load Balancing on an IoT Fog
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TA: Zhuwen Hu
Sponsor: Swarnabha Roy**

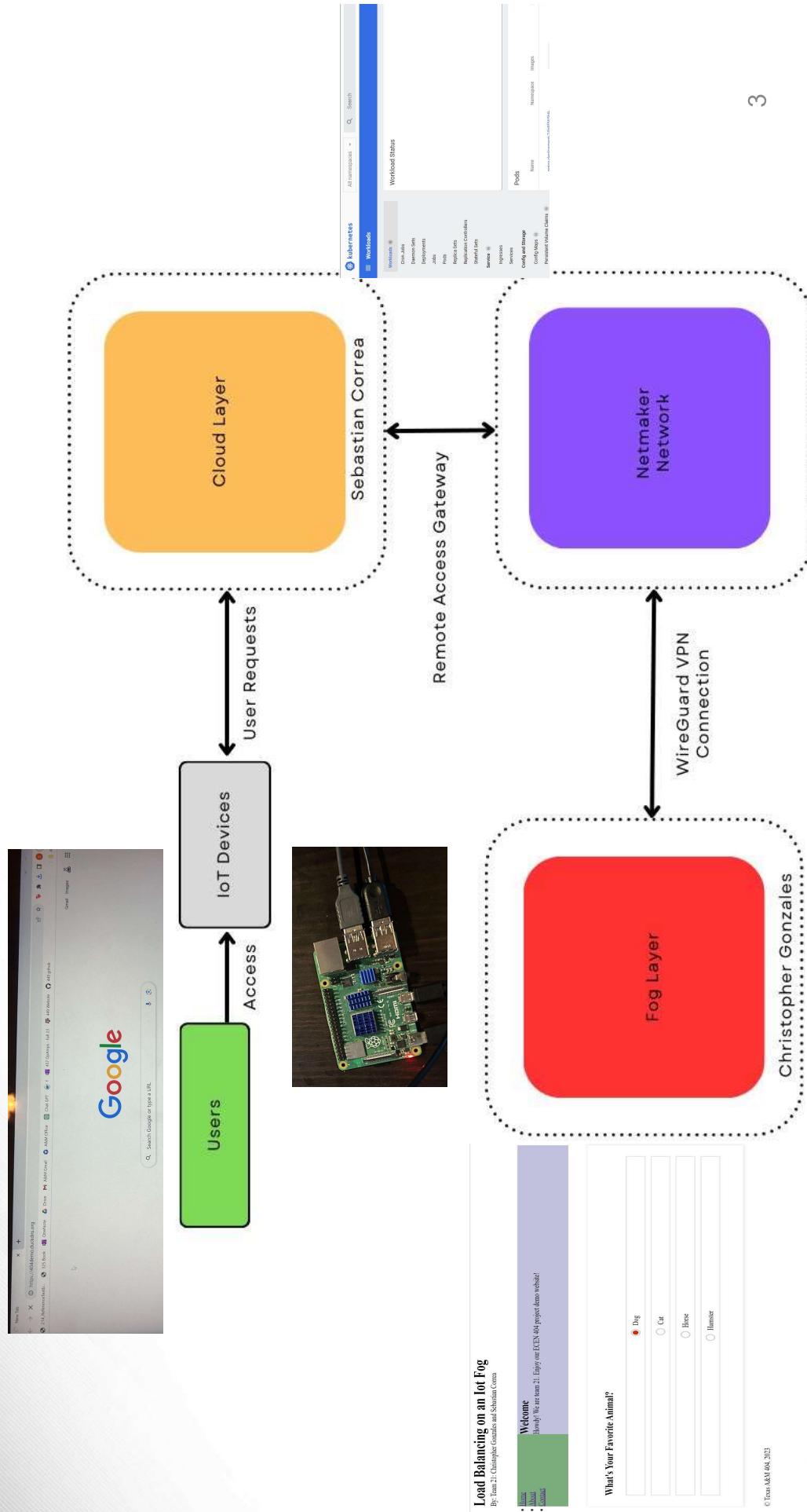
Project Summary

Problem statement:

Load balancing only on the cloud is inefficient for applications, overloads virtual machines, and creates scalability issues.



