

Enterprise Cloud Computing in an AWS Environment

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1. Introduction

This document is prepared for PrintIT to present findings and recommendations for provisioning Amazon Web Services (AWS) for its business with a research study on Amazon SageMaker (ASM).

1.1 Background

PrintIT is an established Small and Medium-sized Enterprise (SME) print company from Stoke-on-Trent in Staffordshire, England that has been sole trading since 1973. PrintIT now operates an online t-shirt printing service at www.printitnow.org for delivery to individual and corporate front end customers – Figure 1. Having attended AWS re:Invent London, PrintIT would like advice on whether migrating services to AWS could fulfil its strategic goals and what ASM could do for the business.

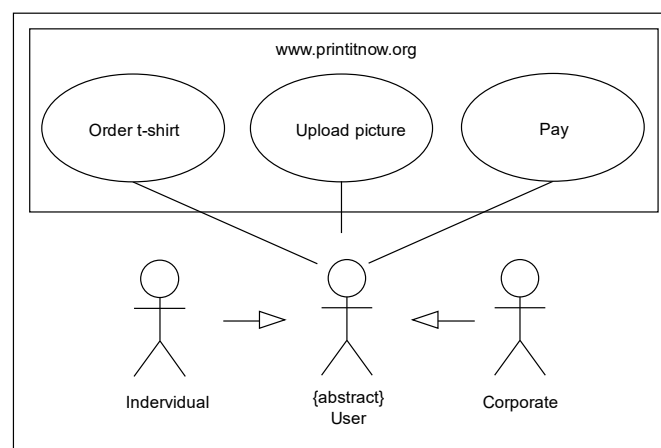


Figure 1 Use case of www.printitnow.org

1.2 Strategic goals

PrintIT avers that more customers are using its services than ever owing to a niche that has emerged in printing either names, squad numbers, or both, onto photographs it has of the Stoke City bet365 football grounds. Consequently, as PrintIT have incurred in-year increases in sales and annual turnover, its goal is to capitalise on continuous customer growth by offering the same service to more football grounds in the United Kingdom. PrintIT are of the view that AWS might help to harness its expansive sales via improved infrastructure and, eventually, geographically with different offices to off-load parts of the workflow.

1.3 Current Infrastructure

The current infrastructure setup is shown in Table's 1 and 2 based on answers given in interview with PrintIT (Appendix A.1).

Table 1 Current On-premises Infrastructural Components

Component (x1)	Manufacture	Function
Web server	Microsoft Internet Information Services (IIS)	Hosts a static website under domain name www.printitnow.org . Installed on windows server.
Database server	Microsoft Access	Carries out transactional queries for the web application users and stores customer details
File storage server	Windows (local network)	Assumed to be a Network Attached Storage. This is for general back office administration.
File server	Windows (local network)	Where image files and customer details have been uploaded via www.printitnow.org .
Print server	Windows	Jobs are routed to the print server before being forwarded to the direct-to-garment printer.
Router	Internet Service Provider	Internet gateway packet forwarding. Also acts as a firewall.
Switch	Netgear	Connects the devices on the PrintIT local area network as a multiport bridge.
Mail Server	Microsoft Outlook Exchange Server	General emailing between colleagues and customers.
Printer	N/A	Direct printing to garments.

Table 2 Current Off-site Infrastructural Components

Component (x1)	Manufacture	Function
FTP server	Windows (Internet)	Storage array backup location. Uploads assumed to be scheduled by automation by the on-site file server. Password accessible.
Merchant API Server	PayPal	Provides a third-party e-commerce service as the dynamic ordering page of www.printitnow.org .

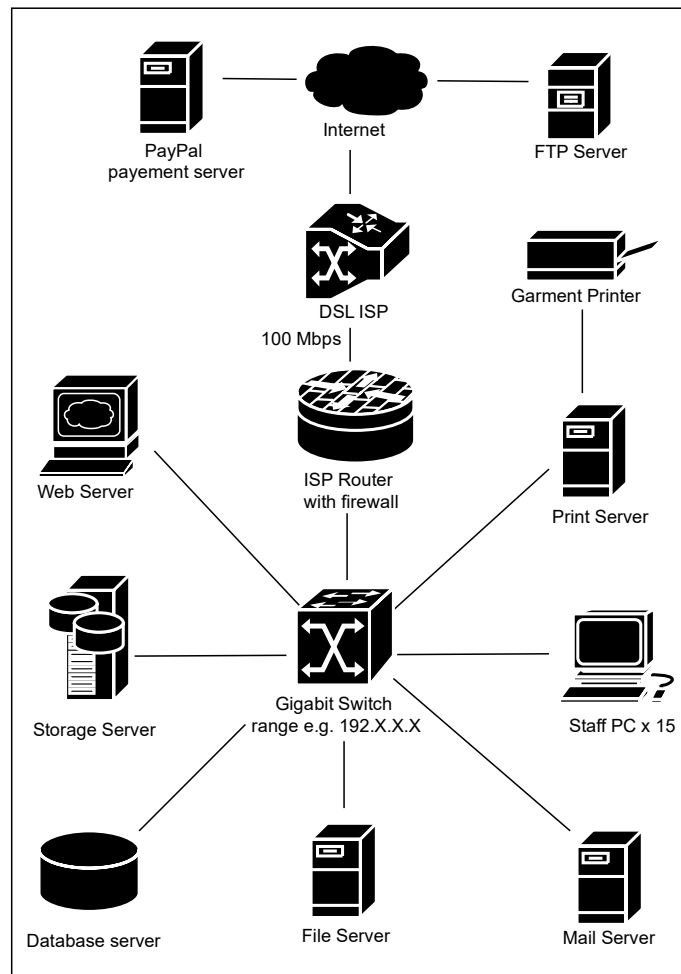


Figure 2 Flat Star Topology - Current On-premise Network

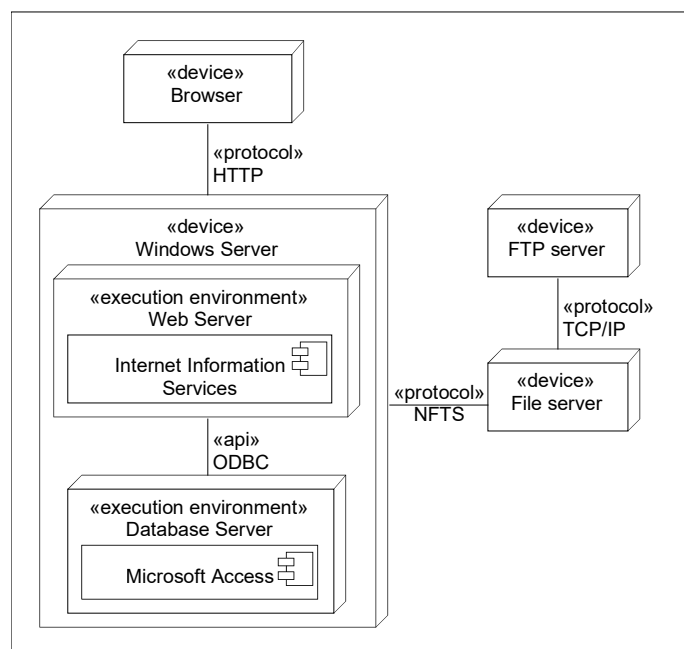


Figure 3 Web Application - Current On-premise Deployment

1.4 Current problems analysis

There are certain problems with the current infrastructure on which the service operates. PrintIT claim these issues may create obstacles to achieving its business goal, and, therefore, want to know whether AWS could resolve them. The problem areas are identified from the scenario and interview (Appendix A.1) in Table 3:

Table 3 Problem Statements

No.	Problem Statement	Category
1	Image file uploads are too large at an average of 5 Megabytes and are increasing in quantity and size.	Server file system capacity
2	There is generally a lack of storage space available to store image files.	
3	While PrintIT are not absolutely sure what is causing it, the company thinks generally that staff are occasionally manually deleting wrong image files to clear space when it has older orders or loses them by misplacement.	
4	An image file cannot be uploaded to the website more than once in situations where it has been lost as it will generate a new job that already exists.	
5	While this [compressing files] helps to reduce megabyte size, and in turn physical storage space increase, it results in quality loss of the file.	Simple Mail Transfer Protocol (SMTP)
6	If it loses an uploaded image file, PrintIT must phone or email a customer to email the image file as an attachment.	
7	The outlook server performance for emailing customer offers has decreased owing to increased customer data. So, an isolated *.CSV file emailing list has to be maintained by the staff to create a mail merge and ensure it is consistent with the Access database.	Database scalability
8	Queries on the database are timing out before completion due to increased use. These are queries on items like sending out emails to all customers with offers. PrintIT has tried running Business Intelligence queries to certain spending patterns to optimise resources. However, these queries seldom ever complete.	
9	There have been three Denial-of-Service (DoS) attacks against www.printitnow.org in the last twelve months thereby disabling access of the service for users. For each DoS the company took the website offline until the Internet Service Provider finished blocking the offending Internet Protocol addresses.	Security
10	Backups of all website data is uploaded via File Transfer Protocol (FTP) to the PrintIT owner's home remote storage array which constantly needs to be increased with additional storage devices once they become 75% full. Storage limitations aka minimum time retention apply under the European General Data Protection Regulation (EU) 2016/679 (GDPR) Article 5 (1) (e) now part of UK law (HM Government, 2018).	Backup storage
11	In the weeks leading to Christmas backups do not complete before PrintIT opens again due to a high amount of orders placed.	High traffic
12	There are no dedicated IT staff. This means PrintIT rely on colleagues who are only seemingly good at one or two duties such as maintaining the database, backing up data, or desktop support. A problem will tend to persist where members of staff try to fit it in the absence of one that knows the solution.	Access control
13	A member of staff is required to compress the file so it can be printed.	
14	PrintIT are trying to optimise resources with the use of the Access database to run Business Intelligence queries to determine customer spending patterns but they seldom complete.	Data analysis
15	PrintIT are of the opinion that Google search optimisation is the best advertising medium because orders are increasing since using it but it has no real proof to this claim.	
16	The electronic direct-to-garment printer cannot print from uploaded image files larger than 1920 X 1080 pixels meaning the file is wasted as a resource.	Printer limitation

2. Benefits and Risks of Developing a Cloud IT Strategy

2.1 Benefits of cloud migration

The benefits and risks of cloud services to a customer has been opined by many authors on the subject of virtualised infrastructural characteristics and external factors. A non-exhaustive list of benefits encompassing both strengths or opportunities are shown in Table 4 for considering a migration strategy for cloud adoption.

