

IT602 Cloud Computing

Project Report



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Introduction

Outline:

The nature of this project required the team to design, and develop a cloud solution for a company, that would support 3 levels of growth.

- Startup
- Medium Scale
- Large Scale

This required the team to call upon all the knowledge that has been gained during the semester, within the Cloud Computing paper, to find the most efficient, and cost effective solution for the company.

Roles:

Shawn Chen

During this project, Shawn's tasks involved analysing the requirements for the system, and developing the major cloud deployment elements.

Durante Guy

During this project, Durante was responsible for developing the necessary system diagrams for the new cloud deployments, as well as being responsible for the report documentation tasks. He was also responsible for designing, and compiling all necessary information into the keynote presentation.

Sharmaine Rufford

During this project, Sharmaine was responsible for analysing all information relating to pricing, and comparisons between different cloud competitors, to understand who would be the best provider for the different solutions, as well as how much it would cost to deploy each system on the chosen provider.

Lessons Learnt:

One of the major lessons, and or skills, that the team has learned doing the project is the being able to decisively make a final decision on which provider to use, from a variety of available cloud providers, on the market, based on the analysis of user requirements, and the services that a cloud provider can offer.

Another lesson, and or skill, that the team has gained, is the ability to more efficiently understand different services provided by different cloud providers, and the best way to apply those services, within a deployment, such as, that virtual machine scale sets could automatically scale up and scale down to cut off some cost of cloud hosting, as well as that Kubernetes are most suitable in the field of micro-services.

Scenario 1

Cloud Provider:

Digital Ocean

Reason For Chosen Cloud Provider:

According to the situation that has been laid out for the team, TradeMe is a new business that is just starting up. This means that all costs must be kept to a minimum, and because of this, Digital ocean has been chosen for the web application.

In addition, Digital Ocean is much cheaper than other, larger cloud service providers, such as Microsoft Azure, and Amazon Web Services.

Finally another reason Digital Ocean has been chosen for this system, is that it is one of the top cloud service providers around New Zealand, as well as being safer than other smaller cloud providers which by some chance, may experience high downtimes, causing serious problems for TradeMe, such as data loss.

Solution Requirements:

- Design cloud-based hosting solution to launch the web-based application
- Application is a NodeJS web application
- The application uses a SQL database but is vendor agnostic so any SQL database will work.
- Ability to handle the goal of 100 000 requests at 1MB per request a month by the end of 1 year
- The goal for TradeMe is to have 0.2 million users by the end of the year with an average of 0.1 million currently listings.
- Must have enough redundancy built into the design to handle individual server failure
- Due to the company being a start-up costs must be kept to a minimum
- As financial transactions are stored backups need to be kept design a backup solution that would ensure all the data was shipped away from the site of the servers and kept secure.
- TradeMe currently has on staff a competent systems engineer with experience in both Windows and Linux.

Solutions:

Estimated Data Rate & Deciding On VM Size:

As has already been confirmed in the requirements above, there will be 100,000 requests per month, at 1MB per request. The assumption can also be made of an estimated 2.3 requests/minute, at 1MB per request, and a maximum of 100GB transferred data per month. CPU and RAM are not consumed. These figures allow for the minimum server size to easily be considered. (Figures are being based on a 30 day month)

VM OS:

All virtual machines are Linux based, as TradeMe already has staff experienced in maintaining Linux systems.

Load Balancers Connected To Multiple Data Centres & VM Redundancy Solutions:

Each load balancer is working with two virtual machines, located in different data centres, within the same region. This allows for redundancy, to handle individual server failures. Load balancers will be manually set up in order to help lower the overall cost.

Database Backups:

A scheduled database dump is used as an overall backup solution for the whole system, not just transactions. These database dumps will then be sent out of the database virtual machine, to a local Linux device, for archiving, in case a database failure appears, or the cloud provider has any serious problems occur. The already existing systems engineer should have the knowledge to be able to keep the database dump files safe, locally.

Application Server Also Managing Bulk Email Functions:

Initially, the bulk email function may be used for the purpose of promotion, auctions, or sales information. This is likely to be very CPU, and RAM intensive.

However, as there are only an estimated 2.3 requests/min on average, each web backend virtual machine should be able to handle both normal web requests, as well as bulk mailing requests.

Specifications:

VM OS:

Ubuntu Linux

External Load Balancer:

1x External Load Balancer + 1x Public IP for External Load Balancer

Web Front-Ends:

2x Virtual machines, using Nginx redirecting to the app server for the purpose of html responses, or static file access from the storage account.

Internal Load Balancer:

1x Internal Load Balancer running haproxy on an Ubuntu VM.

Application Servers:

2x Virtual machines running Node.js for business logic.

Database Server:

A MySQL database, running on an Ubuntu Linux VM, with a scheduled dump function. These database dumps will be sent out of virtual machine to a local Linux device, via a scheduled script on this virtual machine.

An assumption has been made that the storage for each user profile will require 2 rows per user, at 3 kb (user profile data & permissions), and storage for each listing item (including payment transaction) will be around 5kb.

Estimated storage for user profiles:

$3\text{kb} * 0.2\text{million users} / 1024 / 1024 = \text{about } 0.57\text{ GB}$

Estimated storage for listing items (including payment transaction):

$5\text{kb} * 0.1\text{million listing items} / 1024 / 1024 = \text{about } 0.48\text{ GB}$

Other possible usage:

1GB for other usage.

Size for database storage:

$0.57\text{ GB for user profiles} + 0.47\text{ GB for listing items} + 1\text{ GB for other possible usage} = 2\text{GB at least.}$

Storage Server:

Storage account to store images, JS, and CSS files.

An assumption has been made that each listing item will have 5 images, on average, and each user will have a profile image, and that each image will be 500 kb on average.