Integrated Subsystems Diagram



Edge Node Subsystem

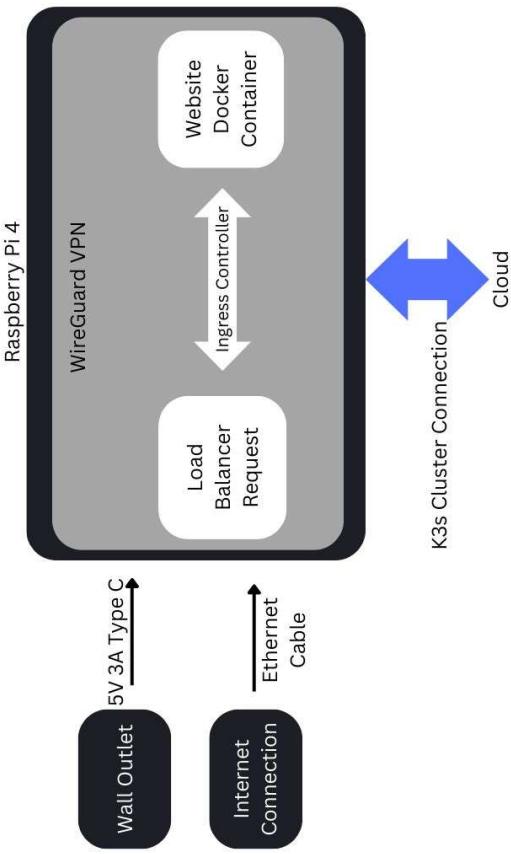
Christopher Gonzales

Function:

- Pi Takes Requests from cloud through k3s cluster
- Request is directed to website container pod
- Request directed back to cloud and user
- If the Pi shuts down then pods get allocated to other worker node

System Requirements:

- Raspbian OS
- Stable Internet Connection
- 5V 3A type C power Supply
- K3s, Docker, Wireguard



Edge Node Subsystem-Challenges/Solutions

Christopher Gonzales

Challenges

- Network and Port Forwarding Issues
- Connection to the k3s Cluster
- Hosting the website
- Accessing Cluster Nodes

Solutions

- Netmaker and Wireguard connection (Point-to-Point)
- Ping and Telnet
- Docker Containerization
- K3s.yaml file exported to the worker nodes

Edge Node Subsystem-Accomplishments

Christopher Gonzales

Accomplishments:

- Pi Hosts Website using ports specified
- VPN connection to the master node network
- Ping master node ip (average time = 70.4 ms)
- Connects to master node port specified
- Access Cluster Nodes From the Pi

```
sebascor@raspberrypi:~$ sudo wg
interface: azure-client-1
public key: Al33ydy5u194Txdimc6VA/69/1e0R6R8qNCMuFnOpAW=
private key: (hidden)
Listening port: 57632
peer: 0+JMyUqs7rCJBM/tweemhEkLVkXAVAAeliqx0B88xx3E=
endpoint: 20.120.1.172:51821
allowed ips: 10.161.6.9/16, 10.0.0/24
latest handshake: 8 seconds ago
transfer: 92 B received, 189 B sent
persistent keepalive: every 26 seconds
sebascor@raspberrypi:~$
```

Network connection 'doker0' active

IP: 172.17.0.1
Wi-Fi network connection 'MyAltice 6/25/0' active: MyAltice 6/25/0 (63%)
IP: 192.168.1.118
VPN connection active