Table 4 Benefits of Cloud Computing

Benefit	Description
Readiness	The readiness driver is also known as ‘On-demand self-service’. That is to say, the cloud will benefit PrintIT by being constantly online allowing the company to use the service and secure resources whenever it sees fit (Ruparelia , 2016, p. 17).
Ubiquitous service	Cloud service can be accessed anywhere for PrintIT especially if they expand. This is referred to by Mell & Grance as ‘broad network access’ (2015) in the sense that over the cloud network, capabilities can be accessed via thick or thin platforms which endorse its use.
Reduction of expenditure	Cost reductions in cloud computing may benefit PrintIT as an SME paying only for use, thereby proffering economic value. This is a ‘measured service’ with two financial implications: First, CapEx can be avoided and trialling is cheaper (Government Digital Service, 2017). Second, running direct costs are potentially cheaper as pricing models are scalable to rent for specific period of time (Choo, 2010). Margins of profit are also allegedly decreased by cloud provider competition (Penzel, et al., 2015).
Fast access	Connecting to cloud virtualized hardware is available for users at rapid speed, satisfying urgent access and deployment, which often results in an expedient time to market (Ghaffari, et al., 2014). In effect this creates rapid provisioning as a result of there being no expense and time-consuming installation tasks (Choo, 2010). PrintIT could find this useful during high orders.
Development innovation	It is purported that cloud infrastructures lead a benefit in innovating technologies via x as service given it dispenses with barriers securing IT resources and opens up social networks (Ghaffari, et al., 2014). This may be attractive to PrintIT who are looking at ASM.
Elasticity	As per the National Institute of Standards and Technology (NIST), cloud technology caters for rapid scaling, horizontally and vertically, of computing resources in proportion with demand, and potentially automatically, commonly known as rapid elasticity (Mell & Grance, 2015) - as illustrated in Figure 4. PrintIT are likely to want this during periods of high demand.
Green	Research on the carbon-footprints have found cloud computing particularly in the use of autoscaling infrastructures have the propensity to offer greener solutions than running on premise business software (Radu, 2017). The UK government recognises that efficient use of cloud services may help meet its green commitments (2017).
Security	Managing security for online applications is crucial (Tawfique & Vejseli, 2018). But in cloud services, upgrades installs and security patches for server instances are applied routinely by the provider. The management of this aspect is a bonus for PrintIT because bugs and vulnerabilities are dealt with as soon as they arrive by the provider (Hill, et al., 2013, p. 232) In AWS the overall configuration security tasks like patching, are carried out by the service (Cole, et al., 2017, p. 44).
Resource pooling	While possessing technological merits, the ability to virtualise hardware means that resources can be pooled together and shared by elastic means (Ruparelia , 2016, p. 19). In so doing, PrintIT has a variety of instant pricing models to suit a certain business agenda, such as AWS Amazon Elastic Compute Cloud (EC2) reserved instances (Piper & Clinton, 2019, p. 285).

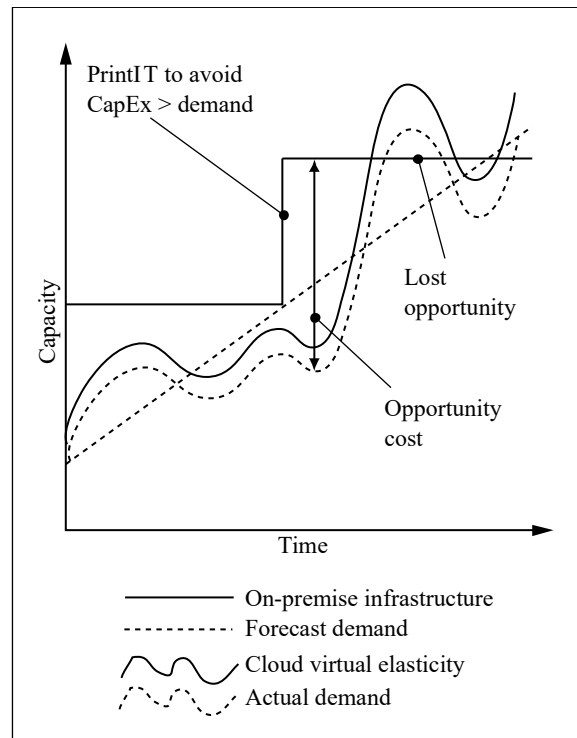


Figure 4 Elasticity – Operating expenditure adapted from (Ruparelia , 2016, p. 84)

2.2 Risks of cloud migration

In terms of risk, threats and weaknesses have been sourced from literature to provide a non-exhaustive list pertinent to strategy of cloud migration in Table 3.

Table 5 Risks of Cloud Computing

Risks	Description
Trust	Notwithstanding the benefits of continuous security patching, academics are wary as to potential threats that can be inflicted on the overall architecture and design of cloud computing itself. That is owing to centralised security, redundancy, and process segmentation that a user needs to rely on via third party integration (Penzel, et al., 2015). PrintIT would have to confide in the cloud provider to deal with its own problems without affecting the service.
Security	Research has found security vulnerabilities in shared-tenancy environments where many separated virtual machines holding data residing on a single physical machine may be targeted by monitoring cache to steal information i.e. side channel attack (Choo, 2010). This is something to bear in mind as PrintIT store more data. The security split is: Provider, AWS, overseas cloud security and customer, PrintIT, is accountable for security inside it (Mina, et al., 2019).

Table 5 Risks of Cloud Computing – Continued (1)

Risks	Description
Availability	Cloud computing must require an internet connection, and one that is usually not slow, whereas on premise applications may not. It not just that such an occurrence could occur on a wired or Wifi network, ISP failure or natural disasters are also a risk to PrintIT. The failure or indeterminate drop of the service could be the cause of a vulnerability or government cessation of data (Choo, 2010).
Governance	Some academics take the view that cloud computing is dubiously insufficient to fulfil privacy regulations (Ghaffari, et al., 2014). It is in part due to a problem that ‘Legislation always lags behind development’ (Penzel, et al., 2015). Because businesses will need to agree to the providers terms of service, failure to comply with data protection laws specific to certain jurisdictions could be punishable by fine and risky if the provider reserves the right to change policies (Choo, 2010). This is important for PrintIT to know since it stores personal identifiable information under the Data Protection Act 2018, which enacts the GDPR.
Politics	According to scholars, the aim of cloud computing is to be borderless, which is at odds with some the political agendas of states that may wish to develop policies that have the effect of separating global technologies (Zissis & Lekkas, 2012). Consequently, as Ghaffari, et al. claim, obtaining locations to store company information on a set of servers has not always been achievable. While providers discuss this issue, open access, sufficient bandwidth, and enough for the technology is also subject to politics, the authors say (2014). However, for PrintIT using AWS means a location can be guaranteed in ‘regional mode’.
Control	Notwithstanding the ability to operate the cloud comparable to a on premise datacentre, PrintIT must still be prepared to accept some devolution of control. This is so considering what Marston, et al. say that a cloud customer usually does not know the exact geographies of their deployments, often unguaranteed, stored data (2011). The decision on functionality, processes for management, and operability to name a few is lost when companies choose to outsource cloud services (Penzel, et al., 2015)
Interoperability	PrintIT risks having its data locked into the cloud and if it chooses to change providers this may be lost or remain non-transferrable (Kryvinska, et al., 2014). The offshoot is that customers may be forced to develop ‘private’ cloud infrastructures and to create strategic plans for possible future transfers (Penzel, et al., 2015).

2.3 Migration to AWS

On a balance of the benefits and risks of cloud services, 2.1 and 2.2 respectfully, it is recommended that a strategy to migrate IT services to AWS is more advantageous than not for PrintIT.

The migration decision concurs with the findings of Mina, et al. (2019) where pros are held to favour small and midsize Business like PrintIT. In their report, disadvantages were given to the AWS payment system which was considered ‘unclear’ and to a lack of appropriate Service Level Agreements (SLA), whereas the ‘speed of implementation’ and ‘back up disaster recovery’ were considered beneficial.