Listing items:

5 image * 500 kb * 0.1 million / 1024 / 1024 = about 240 GB

User profile image:

1 image * 500 kb * 0.2 million / 1024 / 1024 = about 100 GB

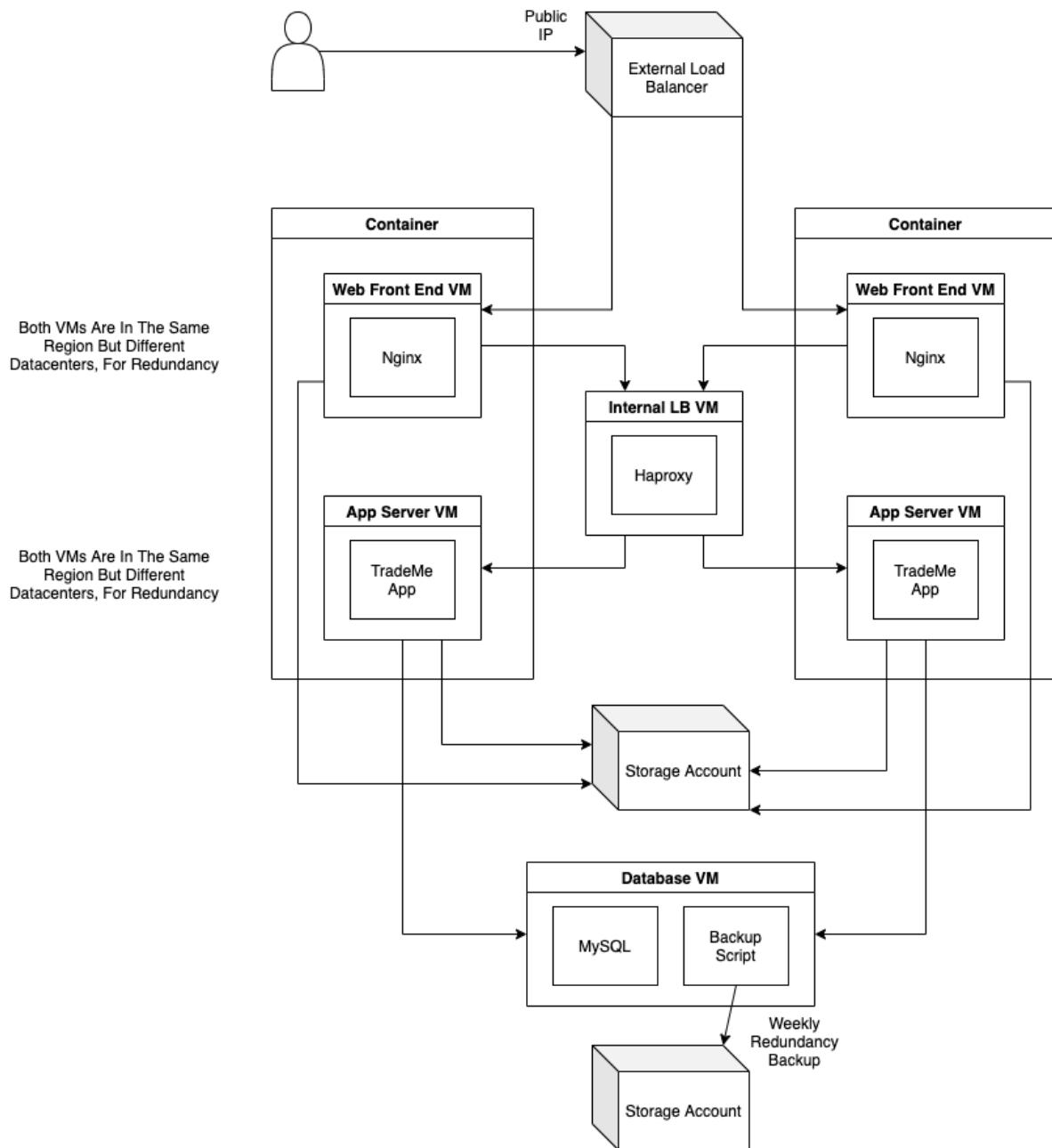
Assumption of System usage:

5GB

Estimated storage for storage account:

240 GB for Listing items + 100 GB for user profile images + 5 GB system usage = 345GB, at least

Solution Diagram:



Pricing:

DigitalOcean vs AWS :

DigitalOcean is known for providing very high-performance servers. DigitalOcean's network speed is 1Gbps; all hard disks are SSD and have an incredible start-up time of only 55 secs. DigitalOcean nodes are placed at the top, this is done by an independent performance tests, and has come out better than Amazon machines. DigitalOcean was in the lead regarding performance vs price. They were on top of the market for a long time which unfortunately for DigitalOcean caused the competitors to clean up the act and revised their network infrastructure to cost less. Support for DigitalOcean:

- Developer Support: DigitalOcean offers free 24/7 technical support. You can contact the company's support staff at any time to get help.
- Business Support: If you have \$500 of monthly spend, you qualify for Business Support, which gives you access to Customer Success Managers and additional support from DigitalOcean.
- Premier Support: For businesses that need a high-touch support setup with guaranteed 30-minute response time and solutions engineering to optimise your deployments, this level of support comes for a monthly fee. (Pollock, 2020)

Amazon AWS: they own the largest data centres in the world located. AWS has a huge support team, and a database of help documents; but there is a catch with this, the support is not included in all of your packages. Getting technical assistance may charge up to 10% monthly expenditure and when you think about big organisation this will add up quick. Support of AWS:

- Developer: This comes with a minimum response time of 12 hours, and costs \$29 or 3% of monthly AWS charges
- Business: This plan comes with a 1-hour response time for system down events, and costs \$100 or 10% of AWS monthly charges.
- Enterprise: The top end of AWS's support plans offers 15-minute response times for business-critical system down events. This tier of support costs \$15,000 or approximately 10% of monthly AWS cost. (Pollock, 2020)

AWS has some large names with them including PayPal, this of course adds to their recognition and makes it easier for marketing. AWS is from Amazon how have worked hard to get their name established, they have had success throughout the years and failures, but they see this as growth. AWS has noticed the difference regarding the prices they have appeared to other application and have worked hard to lower their prices but keep their level of standards high.

I think the main thing that needs to be considered is how big your organisation is, how fast it is growing, and do you need the option of a big service yet?

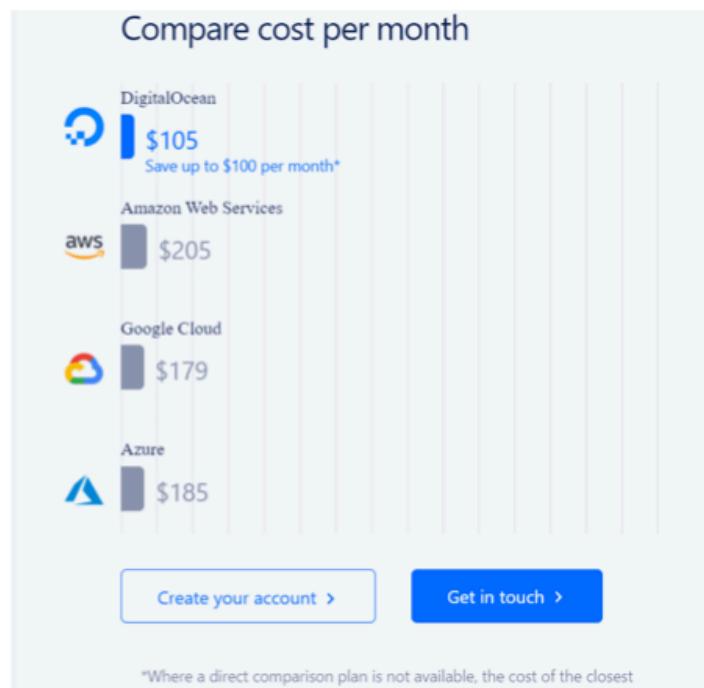
With the information provided about, it would be worthwhile for TradeMe to select DigitalOcean as their cloud service provider. The main reason is they are a lot cheaper and have all the support necessary for their current standing of business. AWS is fantastic for the incredibly large organisations (global) and advising you are with AWS give recognition (as people have heard this name) but their services are matched by DigitalOcean who have managed to keep their prices lower.