By: Team 21: Christopher Gonzales and Sebastian Correa

```
packets transmitted, / received, 0% packet loss, time 6009ms
rtt min/avg/max/mdev = 66.479/70.430/92.143/8.866 ms
sebascor@raspberrypi:~$ export KUBECONFIG=/home/sebascor/Documents/k3s.yaml
sebascor@raspberrypi:~$ kubectl get nodes
NAME          STATUS   ROLES      AGE     VERSION
masternode    Ready    control-plane, master   23h    v1.27.7+k3s2
workernode    Ready    <none>    23h    v1.27.7+k3s2
raspberrypi   Ready    <none>    16h    v1.27.7+k3s2
sebascor@raspberrypi:~$
```

```
sebascor@raspberrypi:~$ sudo wg
interface: azure-client-1
public key: Al33ydy5u194Txdimc6VA/69/1e0R6R8qNCMuFnOpAW=
private key: (hidden)
Listening port: 57632
peer: 0+JMyUqs7rCJBM/tweemhEkLVkXAVAAeliqx0B88xx3E=
endpoint: 20.120.1.172:51821
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Cloud Subsystem

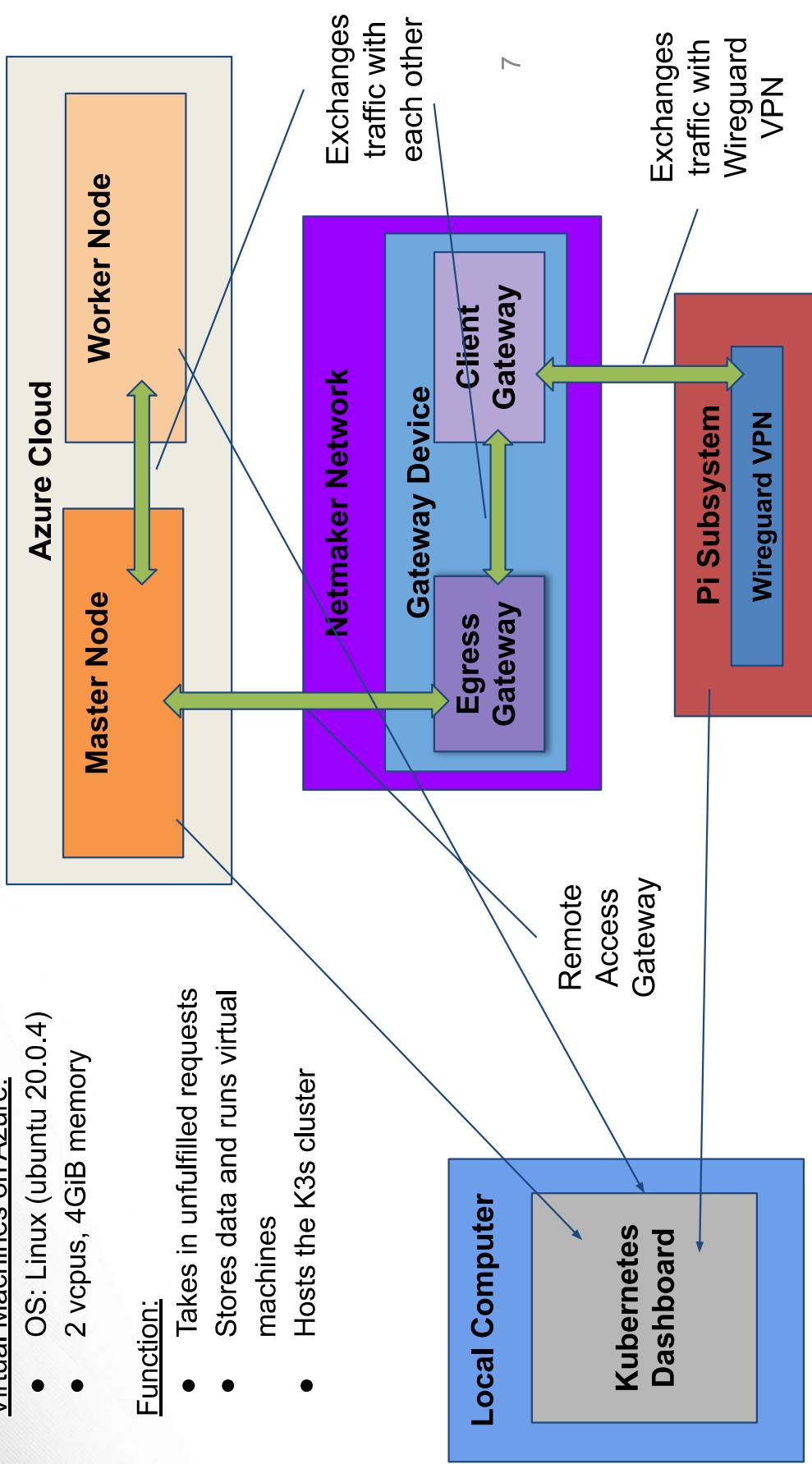
Sebastian Correa

Virtual Machines on Azure:

- OS: Linux (ubuntu 20.0.4)
- 2 vcpus, 4GiB memory

Function:

- Takes in unfulfilled requests
- Stores data and runs virtual machines