2.4 AWS migration strategy

A fitting migration strategy plan for PrintIT should be chosen and put into effect. Table 6 explains the differences between the most common AWS migration strategies.

Table 6 Migration Strategies - Adopted from Orban (2016)

The six 'R's	Process
Rehost	Also known as 'lift and shift'. Rather than using only cloud-native services, the current architecture is moved to the cloud. Often used to preserve legacy application so Infrastructure as-a-Service (IaaS) common. May relate to PrintIT's architecture that has likely remained unchanged since the internet.
Replatform	Sometimes referred to as 'lift and shape' so coined because after moving the current architecture it involves making some cloud adjustments without changing the core components. This an attractive option considering PrintIT wants to take advantage of AWS abilities.
Repurchase	Can be named 'drop and shop' Involves transferring or discontinuing a current licensing model for an application that normally moves to a Software-as-a-Service (SaaS) platform as only data is moved. Could be considered on a segment such as the emailing system.
Refactor	This is alternatively called 'Re-architecting' as it requires the current application to be entirely deployed with AWS native services. Usually the most expensive strategy. This is probably not advisable for PrintIT where there are cheaper options and components can be migrated and optimised.
Retire	An approach that dispenses with current redundant components in a service or combines them before AWS migration to save money. There may be some scope for this if the static www.printitnow.org can be hosted on S3 (see Table 5) rather than an IIS web server.
Retain	Some components in the current environment may not be able to migrate and are kept for reasons ranging from retaining depreciation, to the application not being supportable in a cloud. For instance, PrintIT's MS Access database is not provisioned in AWS's marketplace as a database service but may hold enough valuable data to retain it on-premise.

This report finds that PrintIT should predominantly replatform as a migration strategy with the possibility for hybrid migration retention on some components like the exchange server. As an SME, PrintIT should be guided by a stepwise framework for migration along the lines of Khan and Al-Yasiri (2015), which involves: 'requirements' – market study, and a likely choice of IaaS; 'preparation' – including a feasibility study, readiness questionnaire, and close looks at risks; and, 'migration' – assessing costs and contracts, testing deployments, and monitoring.

3. Discussion of the AWS Elements

The process of translating current PrintIT infrastructure into AWS elements requires an assessment of where there is potential to address a problem group as a needed solution with a candidate cloud service. Furthermore, consideration of the service costs and type of computing model will also influence the degree of migration, and, therefore, the sort of infrastructural elements that can be run x as a service in AWS as a public deployment model (Wittig & Wittig, 2019, pp. 4-16).

3.1 Mapping the problem domain to AWS

The problem number and groups of Table 3 can be mapped to equivalent or similar AWS abstractions as potential solutions (Rabetski, 2011).

Table 7 On-Premise Map to AWS

PrintIT Problem (P) Domain		AWS offering	AWS description	AWS Category
P-No. (Table 1)	P-Group (Table 1)			
1-5	Server file system capacity	Amazon Elastic File System (EFS)	Provides a Network Attached Storage (NAS) automatic scalable solution mounted on to EC2 instances with Network File System protocol version 4. Pay for the storage used on regional service offering required throughput needed, also useful for data analytics which PrintIT might want (Baron, et al., 2017). Average costs are \$0.08/GB-month (Amazon Web Services, Inc., 2020). Only supports Linux and not Windows EC2 instances.	Storage
		Amazon Elastic Block Store (EBS)	Simulates storage drive as hard disk partitioned attached to servers. EBS volumes attachments to EC2 instances are unlimited, can be encrypted, and copied with a snapshot. There are a range of EBS storage types to choose with different costs e.g. General-purpose Solid-State Drive 4 GB–16 TB \$0.10/GB-month and Cold Hard Disk Drive 500 GB–16 TB \$0.025/GB-month (Piper & Clinton, 2019). Potentially useful for having a dedicated drive for storing PrintIT's uploaded image files.	
		Auto Scaling	Freely applicable to EC2 instances that can be copied as template images for scaling up on launch on the demand of client use where compute capacity is exceeded and then destroyed or scaled down on demand decline (Piper & Clinton, 2019, p. 8).	Compute
6-7	Simple Mail Transfer Protocol (SMTP)	Amazon Simple Email Service (SES)	Email service for general transactions, marketing messages, and content to deliver to customers. Other functions include received messages, S3 storage, AWS Lambda calls (Baron, et al., 2017). Can be used as SMTP for an emailing client. For apps in AWS, \$0 for the first 62,000 emails sent then \$0.10 every 1000. The latter also applies purely to emails sent from an email client (Amazon Web Services, Inc., 2020) i.e. PrintIT could continue using Outlook on premise with an SES SMTP.	Customer Engagement

Table 7 On-Premise Map to AWS – Continued (1)

PrintIT Problem (P) Domain		AWS offering	AWS description	AWS Category
P-No. (Table 1)	P-Group (Table 1)			
8	Database scalability	Relational Database Service (RDS)	Managed service for building scalable and reliable databases over availability zones (AZ) that can be run with a range of market database engines e.g. Microsoft SQL Server, MySQL, Oracle. Also includes Amazon Aurora – Enhanced performance MySQL / PostgreSQL replacement. Data is stored on a cluster volume rather than an EBS volume so no single point of failure (Wittig & Wittig, 2019). As a price aid, an on-demand express single A-Z db.t3.medium costs \$0.088 per hour (Amazon Web Services, Inc., 2020). NB. PrintIT uses an Access database which is not available as a driver in RDS. Data extract, transform, and load (ETL) may be required as part of the migration.	Database
9	Security	AWS Shield	Protects internet-facing applications from Distributed Denial of Service (DDoS) attacks. Two levels: free AWS Shield Standard - Automatically enabled for layer 3 and 4 DDoS e.g. UDP reflection and SYN flood. And chargeable (minimum \$3,000.00 per month for a year) layer 7 attacks (Piper & Clinton, 2019, p. 268).	Security, Identity & Compliance
		Security Groups	Non-chargeable security groups behave as a ‘stateful firewall’ to control traffic both incoming and outgoing on load balancers, to virtual machines, and database servers (Wittig & Wittig, 2019, p. 38). There are different types of security groups that determine capability E.G. EC2-Classic Security Groups for outgoing instance traffic, and Amazon Virtual Private Cloud (VPC) security groups for controlling outgoing and incoming instant traffic (Baron, et al., 2017). They ‘ingress’ or ‘egress’ an instance’s Elastic Network Interface (ENI) (Piper & Clinton, 2019). PrintIT may need to liaise with its ISP for more information on the past DoS to help configure the firewall.	
		Network Access Control Lists (NACLs)	Unlike Security Groups, NACLs attach to subnets rather than ENI’s and are stateless so connections flowing through are not tracked. Similarly, non-chargeable, they act as a firewall with outbound and inbound rules to control traffic on source and destination ports, protocol, and CIDR (Piper & Clinton, 2019). Combined with security groups, NACLs contribute to the resilience of DDoS architecture in a (VPC) (Amazon Web Services, Inc., 2015).	Security, Identity & Compliance
		Network address translation (NAT)	Measures can be applied to private EC2 instances that may still need to receive updates and patches from the internet through use of a public NAT instance and gateway with its own subnet (Piper & Clinton, 2019, p. 31). Price per NAT gateway per hour and per GB data processed are both \$0.05 in EU London area (Amazon Web Services, Inc., 2020).	

Table 7 On-Premise Map to AWS – Continued (2)

PrintIT Problem (P) Domain		AWS offering	AWS description	AWS Category
P-No. (Table 1)	P-Group (Table 1)			
10	Backup storage	Simple Storage Service (S3)	Comparable to an ‘unlimited FTP server’ (Expedited Security, 2020). Performs object (file) storage with buckets (folders). Inexpensive and reliable can be used for backups. Objects can be addressed by a unique URL Standard cost storage pricing is \$0.023 per GB (Piper & Clinton, 2019, pp. 48-62). A use could be for PrintIT regular backups of image files or for buckets to host static printitnow.org in HTML.	Storage
		Glacier	Magnetic tape replacement slow retrieval long term data storage archive. Configurable to ingest data from S3 with lifecycle management. Storage pricing is \$0.004 per GB (Piper & Clinton, 2019, pp. 7-11).	
11	High traffic	Elastic Load Balancing (ELB)	Can direct requests to the PrintIT web application hosted on multiple EC2 instances in different AZs. Automatically scales to distribute the traffic load according to demand (Sequeira, 2019).	Networking and content delivery
12-13	Access control	Identity and Access Management (IAM)	IAM controls AWS infrastructural resources via Command Line Interface, AWS Management Console, or AWS Software Development Kit. A ‘root’ user is created at the inception of an account as a single sign-in principal with the ability to create further IAM users controlled by policy permissions and roles (Baron, et al., 2017). There is no charge for the IAM feature.	Security, Identity & Compliance
		Key pairs	Akin to remoting to an on-premise server – non-chargeable connection login sessions to EC2 instances are secured by way of encryption. That is achieved by generating a public key, saved in the EC2 instance, and a private key, stored locally, together called a ‘key pair’ (*.pem). Access differs, e.g. windows Amazon Machine Image (AMI) uses Remote Desktop Protocol, and Linux AMI requires Secure Shell (SSH) protocol (Piper & Clinton, 2019).	
14-15	Data analysis	Amazon QuickSite	An analytics service for Business Intelligence to gain insight through visualisations and data analysis. Scalable to many users, data sources are found automatically, and performance responsive (Amazon Web Services, Inc., 2020). Standard edition priced at \$9 per user per month and fully managed so no install or maintenance (Nadipalli, 2017, p. 230).	Analytics
16	Printer limitation	Not applicable	There are no printing services offered by AWS. PrintIT will have to work with the current pixel limitations that the garment printer can manage and consider applying constraints on uploads exceeding 1920 X 1080 pixels.	Not applicable
11	High traffic	EC2	In the case of PrintIT, EC2 instances could account for web servers or file servers as Windows AMI’s. They come in different size types, prices, and tenancy models. Some, like T2 general purpose types, are burstable (Piper & Clinton, 2019). May not be required if autoscaling and ELB is in place. As a price guide if we choose m4.large, two CPU ‘s, and 8GB is \$0.1 per hour. (Wittig & Wittig, 2019).	Compute
*	*	VPC	It is free to make and use the VPC itself and can be configured to provide an isolated network foundation for EC2 instances. In doing so, classless inter-domain routing (CIDR) Internet Protocol (IP) addresses can be created by PrintIT and assigned to instances and subnets, inter alia. (Piper & Clinton, 2019, pp. 88-89).	Networking and content delivery