There are a huge amount of service providers out there that have the same abilities as DigitalOcean and the same easy access to materials. DigitalOcean takes the win over this regarding their security measures and have are a larger empire so you do not have to worry the same regarding loss of data or closure of business.

The picture below gives you a brief idea of what you are going to be paying using the calculator provided from DigitalOcean. They have 3 other top companies they compare the information to. With the information on the left, you can see what has been picked and, on the right, how much it will cost per month. You can see DigitalOcean is a lot cheaper appeared to other cloud providers.

Build your Droplet

STANDARD	GENERAL PURPOSE	CPU-OPTIMIZED	MEMORY-OPTIMIZED
Configuration			
CPUs	1		
Memory	2 GB		
Storage	50 GB		
Transfer	2 TB		
Total Storage +1 TB			
Total Transfer +1 TB			



Analysis of Service Options :

Please note all the figures mentioned below are in USD.

External load balancer \$10.00 per month

Create Load Balancer \$10/mo

Load balancers distribute traffic between Droplets within the same datacenter.
Create a load balancer, then add Droplets by name or by tag.

Below are the prices for the standard droplet: this type of droplet is used for applications like blogs, web apps, testing and staging environments, in-memory caching, and databases.

Memory	vCPUs	Transfer	SSD Disk	\$/HR	\$/MO
1GB	1vCPU	1TB	25GB	\$0.007	\$5
2GB	1vCPU	2TB	50GB	\$0.015	\$10
3GB	1vCPU	3TB	60GB	\$0.022	\$15
2GB	2vCPUs	3TB	60GB	\$0.022	\$15

Another option is the general-purpose droplet which is designed for the widest range of mainstream or production workloads, including web application hosting, e-commerce sites, medium-sized databases, and enterprise applications.

Memory	vCPUs	Transfer	SSD	\$/HR	\$/MO
8GB	2vCPU	4TB	25GB	0.089	\$60
16GB	4vCPUs	5TB	50GB	\$0.179	\$120
32GB	8vCPUs	6TB	100GB	\$0.357	\$240

Considering the size of TradeMe right now and what the VM's will be used for, it will be worthwhile to use the standard option and consider upgrading later when TradeMe requires it. As TradeMe is a growing company, the general-purpose droplet may need to be considered.

A MySQL Database will be running on an Ubuntu VM. The VM supports 25 GB storage which is enough to handle only 2 GB overall requirement for all current users and listing items, however, if the demand of storage increases later; it is available to add extra volume.

The current fee for data transfer is \$0.00 until December 2020 but will be billed again at \$0.01 per GB per month thereafter.

DigitalOcean has 2 options when it comes to storage: Block storage and Spaces Object Storage. Both are good and have their advantages.

Block storage volumes are network-based block devices that provide additional data storage for Droplets. You can move them between Droplets and resize them at any time. They are \$0.10 per GiB per month and range from 1GiB to 16GiB.

Block Storage Features:

- Use cases: Volumes are most useful when you need more storage space but do not need the additional processing power or memory that a larger Droplet would provide, like:
 - As the document root or media upload directory for a web server
 - To house database files for a database server
 - As a target location for backups
 - As expanded storage for personal file hosting platforms like ownCloud
 - As components for building more advanced storage solutions, like RAID arrays

The base rate of a Spaces subscription is \$5/month and gives you the ability to create multiple Spaces.

The subscription includes 250 GiB of data storage (cumulative across all your Spaces). Additional storage beyond this allotment is \$0.02/GiB. If you cancel your subscription by destroying all your Spaces, your bill will be prorated hourly.

Spaces subscriptions include 1,024 GiB of outbound data transfer (from Spaces to the internet), which is shared between all Spaces. Inbound bandwidth to Spaces never counts against your Spaces transfer allowance.

Spaces is a new feature that will most likely change, add upgrades and more options. Right now, the fees are great and the feature itself is excellent, any upgrades added will only increase an amazing product.

Affordable, predictable pricing

- ✓ \$5/mo
- ✓ 250 GB of storage
- ✓ 1TB of outbound transfer
- ✓ Unlimited uploads
- ✓ Unlimited Spaces

Total Estimate

Load Balancer @ \$10.00 each

Droplets (Virtual Machines) x6 @ \$5.00 each= \$30.00

Storage using Spaces \$5.00 + \$1.90 (345GB required, 95GB remaining $95 * 0.02$) = \$6.90

Total estimate is \$46.90

Advantages:

Local Database Backups:

Another copy of the database dump file, kept on a local Linux device, will minimise the risk of any database virtual machine failure that could cost not just company data, but also the backup files on the database server being lost.

Load Balancers:

Load balancers are designed to separate the inbound stress, and to provide an emergent solution, when an individual server fails.

Disadvantages:

No Automatic System Scaling:

This design is not able to automatically handle if the users grow significantly. There has to be an IT engineer to test, and scale up the number of virtual machines. Also, it is not able to automatically scale down the number of virtual machines, when the virtual machines are not in high demand.

Over Designing For Unlikely Failures:

An extra virtual machine for an nginx server is used to handle a situation where any individual server fails.

However, in reality, once the server has been deployed and tested, it will not commonly fail, and as the business has just started, and there are estimated to only be 2.3 requests/min on average, it is highly unlikely that all web front-end virtual machines will be heavily loaded, so, there are potentially unnecessary resources being deployed, causing an unnecessary expense.

Scenario 2

Cloud Provider:

Microsoft Azure

Reason For Chosen Cloud Provider:

Because of requirements raised, the services that Digital Ocean provided could not meet new requirements, the only cloud providers that provide an appropriate solution for the new requirements, are Microsoft Azure and Amazon AWS. Azure has been chosen for this application as Amazon AWS is a little bit more expensive than Azure.