- Hosts the K3s cluster



Cloud Subsystem-Challenges/Solutions

Sebastian Correa

Challenges

- Connection with the Pi and the Azure Virtual Network
- Monitoring the K3s cluster
- Deploying the website to end users

Solutions

- Netmaker and Wireguard connection (Point-to-Point) connection
- Kubernetes Dashboard to monitor the cluster
- Nginx-Ingress-Controller to deploy website

Cloud Subsystem-Accomplishments

Sebastian Correa

Accomplishments:

- Switched to new cloud service
- Created VPN for Point-to-Point connection
- Applied new Load Balancer (Nginx Service with NodePort)
- Generated the Kubernetes Dashboard for monitoring
- Organized resources in designated namespaces

Cloud Subsystem-Netmaker

Sebastian Correa

View All Networks

netmaker

Hosts (1)

Host Name	Private Address (IPv4)	Public Address	Connectivity	Health Status
MasterNode	10.101.0.1/16	20.127.241.65	Connected	Healthy

Hosts (2)

Egress (1)

DNS

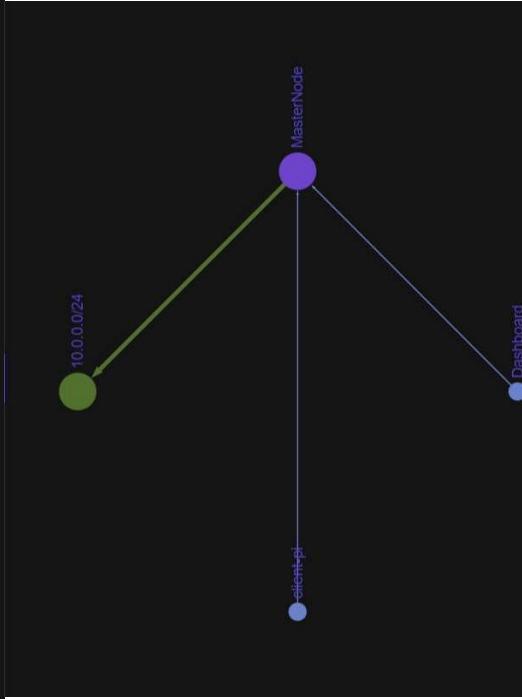
Access Control

Graph

Network Settings

+ Add New Host

Search hosts



Connection Tests