4. Topology Deployment Using the AWS Environment

To provision a new bespoke VPC for PrintIT, a member of its staff should set up IAM with a root account for business (Wittig & Wittig, 2019, pp. 23-25). A new user ‘principal’ should be created and added to a new group associated with the Administrator Access policy document à la:

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    }
  ]
}
```

4.2 Development

The following demonstration will develop an AWS VPC in a limited services Vocareum lab.

4.2.1 VPC

A VPC is a service listed in the AWS Management Console which when selected can be initiated with a setup assistant interface via ‘Launch VPC Wizard’. It will exist alongside the default VPC - Appendix A.2. The VPC is configured with ‘Public and Private Subnets’ at Step 1 which creates a /16 network with two /24 subnets. The private subnet cannot reach the internet through a NAT and the public subnets access it using elastic IP’s – Figure 5.

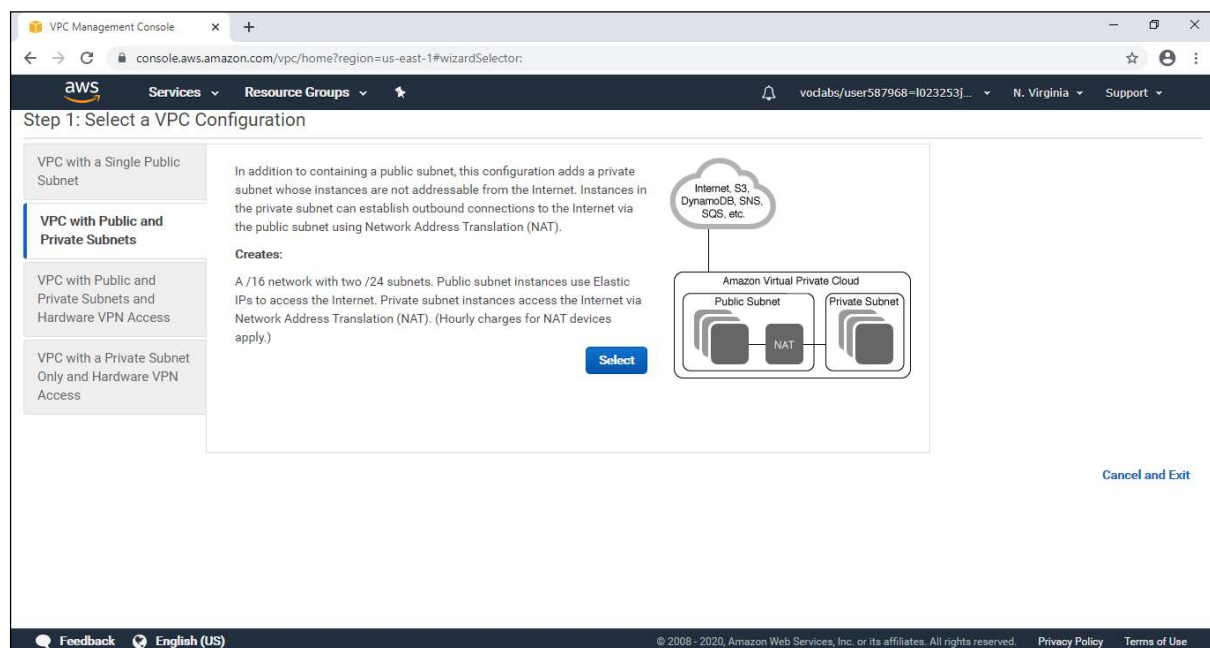


Figure 5 VPC with Public and Private Subnets

4.2.2 Subnets

Subnets for this demo use AZ us-east-1a and 1b US East (N. Virginia). In production, PrintIT should likely use local region eu-west2, EU (London) to reduce latency (Wadia, 2016, p. 5) – Figure 6.

The screenshot shows the AWS VPC Management Console interface for creating a VPC with public and private subnets. The page is titled "Step 2: VPC with Public and Private Subnets". The configuration includes:

- IPv4 CIDR block:** 10.0.0.0/16 (65531 IP addresses available)
- IPv6 CIDR block:** No IPv6 CIDR Block (selected)
- VPC name:** Print IT VPC
- Public subnet's IPv4 CIDR:** 10.0.0.0/24 (251 IP addresses available)
- Availability Zone:** us-east-1a
- Public subnet name:** Public Subnet 1
- Private subnet's IPv4 CIDR:** 10.0.1.0/24 (251 IP addresses available)
- Availability Zone:** us-east-1a