Solution Requirements:

- Solution must be able to handle 20 million requests per month at an average of 1Mb per request
- They now have 4.5 million users with 6.5 million current listings.
- Solution should be able respond to the current level of demand and provide cost savings by scaling down in times of lower demand
- Must have the ability to handle individual datacenter failure
- User Profiles will now be stored in a MongoDB NoSQL document database, the transactions will remain on an SQL database
- Trademe is also looking to minimise the ITS maintenance burden of the application delivery platform.
- TradeMe's systems engineer has since left the company and TradeMe is looking to outsource the role to an MSP. As such they would like any solution presented to require as little systems engineering/administration as possible so that they do not have to contact their new MSP.

Solutions:

Estimated numbers & VM size:

20 million requests per month at an average of 1MB per request (463 request / minutes and 1 TB/ month transferred data) indicates that there is still no high demand on each virtual machines or unit within the cloud hosting environment, which allows for the minimum server size to easily be considered.

Individual Bulk mailing system:

The bulk mailing service has considered to be spilt out of the web application system as it will be really CPU and RAM consumed while it is sending email to clients due to the numbers of live users, then deployed on an individual virtual machine scale set with the number of initial virtual machine to be 0 with no public IP address on each virtual machine which means this service is only available under the private networking calling by other virtual machine on this cloud environment. The reason why to set the minimum number of VMs to be 0, is because the TradeMe is not always sending email to clients, so there will be no cost when it is not running.

VMSS (Virtual machine scale set) introduced in system:

Scaling up and scaling down virtual machines by using the VMSSs and set minimum number virtual machine for each VMSS to be 0, just in case of if no user currently using the system, there will be no cost.

Redundancy consideration for VMSS:

Each VMSS must be available for at least 2 availability zone in order to handling any datacenter-level failure.

MongoDB NoSql database & Redundancy solution:

Cosmos DB account for managed MongoDB will be used for only storing user profile with the geo-redundant solution to keep data safe when any regional or datacenter level failure.

Managed MySQL database & Redundancy solution:

A managed MySQL database for other types of data. The Azure database backup solution will apply for this database with geo-redundant option to handle any regional level failure.

Minimise ITS and calling MSP when necessary only:

As the virtual machine scale set will be applied in this scenario, the TradeMe do not necessarily need many maintenance staffs as they only need to call MSP when a region-level failure or a security accident that the entire cloud environment could not recover automatically.

When system slower than normal, the scale set will scale up the numbers of virtual machine to increase the speed of the entire system, then scale down when CPU usage of all virtual machines goes lower.

setting up more than 2 available zone would help to switch different datacenter in the same region automatically for TradeMe if any datacenter-level failure, which means, there are not too much work to do with it for ITS maintenance to deal with the site recovery.

Specifications:

VM OS:

Ubuntu Linux

Regions:

The region will be at Southeast Asia as all regions located at Australia does not support multiple availability zone which is not suitable for this project, and the Southeast Asia is the closest one.

External Load Balancer:

1x load balancer for the external communication with 1 public IP Address.

Front End VMSS (Virtual Machine Scale Set):

A Virtual Machine Scale Set with Virtual Machine size of Standard_A1_v2 for application front-end.

Application Internal Load Balancer:

1x internal load balancer for application back-end VMSS

Back End VMSS (Virtual Machine Scale Set):

A Virtual Machine Scale Set with Virtual Machine size of Standard_A1_v2 for application back-end.

Bulk Mailing Internal Load Balancer:

Another internal load balancer for bulk mailing service VMSS.

Bulk Mailing VMSS (Virtual Machine Scale Set):

A Virtual Machine Scale Set with Virtual Machine size of Standard_A1_v2 for bulk mailing service.

Cosmos DB:

Cosmos DB account for MongoDB with geo-redundancy back-up solution.

Assume storage for each user profile will be 2 row per user at 3 kb (user profile data & permissions).

Estimated storage for user profiles:

$3\text{kb} * 4.5 \text{ million users} / 1024 / 1024 = \text{about } 13 \text{ GB}$

Other possible usage:

1GB for other usage.

Size for database storage:

13 GB for user profiles + 1 GB for other possible usage = 14GB at least.

Managed MySQL DB:

Managed Mysql database with geo-redundancy back-up solution when any datacenter-level failure.

Assume the storage for each listing items (including payment transaction) will be at 5kb.

Estimated storage for listing items (including transactions):

5kb * 6.5 million listing items / 1024 / 1024 = about 31 GB

Other possible usage:

1GB for other usage.

Size for database storage:

31 GB for user profiles + 1 GB for other possible usage = 32GB at least.

Storage Account:

Storage account located at Southeast Asia as the files and static storage account with Geo-redundancy solution.

Assume each listing item will have 5 images in average and each user will have a profile image and each image will be 500 kb in average.

Listing items:

5 images * 500 kb * 6.5million / 1024 / 1024 / 1024 = about 15.2 TB

User profile image:

1 image * 500 kb * 4.5 million / 1024 / 1024 = about 2 TB

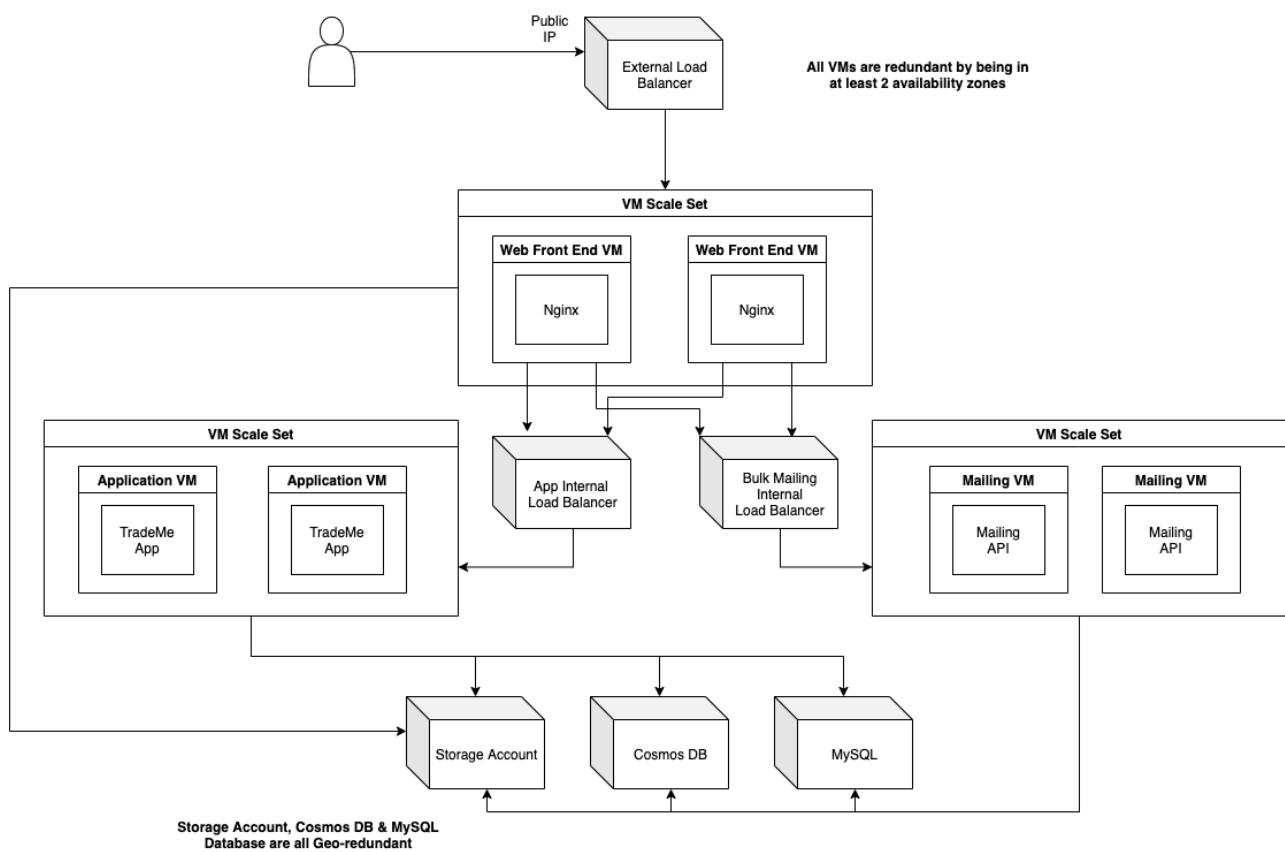
Assume the System usage:

5GB

Estimated storage for storage account:

15.2 TB for Listing items + 2 TB for user profile images + 5 GB system usage = 18 TB at least

Solution Diagram:



Pricing:

Consideration of Services :

The decision has been made to use Microsoft Azure. This decision has been made so each component mentioned above will be used to their best ability and become as asset for TradeMe.

With the use of Microsoft Azure calculator feature we have made 3 options to be viewed, each with different prices and length of use:

- Pay as you go service
- 1-year service
- 3-year service

Each option has their own advantage and disadvantage. What needs to be considered is how long you will need the service for and if it will value the organisation to have the service for a short time so can continue keeping your options open or a long length of time and not have to worry about again for 3 years. As TradeMe is an organisation that has been continuous growing it may be better to consider using the pay as you go option or 1-year service.

Reviews for Microsoft Azure from other users :



The image above advising all the locations in which Microsoft Azure is located around and how close they are to you. Of course, not every service is available on every network; if our case we have looked at the options close to New Zealand and Australia, and found the best option is SouthEast Asia as they offer better services for this particular scenario.

One of the reviews about Microsoft Azure is that it can become pricey when you require support and help with your service. If an error has occurred, you are likely to get a service fee to fix this issue. The options for developer support, costs \$29 a month, standard support costs \$100 and professional costs \$1,000. These options need to be considered

when the final plans are made. If support is not arranged at the start you will only get help with billing and subscriptions.

Microsoft Azure is known for its speed and has been given high recommendations from users for their security system. With the security features the user can make everything more secure by encrypting all data store server-side.

Microsoft Azure is popular regarding its price appeared to Google Cloud (for example), they offer a huge range of services but are more costly.

Analysis of Service Options

Please note all the figures are in USD. When a comparison is made between the upfront cost for 3-years and 1-year service, the only difference is the upfront cost; \$14,193.30 for the 3-year service and \$5735.17 for 1-year service. If the 1-year service is picked and renewed, the upfront fee may be required again so the 1-year service fee for 3-years is \$17,205.51, which is more expensive than the 3 year upfront fee with a difference of \$3012.21.

Comparison between 1-year and 3-year service:

The is no difference per month between the two options.

As the 1-year option calculates to be the same as the 3-year option per month I will advise the figures below:

Per month: \$2865.68

Per year: \$34,388.16

Over 3-years: \$103,164.48

Pay as you go service:

The third option is pay as you go (PAG), this is a monthly payment. This is subject to change as it is set up as PAG, so some services may increase or decrease in price. PAG does not have an upfront fee, this fee is built into the monthly cost because a length of time contract has not been set up. With the current standings the fees are:

Per month: \$3522.10

Per year: \$42265.2

Over 3-years: \$126,795.6

Service decision

After all the research done above and the options considered, the final decision which service to use is the 1-year option. This service works out to be cheaper in the long run and has all features required for TradeMe. As TradeMe is a growing organisation and with the technology of todays world, TradeMe will need to consider that they will be upgrading their services in the near future; this means they do not want to get themselves stuck in a contract they cannot get out of or will have to pay a fee to retire that service.

With the inclusion of the upfront fee of \$5735.17 the yearly fee will be \$40,123.33.

3-year option:

Microsoft Azure Estimate					
Scenario 2 Estimate (3 years reserved)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Cosmos DB			Multiple Region Write (Multi-Master); 3 year reserved capacity; 400 RU/sec; 15 GB Storage	\$3.75	\$11,773.44
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore), 3 year reserved, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$28.83	\$2,419.86
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High Priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Support			Support	\$0.00	\$0.00
			Licensing Program	Microsoft Online Services Agreement	
			Total	\$2,865.68	\$14,193.30
Disclaimer					
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This estimate was created at 6/17/2020 8:09:24 AM UTC.					

1-year option:

Microsoft Azure Estimate					
Scenario 2 Estimate (1 year reserved)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Cosmos DB			Multiple Region Write (Multi-Master); 1 year reserved capacity; 400 RU/sec; 15 GB Storage	\$3.75	\$4,485.12
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore), 1 year reserved, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$28.83	\$1,250.05
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High Priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Support			Support	\$0.00	\$0.00
			Licensing Program	Microsoft Online Services Agreement	
			Total	\$2,865.68	\$5,735.17
Disclaimer					
All prices shown are in US Dollar (\$). This is a summary estimate, not a quote. For up to date pricing information please visit https://azure.microsoft.com/pricing/calculator/					
This estimate was created at 6/17/2020 8:08:45 AM UTC.					