```
C:\Users\sebas\Downloads\MasterNodeFiles>ping 10.0.0.4
```

```
Pinging 10.0.0.4 with 32 bytes of data:  
Reply from 10.0.0.4: bytes=32 time=69ms TTL=64  
Reply from 10.0.0.4: bytes=32 time=88ms TTL=64  
Reply from 10.0.0.4: bytes=32 time=94ms TTL=64  
Reply from 10.0.0.4: bytes=32 time=107ms TTL=64  
  
Ping statistics for 10.0.0.4:  
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),  
    Approximate round trip times in milli-seconds:  
        Minimum = 69ms, Maximum = 107ms, Average = 89ms
```

```
C:\Users\sebas\Downloads\MasterNodeFiles>
```

```
C:\Users\sebascor@raspberrypi:~ $ telnet 10.0.0.4 6443
```

```
Trying 10.0.0.4...
```

```
Connected to 10.0.0.4.
```

```
Escape character is '^]'.  
Ping 10.0.0.4.
```

```
Connection closed by foreign host.
```

```
sebascor@raspberrypi:~ $ ping 10.0.0.4  
PING 10.0.0.4 (10.0.0.4) 56(84) bytes of data.  
64 bytes from 10.0.0.4: icmp_seq=1 ttl=64 time=92.1 ms  
64 bytes from 10.0.0.4: icmp_seq=2 ttl=64 time=66.8 ms  
64 bytes from 10.0.0.4: icmp_seq=3 ttl=64 time=66.6 ms  
64 bytes from 10.0.0.4: icmp_seq=4 ttl=64 time=67.2 ms  
64 bytes from 10.0.0.4: icmp_seq=5 ttl=64 time=67.0 ms  
64 bytes from 10.0.0.4: icmp_seq=6 ttl=64 time=66.5 ms  
64 bytes from 10.0.0.4: icmp_seq=7 ttl=64 time=66.9 ms  
^C  
--- 10.0.0.4 ping statistics ---  
7 packets transmitted, 7 received, 0% packet loss, time 6009ms  
rtt min/avg/max/mdev = 66.479/70.439/92.143/8.866 ms
```