- Private subnet name:** Private Subnet 1
- Elastic IP Allocation ID:** eipalloc-06322e278a3e21acb
- Service endpoints:** A tooltip shows the Allocation ID (eipalloc-06322e278a3e21acb) and Elastic IP Address (3.216.64.204).

Figure 6 Public and Private Subnet Creation

VPC User Guide (2020) recommends a maximum CIDR block /16 from private IPv4 meaning 10.0.0.0 - 10.255.255.255 (10/8 prefix) is used: RFC 1918 (Rekhter, et al.). The NAT gateway is given a public elastic IP with an ID. Additional public and private subnets are created in AZ 'b', - Figures 9 and 10.

The screenshot shows the AWS VPC Management Console interface for creating a subnet. The page is titled "Create subnet". The configuration includes:

- Name tag:** Public Subnet 2
- VPC*:** vpc-079d98ebac38bcb81
- Availability Zone:** us-east-1b
- VPC CIDRs:** A table showing the CIDR block 10.0.0.0/16 with status "associated".
- IPv4 CIDR block*:** 10.0.2.0/24

Figure 7 Additional Subnets

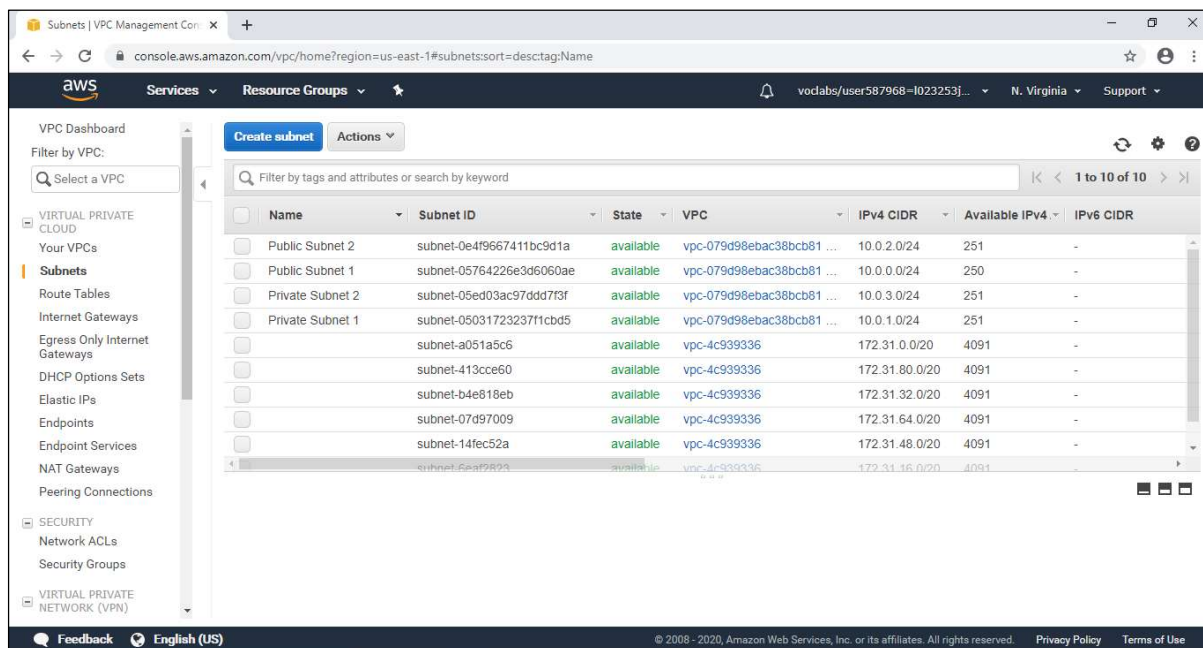


Figure 8 Created Subnets

Two pairs of private and public subnets provide high availability across multiple AZs promoted by the Reliability Pillar of the AWS Well-Architected Framework (Piper & Clinton, 2019, p. 191). As the VPC Wizard creates only one NAT gateway for Public Subnet 1, a second is created as per Figure 9.

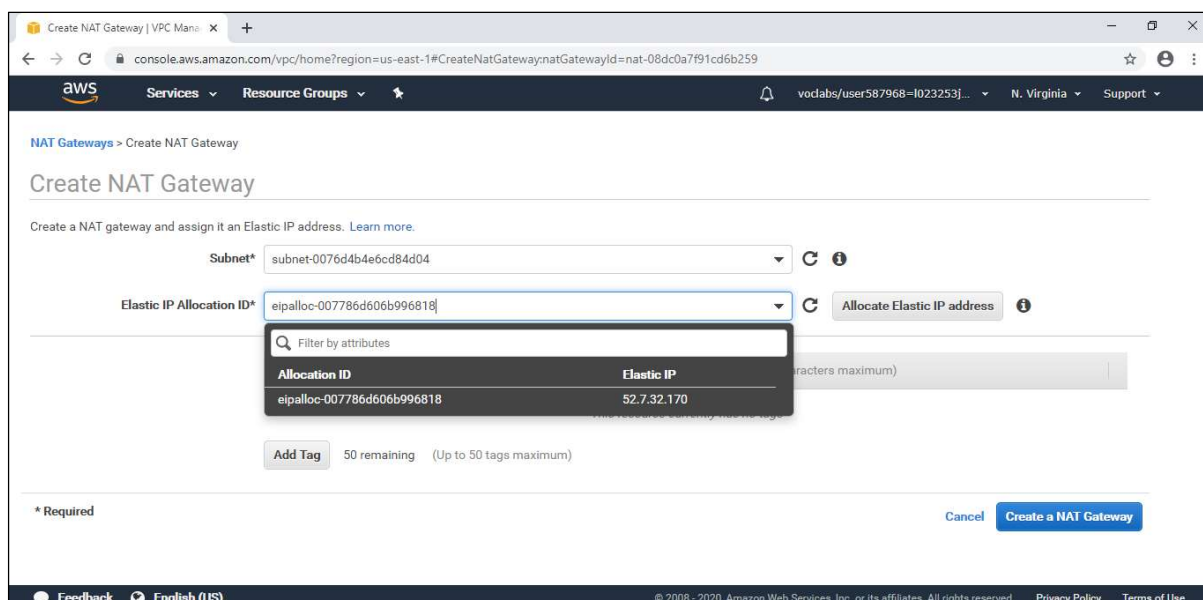


Figure 9 Second NAT Gateway

4.2.3 Routing

The NAT gateways send packets to the internet which requires the private and public subnets to be configured to route internet bound traffic to them using an associated route table - Figure 10.

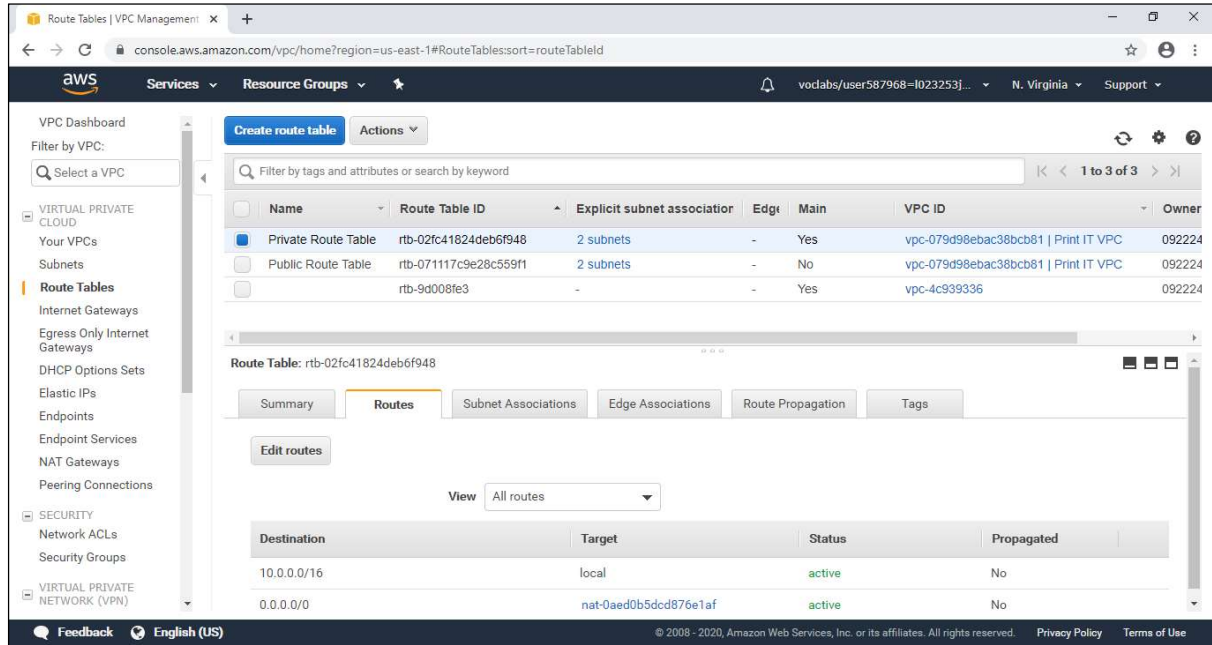


Figure 10 Configured Route Tables

The result of the cloud topology and routes thus far are shown in Figure 11 and Table 8 respectively.

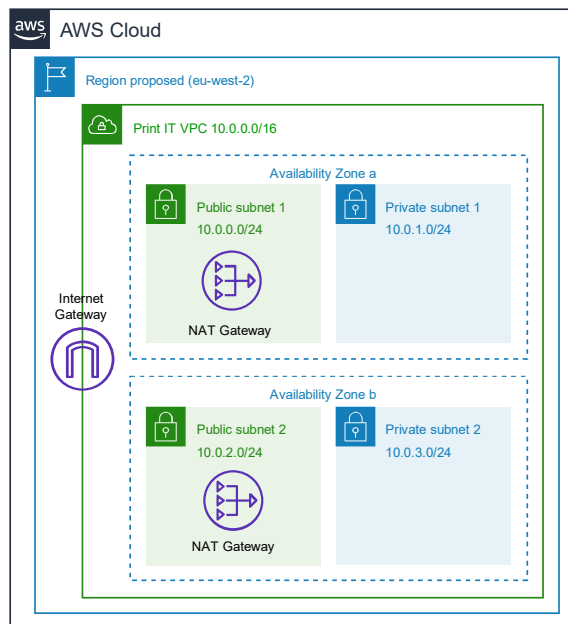


Table 8 Routes for Private and Public Subnets