Pay as you go option:

Microsoft Azure Estimate					
Scenario 2 Estimate (Pay as go)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Cosmos DB			Multiple Region Write (Multi-Master) - Southeast Asia; Pay as you go; 4 x 100 RUs x 730 Hours; 15 GB Storage	\$470.95	\$0.00
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore) x 730 Hours, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$218.05	\$0.00
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High Priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Support			Support	\$0.00	\$0.00
			Licensing Program	Microsoft Online Services Agreement	
			Total	\$3,522.10	\$0.00
Disclaimer					
All prices shown are in US Dollar (\$). This is a summary estimate, not a quote. For up to date pricing information please visit https://azure.microsoft.com/pricing/calculator/					
This estimate was created at 6/17/2020 8:07:39 AM UTC.					

Advantages:

Flexibility:

One of the major advantages that a VMSS (Virtual Machine Scale Set) can offer, is unrivalled flexibility to handle almost any size of task, while offering an incredibly cost-efficient deployment, as you only pay for higher processing when there is high demand.

Can Have Zero VMs:

Expanding on the first advantage, to save even more money for a company that happens to have part of a system that is only used on occasion (Such as the bulk mailing system, in the above scenario), when that particular part of the system is not needed, a VMSS can shrink to the point of having no VMs at all, costing the company nothing, during those times of no use.

Disadvantages:

Complex To Set Up:

Due to the nature of a VMSS (Virtual Machine Scale Set), they can in some instances be rather complex to set up, and configure. This can end up being a rather time consuming process, and overall a disadvantage for this style of deployment.

Using Multiple DBs Can Costly:

Depending on the nature of the deployment, and the requirements of the company that the system is being designed for, there are some cases where multiple DBs can be beneficial, however, there is no hiding from the fact that both the long term deployment, and maintenance costs for multiple databases will be significantly higher, and this can be seen as a major disadvantage.

Data & System Migration:

Resources:

To be able to copy all the resources that are currently stored in the storage account, on Digital Ocean, firstly, a new storage account on Azure, must be created, with the expected path/directories.

Then it is a simple case of running a customised script to read all the files on the Digital Ocean storage account, except the static files, then write to the expected directory of the storage account on Azure.

Database servers:

Before making a database dump, the data normalisation will be completed to split out all user profile data from current database.

Then a temperate virtual machine with MongoDB NoSQL database installed, will be created, to store those user profile data in it.

Finally, generate dump files for both MySQL database, and MongoDB NoSQL database. Then restore data from those dump files to the database servers on Azure.

Servers & Load balancers:

Virtual machine scale sets will be deployed manually via PowerShell and CLI. Initially, to create 2 virtual machines, one with Nginx deployed, another with the application deployed (collecting static files and copying them to the storage account on Azure, while deploying the web application server), next, create images for those VMs for the VMSSs deployment.

The internal and external load balancers will be manually deployed using the Azure portal, with settings of back-end pools, health probes, and load balancing rules.

Scenario 3

Cloud Provider:

Microsoft Azure

Reason For Chosen Cloud Provider:

The reason of continuing to use Microsoft Azure for this stage, is because the extended requirements can be sorted on this cloud provider and the consideration of the price after compared between Azure and Amazon AWS.

Solution Requirements:

- TradeMe is looking to provide businesses with the option to use their platform as a mechanism to sell to customers, they need a convenient way for the staff at these companies to sign onto the TradeMe platform.
- TradeMe is focusing on mobile first clients this will mean an API end point for the various mobile apps which will run alongside the existing web frontend.
- With the mobile first clients TradeMe has encountered an issue with image processing and storage as every picture uploaded for an auction the imaged needs to be resized into multiple copies for the various mobile screen sizes. Doing this efficiently within the existing application has proved a challenge.
- Finally, TradeMe will be rearchitecting their platform to one that uses micro services, so the monolithic application servers are no longer required. This will entail re architecting the way in which the application layer of the application is delivered.

Solutions:

Ability to provide business account:

Using the Azure Active Directory to create several access tokens for those users who are at the organisation-level, as they could use their own organisation account to log onto the TradeMe platform without account recreation.

Mobile End point applied in new system:

Using the same front-end by adding multiple new IP address as mobile API end points in Nginx settings, to enable the existing front-end directing user requests to Mobile application back-end k8s service, and all resources used for mobile application will be stored at the same storage account but different directory.

Breaking into micro-services:

For the requirement of breaking the monolithic application into a set of micro services (for both web application and mobile application), the Kubernetes service is the solution that groups containers that make up either web application or mobile application into logical units for easy management and discovery. In addition, the Azure Kubernetes Service allows each individual node to be able to autoscaling based on demand.

Units running on Kubernetes service can be:

Assume that the response of the backend of web application will be different with the mobile application, so, there will be 2 set of Kubernetes services

- Login & Registration system
- Image resizing function
- Payment function
- Shopping Cart & purchase history
- Product search

Back-up and recovery solution for k8s services:

The back-up solution for each of Kubernetes service will be in 2 types

- If one Kubernetes service is down or any datacenter-level failure occurs (less likely to happen), the solution is to run the deployment scripts which is created while node deployment stage, to recreate the entire Kubernetes service.
- If any individual node of any Kubernetes service is failed, the auto scaling function will directly create a new one.

Specifications:

VM OS:

Ubuntu Linux

Regions:

The region will be the same as Southeast Asia.

Services Kept From Solution 2:

The storage account, CosmosDB, MySQL database, external load balancer, web front-end VMSS, one of internal balancer for mailing service VMSS, and mailing service VMSS will be kept.

Web Back End VMSS & Internal web backend Load Balancer:

The web backend VMSS and internal web backend load balancer will be replaced by a set of web services in k8s service with 6 nodes and running one/multiple services on each node (the 1 of these 6 nodes is for master node usage which is in charge of monitoring for k8s and controlling other nodes). The size of each node will be the Standard_B2s (2 vCPUs, 4 RAM, Max IOPS 1280, temporary storage 8 GB) which is the cheapest one but enough for each individual node.