```
sebascor@raspberrypi:~ $
```

Pods Deployed

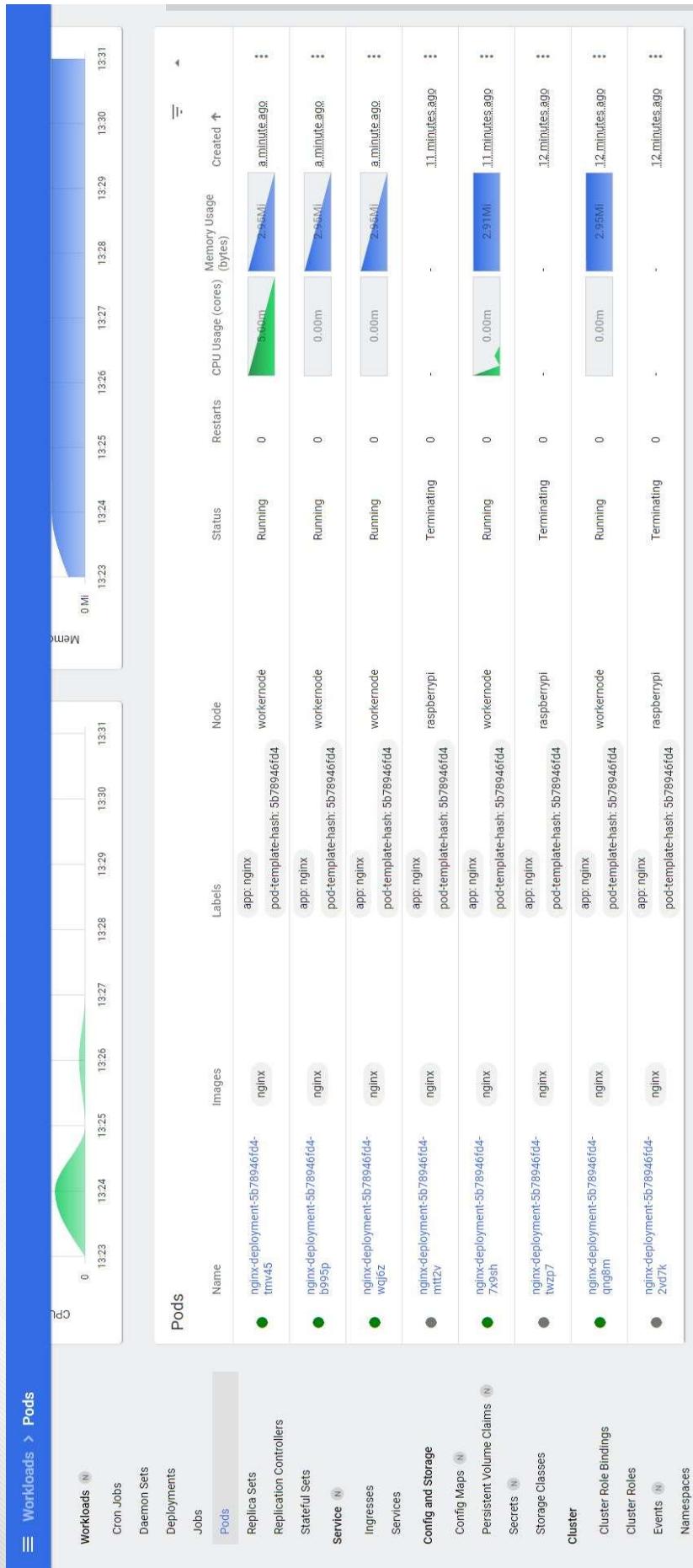


The screenshot shows the Kubernetes UI for managing workloads. The main navigation bar includes 'Workloads' (selected), 'Pods' (active), 'Services', 'Ingresses', 'Config and Storage', 'Secrets', and 'Storage Classes'. The 'Pods' section displays a table of running pods across three worker nodes.

	Name	Labels	Node	Status	Restarts	CPU Usage (cores)	Memory Usage (bytes)	Created
●	nginx-deployment-5b78946fd4-7x9sh	nginx	workernode-946fd4	Running	0	-	-	44 sec. ago
●	nginx-deployment-5b78946fd4-mntt2v	nginx	workernode-946fd4	Running	0	-	-	44 sec. ago
●	nginx-deployment-5b78946fd4-twzp7	nginx	workernode-946fd4	Running	0	-	-	2 minutes ago
●	nginx-deployment-5b78946fd4-qngq8m	nginx	workernode-946fd4	Running	0	0.00m	2.94Mi	2 minutes ago
●	nginx-deployment-5b78946fd4-2vd7k	nginx	workernode-946fd4	Running	0	-	-	2 minutes ago

60% of pods distributed to the Pi 40% to VM Worker node

Fault Tolerance



Time to redistribute workload: 5 mins

Reading Traffic

```
sebascor@raspberrypi:/Documents/403/website$ wrk -t2 -c50 -d30s http://192.168.1.118:30303/
Running 30s test @ http://192.168.1.118:30303/
  2 threads and 50 connections
Th|ead Stats          Avg      Stdev     Max     +/- Stdev
Latency        5.63ms    5.00ms   59.07ms   84.52%
Req/Sec       1.25k     491.55    3.46k    73.91%
64000 requests in 30.09s, 52.06MB read
Requests/sec: 2126.70
Transfer/sec: 1.73MB
```

Nginx Website



Welcome to nginx!

If you see this page, the nginx web server is successfully installed and working. Further configuration is required.

For online documentation and support please refer to nginx.org.
Commercial support is available at nginx.com.

Thank you for using nginx.

Conclusions

Changes

- Changed to website Demo
- Required Wireguard VPN Connection
- New Cloud Service

Current status:

- Integration Complete
- Load Balancer Not Fully Validated
- Demo website Not Fully Validated
- Validation to be Completed in 1 week

Questions?