Subnets	Destination	Target
Public	10.0.0.0/16	Local
Public	0.0.0.0/0	Internet Gateway
Private	10.0.0.0/16	Local
Private	0.0.0.0/0	NAT Gateway

Figure 11 VPC with Public and Private Subnets in Two AZ's

4.2.4 Security groups

A ‘security group’ can be created to behave as a stateful firewall on the EC2 instances as web servers to regulate port access, IP authorised ranges, inbound, and outbound network traffic seen in Figure 12.

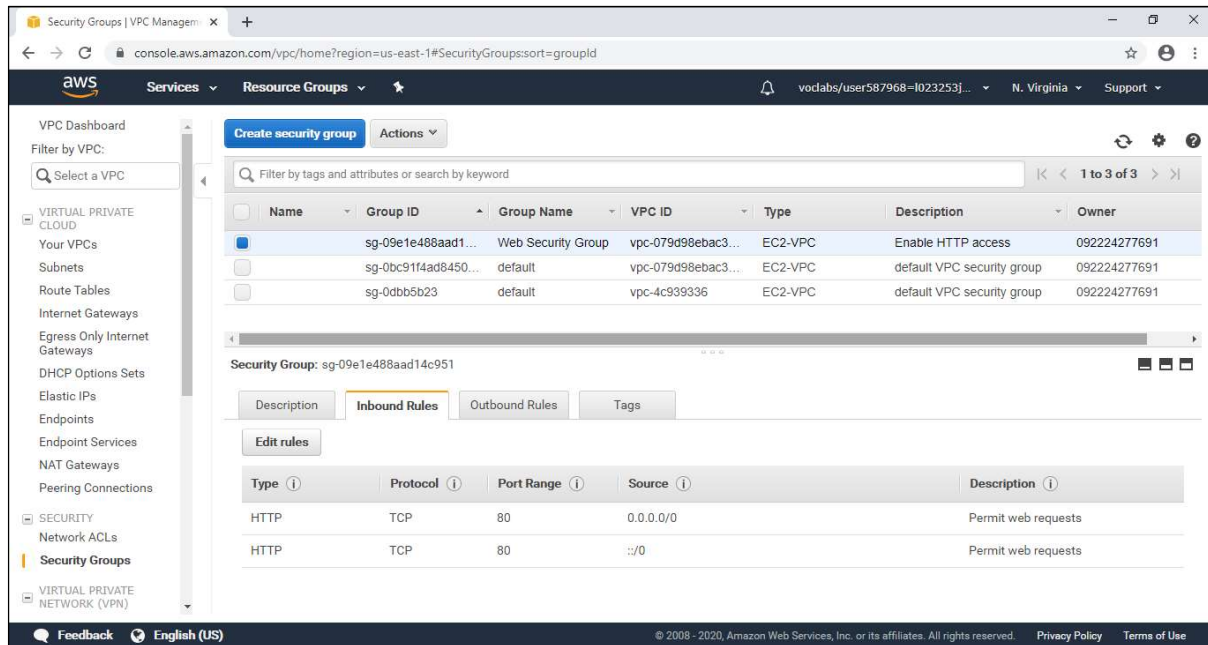


Figure 12 Security Group Creation

4.2.5 EC2 instances

‘Dedicated’ Windows Server OS is used to launch and eventually host IIS as a web server – Figure 13.

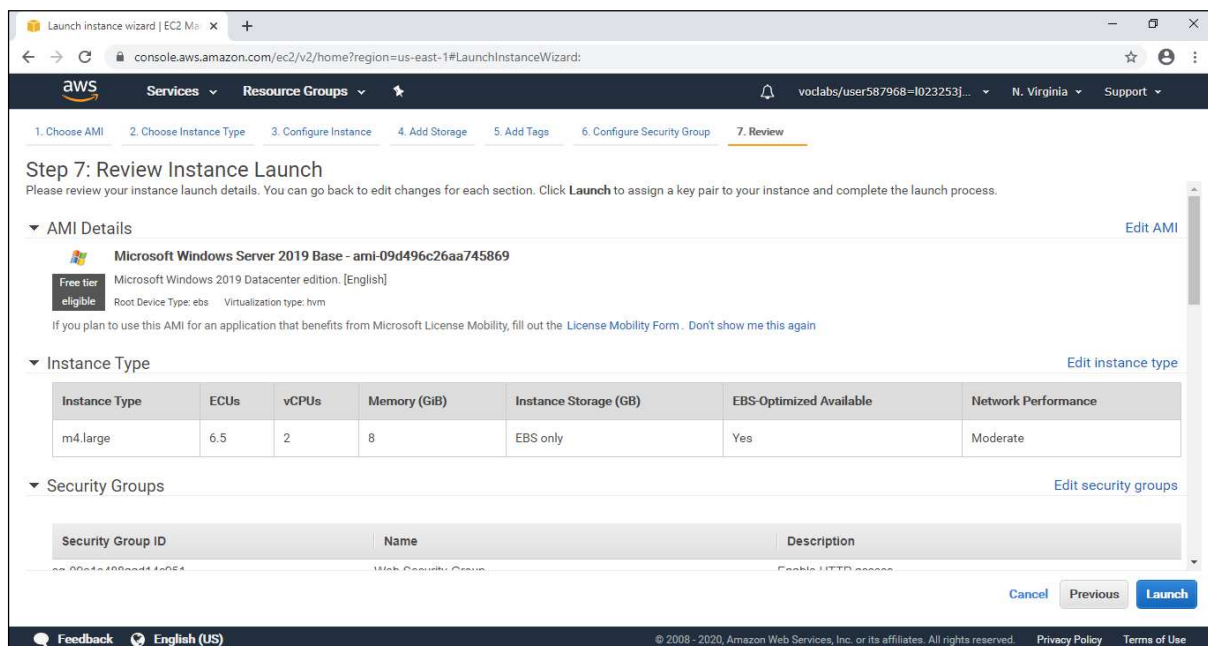


Figure 13 Temporary Instance launch

An AMI is created and stored in the Print IT VPC and the instance is deleted from the public subnet as production will use AMIs in private subnets - Figure 14.

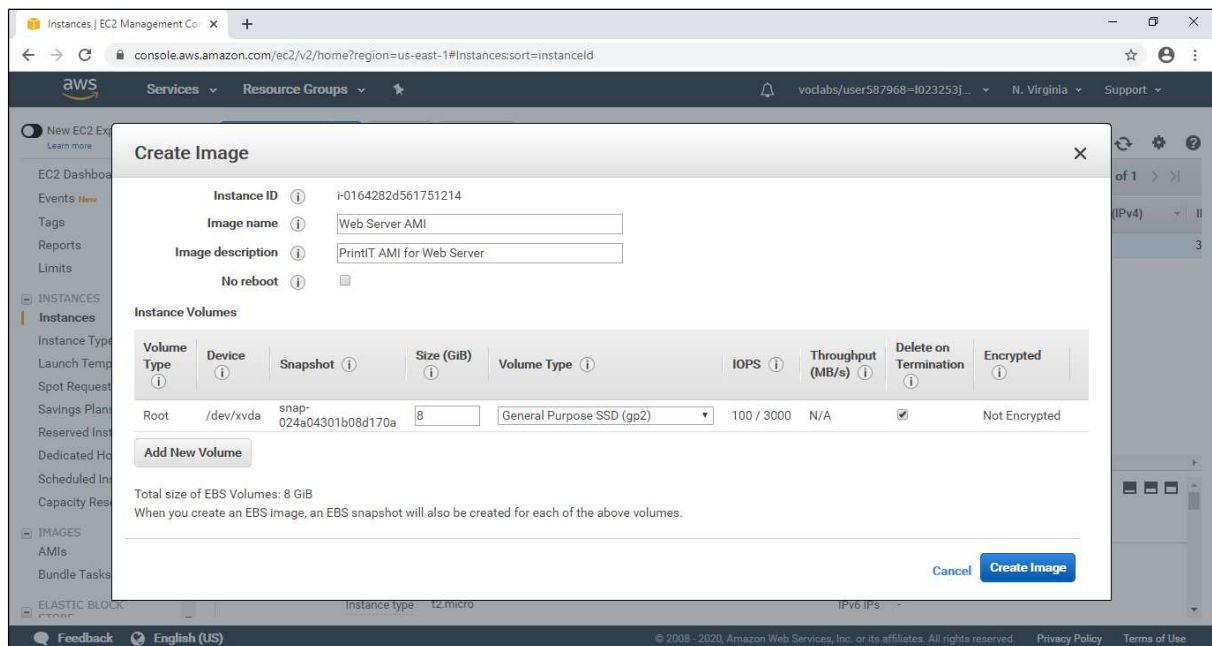


Figure 14 Image Creation

4.2.6 RDS DB instances

For the database, a security group is created to allow packets from the Web Security Group - Figure 15.

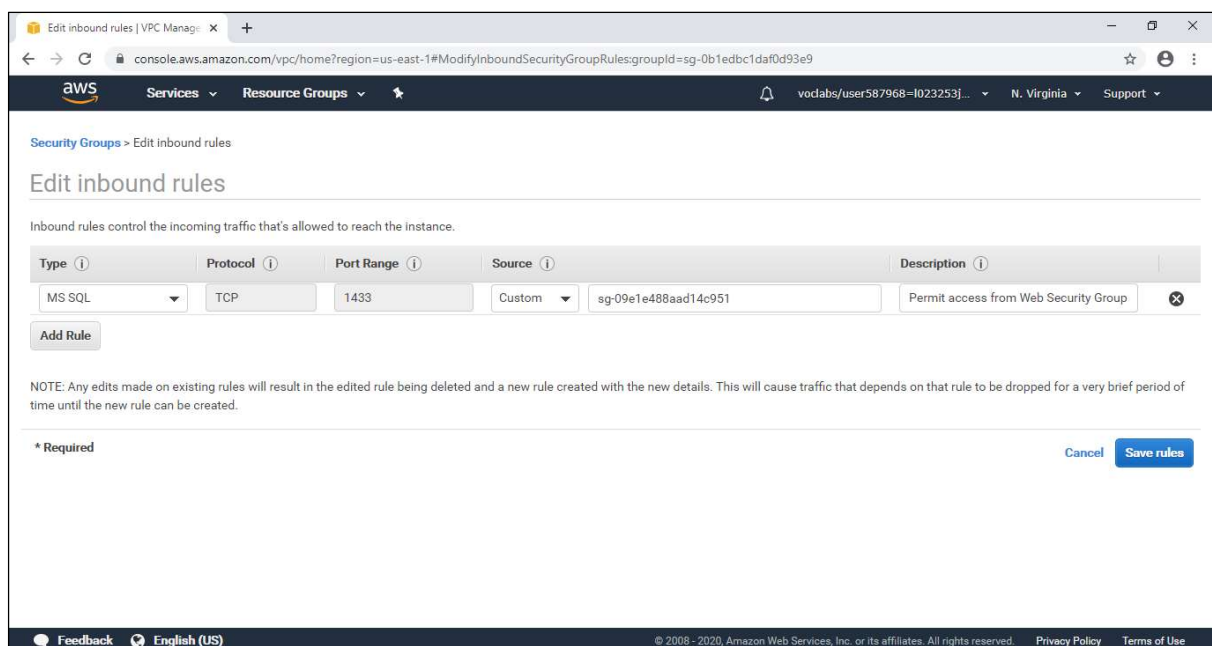


Figure 15 Configuring DB Security Group

A database subnet group is configured to instruct the forthcoming RDS what subnets to utilise in Figure 16.

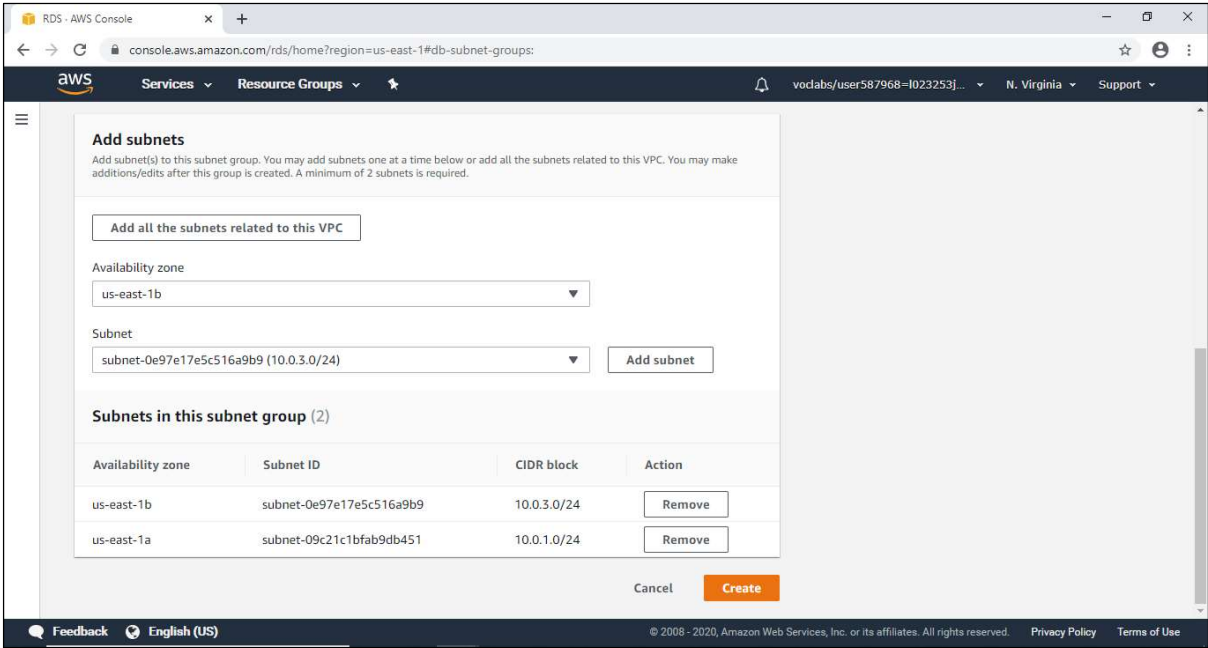


Figure 16 Configuring DB Security Group

A MS SQL database is chosen to which data from PrintIT’s Access database can undergo ETL after its instantiation – Figure 17. The database is configured with an identifier, username, and password.

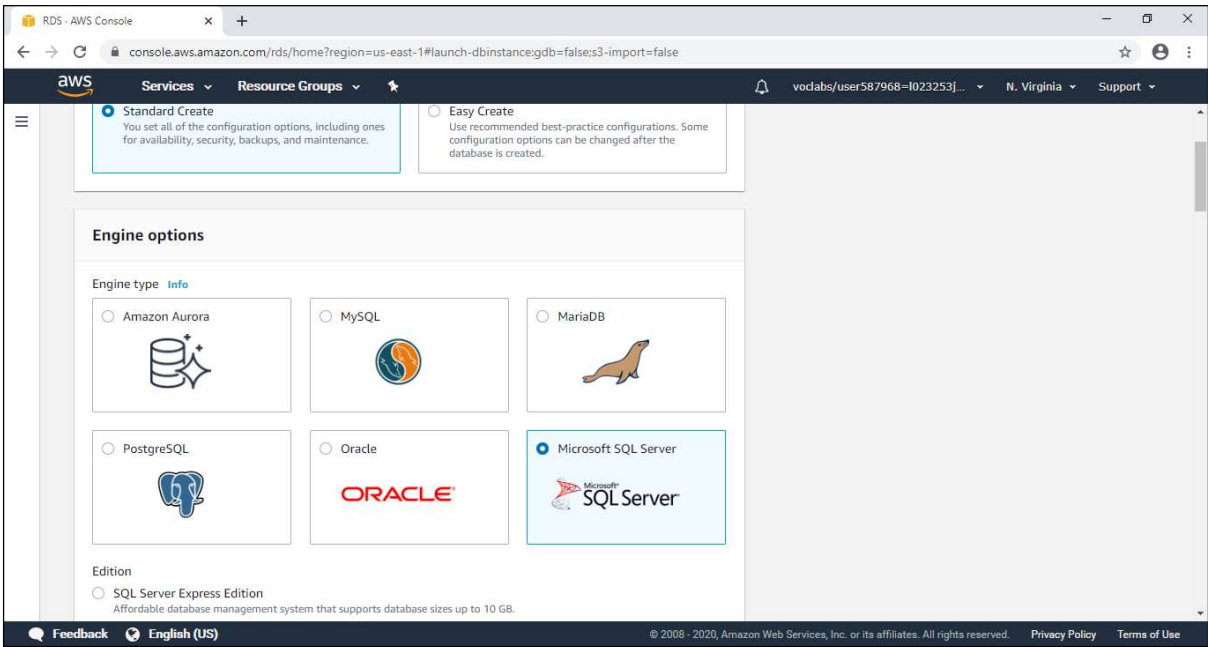


Figure 17 Create Database

The option for logging performance information for CloudWatch is selected too – Figure 18.

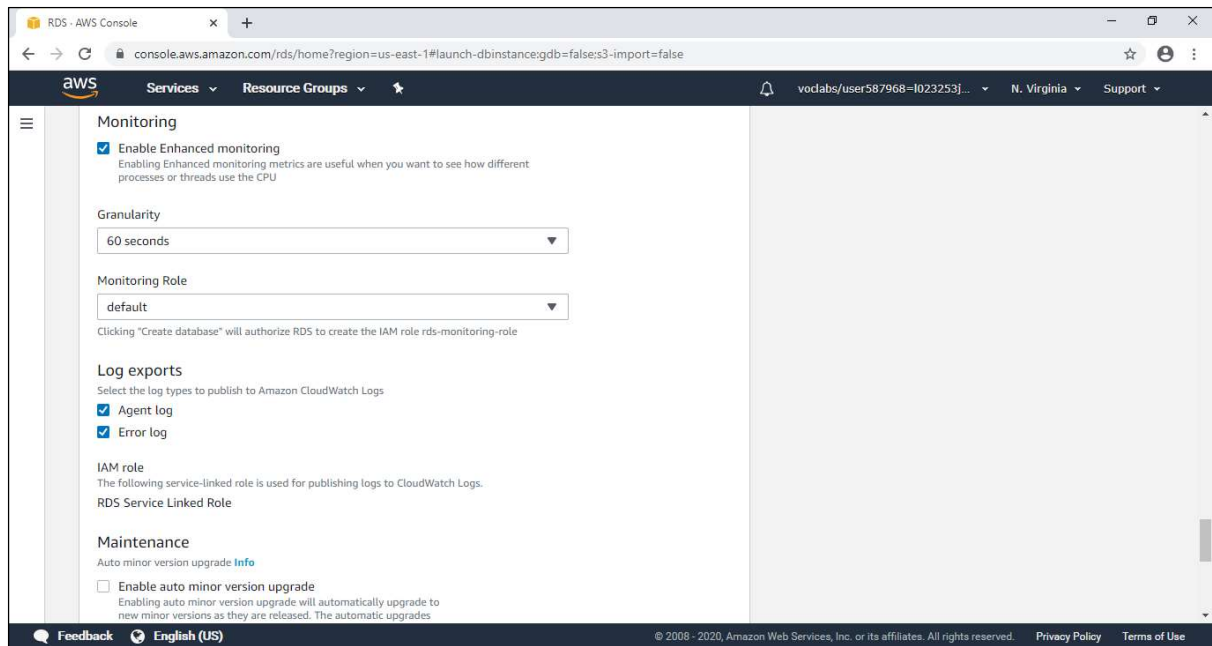


Figure 18 Monitoring

The RDS instance is also replicated for Multi-AZ deployment to be highly available under production loads – Figure 19.