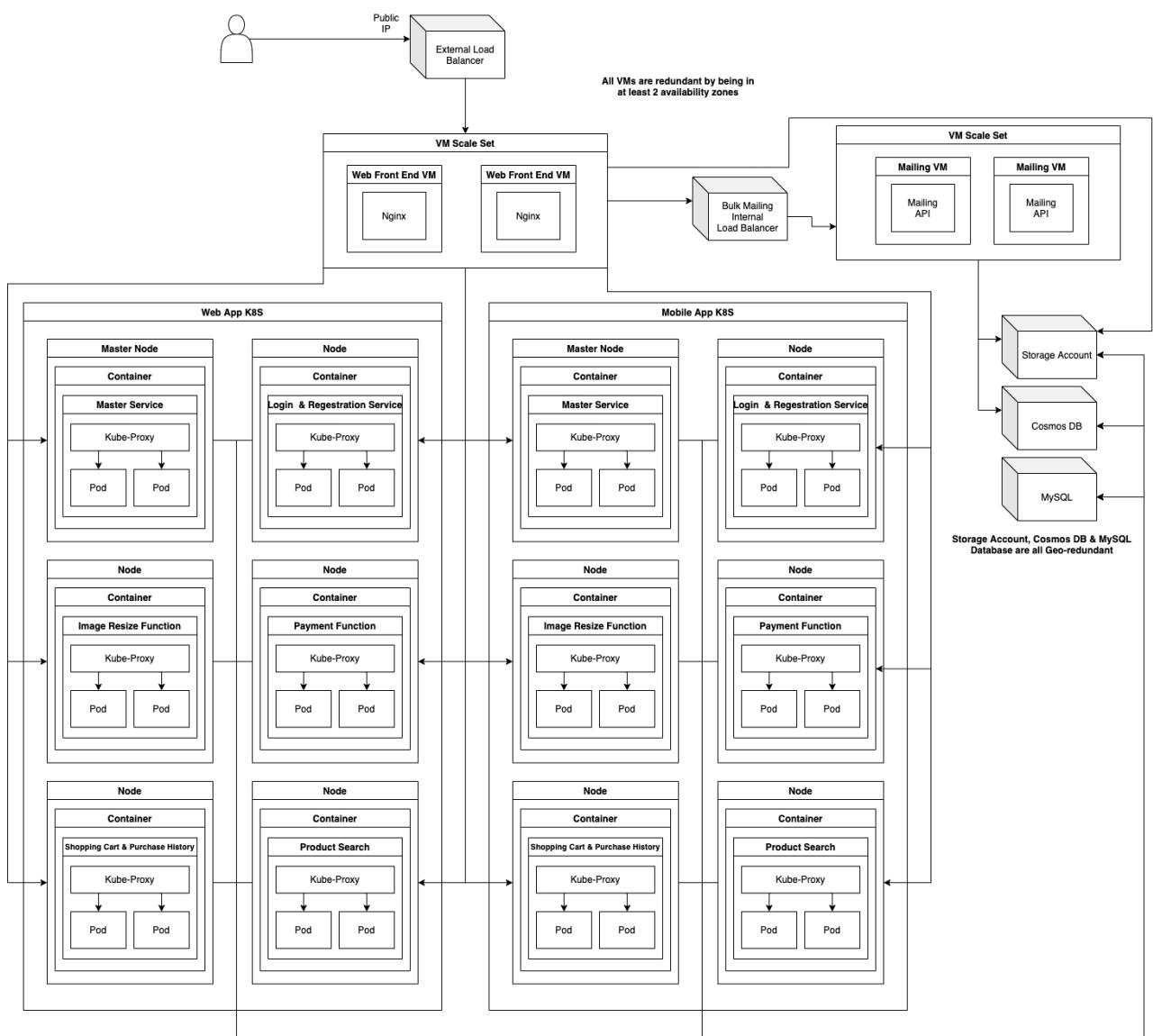
Extra Kubernetes Service:

Due to the considerations of mobile application may extended, and easy to maintenance, another k8s service will be deployed for mobile application usage which will be the same as web k8s service that will consist of 6 nodes and running one/multiple services on each node (the 1 of these 6 nodes is for master node usage which is in charge of monitoring for k8s and controlling other nodes). The size of each node will be Standard_B2s, and auto scaling function applied for each service.

Azure Active Directory:

The tier of Azure AD will set at Premium P1 standard (\$6.00/app user) as the free tier will have the limitations of 500k Directory Objects and SSO for SaaS Apps 10 Apps/User which is might not enough to meet TradeMe current requirement.

Solution Diagram:



Pricing:

AWS vs Microsoft Azure vs Google Cloud :

AWS first came into the market in 2002, their first competitor was Google Cloud which came around in 2009. This means AWS got in early, managed to make a fantastic name for themselves and had everything on their side for 7 years. This is a long time in the technology world, and a long time without competition. AWS is known as the more expensive cloud option, but they still have large names with them, and they are keeping them on top of the market. It is noted that Microsoft thought that cloud services were trend, so they had to play catch up, they joined the marketing cloud crew in 2010. Microsoft unfortunately took a dive in the cloud world, they had a lot of challenges to face, mainly AWS, they had 7 years on them, AWS could add new features, improve their current and show amazing stats, this made it hard for all of the competition.

Google Cloud and Microsoft Azure were late, but they grew to become incredibly great cloud providers. Google is known for its data centres and fast response time. Many organisations use Microsoft products, so naturally it would make sense for them to carry on using them with a Microsoft Cloud option.

Vendor	Strengths	Weaknesses
AWS	<ul style="list-style-type: none">• Dominant market position• Extensive, mature offerings• Support for large organizations• Extensive training• Global reach	<ul style="list-style-type: none">• Difficult to use• Cost management• Overwhelming options
Microsoft Azure	<ul style="list-style-type: none">• Second largest provider• Integration with Microsoft tools and software• Broad feature set• Hybrid cloud• Support for open source	<ul style="list-style-type: none">• Issues with documentation• Incomplete management tooling
Google	<ul style="list-style-type: none">• Designed for cloud-native businesses• Commitment to open source and portability• Deep discounts and flexible contracts• DevOps expertise	<ul style="list-style-type: none">• Late entrant to IaaS market• Fewer features and services• Historically not as enterprise focused

Figure 2 <https://www.datamation.com/cloud-computing/aws-vs-azure-vs-google-cloud-comparison.html>

As you can see from the chart above, each of the three cloud providers has their own advantages and disadvantages. With all the research I have done in regards to comparing services, the one thing that is always mentioned is price for AWS, sure Azure and Google are not as cheap as DigitalOcean but they are better value if they provide all the services you require.

Price Evaluation

The price difference between the 3 services is substantial this time around. The PAG option is more expensive and overall, not worth the extra money as the longer services offer the same services. Please note all the figures stated below are in USD.