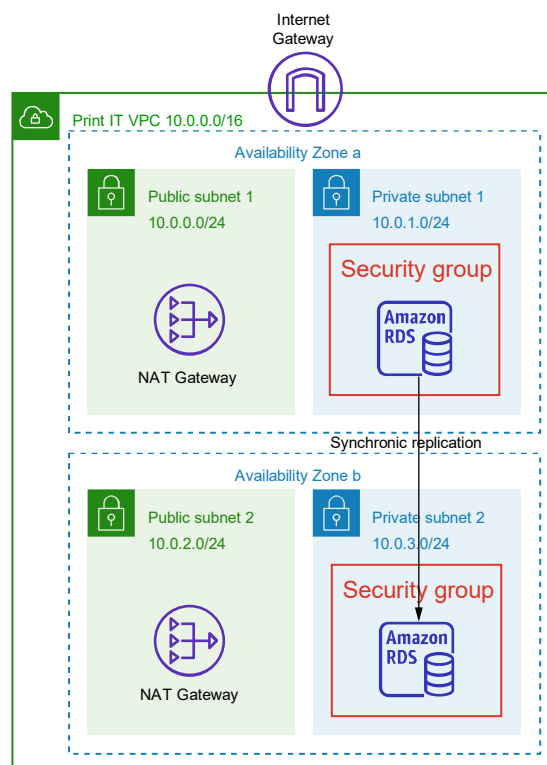


Figure 19 Deployed RDS

4.2.7 Load balancing and scaling

A load balancer is created to spread traffic across AZs and the EC2 instances that will be launched into private subnets with the database servers, routing requests to targets using HTTP port 80 – Figure 20

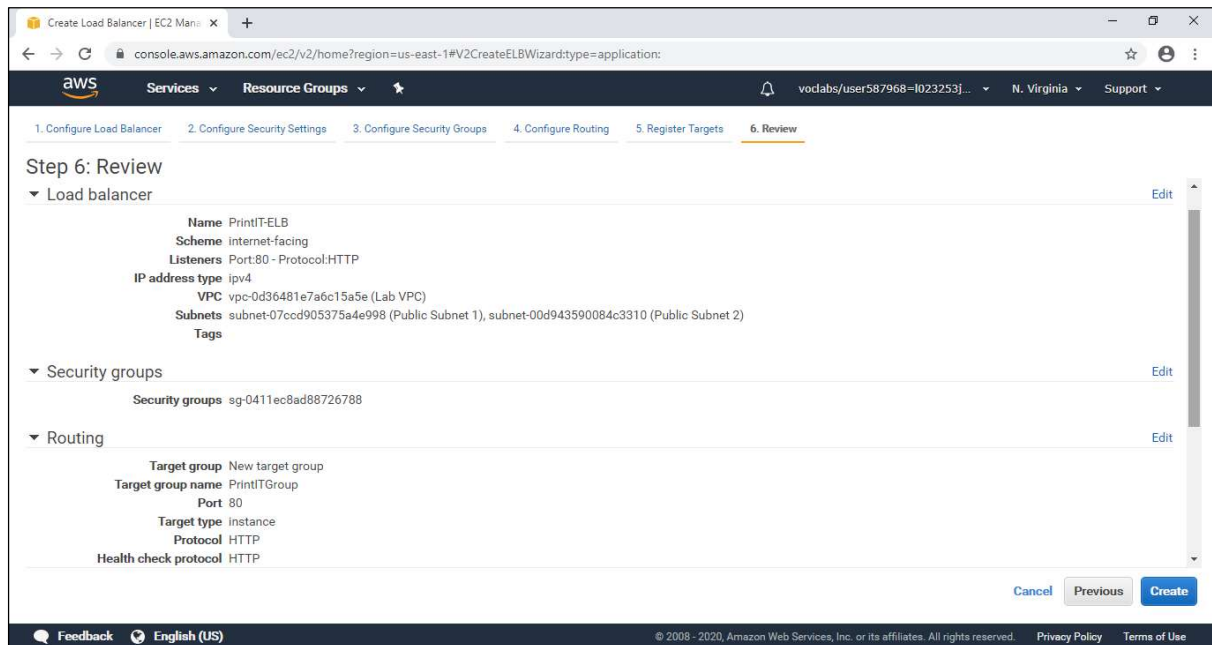


Figure 20 Review of the Load Balancer

Next, Auto Scaling comprises a Launch Configuration, Auto Scaling group, and non-compulsory scaling policy (Baron, et al., 2017). AMI Web Server 1 can be used to launch the configuration - Figure 21.

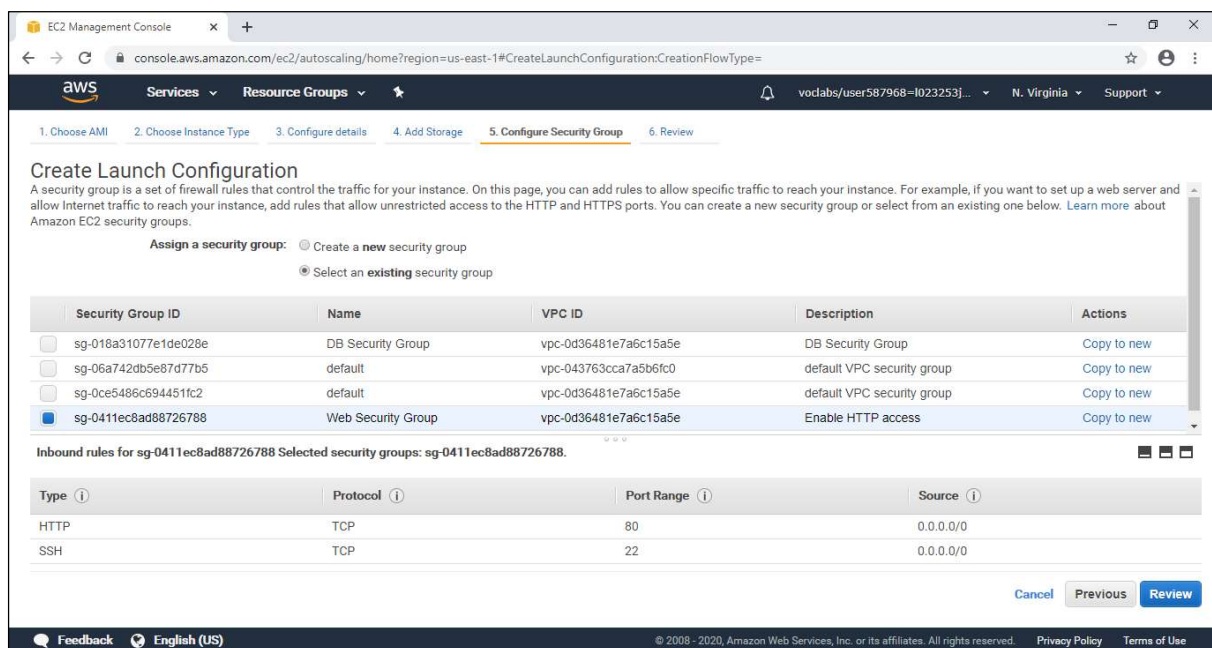


Figure 21 Launch Configuration

The autoscaling group is set to start with two instances in Private Subnet 1 (10.0.1.0/24) and Private Subnet 2 (10.0.3.0/24) – Figure 22

EC2 Management Console

console.aws.amazon.com/ec2/autoscaling/home?region=us-east-1#CreateAutoScalingGroup:source=lc:launchConfigurationName=PrintITConfig

aws Services Resource Groups

1. Configure Auto Scaling group details 2. Configure scaling policies 3. Configure Notifications 4. Configure Tags 5. Review

Create Auto Scaling Group

Group name

Launch Configuration

Group size Start with 2 instances

Network [Create new VPC](#)

Subnet [Create new subnet](#)

No public IP addresses will be assigned

None of the instances in this Auto Scaling group will be assigned a public IP address because you have not chosen to launch in your default VPC and subnet.

You can ensure a public IP address is assigned to instances launched with this configuration by selecting only default subnets of your default VPC.

[Cancel](#) [Next: Configure scaling policies](#)

Feedback English (US)

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Figure 22 Auto Scaling Group

As regards scaling policies, for the EC2's, Print IT may be given a scale between two and six instances with average CPU use at 60 in Figure 23.