Monthly Fee: \$4,010.85

Yearly Fee: \$48,130.2

3-Year Fee: \$144,390.6

The yearlong service has the same monthly fee as the 3-year fee, so they calculate to the same amount:

Monthly Fee: \$3,387.14

Yearly Fee: \$40,645.68

3-Year Fee: \$121,937.04

1-year upfront fee: $\$4,298.53 \times 3 = \$12,895.59$ (as you renew yearly, it is highly possible that the upfront fees will be required to be paid again)

3-year upfront fee: \$8,310.79

Difference: \$4,584.8

With the information and data worked out above, it would be advisable to take the 3-year service option as this is better value for money and TradeMe will unlikely need to upgrade their service within 3-years. With the upfront fee included the total 3-year amount will be \$130,247.83.

3-year option:

Microsoft Azure Estimate Scenario 3 Estimate (3 years reserved)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Azure Active Directory		West US	Premium P1 tier, Standard directory objects, 730 User forest hours, 730 Resource forest hours.	\$115.50	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 20 GB Data Processed	\$18.35	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Kubernetes Service (AKS)		Southeast Asia	6 B2S (2 vCPU(s), 4 GB RAM) nodes; 3 year reserved; 0 managed OS disks -P1, 0 clusters	\$0.00	\$2,945.46
Azure Kubernetes Service (AKS)		Southeast Asia	6 B2S (2 vCPU(s), 4 GB RAM) nodes; 3 year reserved; 0 managed OS disks -P1, 0 clusters	\$0.00	\$2,945.46
Azure Cosmos DB			Autoscale provisioned throughput, Multiple Region Write (Multi-Master) - Southeast Asia; 4 x 1,000 RUx 730 Hours; 15 GB Storage	\$470.95	\$0.00
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore), 1 year reserved, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$28.83	\$2,419.86
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High Priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Support			Support Licensing Program	\$0.00 Microsoft Online Services Agreement	\$0.00
			Total	\$3,387.14	\$8,310.79
Disclaimer All prices shown are in US Dollar (\$). This is a summary estimate, not a quote. For up to date pricing information please visit https://azure.microsoft.com/pricing/calculator/ This estimate was created at 6/23/2020 6:56:20 AM UTC.					

1-year option:

Microsoft Azure Estimate					
Scenario 3 Estimate (1 year reserved)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Azure Active Directory		West US	Premium P1 tier, Standard directory objects, 730 User forest hours, 730 Resource forest hours.	\$115.50	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 20 GB Data Processed	\$18.35	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Kubernetes Service (AKS)		Southeast Asia	6 B2S (2 vCPUs), 4 GB RAM nodes; 1 year reserved; 0 managed OS disks - P1, 0 clusters	\$0.00	\$1,524.24
Azure Kubernetes Service (AKS)		Southeast Asia	6 B2S (2 vCPUs), 4 GB RAM nodes; 1 year reserved; 0 managed OS disks - P1, 0 clusters	\$0.00	\$1,524.24
Azure Cosmos DB			Autoscale provisioned throughput, Multiple Region Write (Multi-Master) - Southeast Asia; 4 x 1,000 RUx 730 Hours; 15 GB Storage	\$470.95	\$0.00
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore), 1 year reserved, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$28.83	\$1,250.05
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High Priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Support			Support	\$0.00	\$0.00
			Licensing Program	Microsoft Online Services Agreement	
			Total	\$3,387.14	\$4,298.53
Disclaimer					
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Pay as you go option:

Microsoft Azure Estimate					
Scenario 3 Estimate (Pay as go)					
Service type	Custom name	Region	Description	Estimated monthly cost	Estimated upfront cost
Azure Active Directory		West US	Premium P1 tier, Standard directory objects, 730 User forest hours, 730 Resource forest hours.	\$115.50	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 20 GB Data Processed	\$18.35	\$0.00
Load Balancer		Southeast Asia	Standard Tier: 5 Rules, 1 TB Data Processed	\$23.37	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Virtual Machine Scale Sets		Southeast Asia	1 A1 v2 (1 vCPU(s), 2 GB RAM) x 730 Hours, Linux, Pay as you go	\$32.85	\$0.00
Azure Kubernetes Service (AKS)		West US	6 B2S (2 vCPUs), 4 GB RAM nodes x 730 Hours; Pay as you go; 0 managed OS disks - P1, 0 clusters	\$217.25	\$0.00
Azure Cosmos DB			Autoscale provisioned throughput, Multiple Region Write (Multi-Master) - Southeast Asia; 4 x 1,000 RUx 730 Hours; 15 GB Storage	\$470.95	\$0.00
Azure Database for MySQL		Southeast Asia	General Purpose Tier, 1 Gen 5 (2 vCore) x 730 Hours, 35 GB Storage, 100 GB Additional Backup storage - GRS redundancy	\$218.05	\$0.00
Storage Accounts		Southeast Asia	Block Blob Storage, Blob Storage, GRS Redundancy, Hot Access Tier, 20 TB Capacity - Pay as you go, 100,000 Write operations, 100,000 List and Create Container Operations, 100,000 Read operations, 100,000 Archive High Priority Read, 1 Other operations, 1,000 GB Data Retrieval, 1,000 GB Archive High priority Retrieval, 1,000 GB Data Write, 20 TB Geo-replication data transfer	\$2,664.44	\$0.00
Azure Kubernetes Service (AKS)		West US	6 B2S (2 vCPUs), 4 GB RAM nodes x 730 Hours; Pay as you go; 0 managed OS disks - P1, 0 clusters	\$217.25	\$0.00
Support			Support	\$0.00	\$0.00
			Licensing Program	Microsoft Online Services Agreement	
			Total	\$4,010.85	\$0.00
Disclaimer					
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This estimate was created at 6/23/2020 6:54:22 AM UTC.					

Advantages:

Maintenance:

Using micro-services may be very helpful when it comes to system maintenance. This is especially so, when breaking the system down into 2 sets of k8s.

VMSS For Bulk Mailing:

Continuing to use an individual VMSS for the bulk mailing system, could be cheaper and much more efficient, than if this service was to be contained on a node, within one of the k8s services.

Disadvantages:

Kube-Proxy IP Tables:

One of the major, and most known weaknesses of IP tables for kube-proxy is the significantly increasing response delay that occurs, the more pods that are created inside an individual node/VM.

Complex To Understand New System:

Another major disadvantage of deploying a Kubernetes based deployment, currently, is that understanding how to design, develop, and maintain a Kubernetes based deployment, can be a major learning curve for systems engineer, so, they must have the time to undergo this level of training.

Extra Notes:

More expensive but, more efficient:

An interesting consideration when developing a Kubernetes based deployment is that even though Kubernetes can, in some cases, cost more to deploy, the efficiency, and response speed of the system can be significantly increased, over a standard VM deployment. This shows that whether or not Kubernetes is the best solution for a particular company is very much dependant on what kind of system the company is planning to run on it.