EC2 Management Console

console.aws.amazon.com/ec2/autoscaling/home?region=us-east-1#CreateAutoScalingGroup:source=lc:launchConfigurationName=PrintITConfig

aws Services Resource Groups

1. Configure Auto Scaling group details 2. Configure scaling policies 3. Configure Notifications 4. Configure Tags 5. Review

Create Auto Scaling Group

You can optionally add scaling policies if you want to adjust the size (number of instances) of your group automatically. A scaling policy is a set of instructions for making such adjustments in response to an Amazon CloudWatch alarm that you assign to it. In each policy, you can choose to add or remove a specific number of instances or a percentage of the existing group size, or you can set the group to an exact size. When the alarm triggers, it will execute the policy and adjust the size of your group accordingly. [Learn more about scaling policies.](#)

☐ Keep this group at its initial size

☒ Use scaling policies to adjust the capacity of this group

Scale between and instances. These will be the minimum and maximum size of your group.

Scale Group Size

Name:

Metric type:

Target value:

Instances need: seconds to warm up after scaling

Disable scale-in: ☐

[Cancel](#) [Previous](#) [Review](#) [Next: Configure Notifications](#)

Feedback English (US)

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Figure 23 Scaling Policy

4.2.8 Proposed topology

Further components may be added to the VPC topology namely: stateless NACLs's to allow PrintIT staff access to the VPC via a Site-to-Site Virtual Private Network with gateways at either end. The NACLs will function like additional firewalls on the edge of the private subnets and will restrict access only to the onsite network. Linux EC2 could use EFS with mounts in the subnets where Windows instances cannot, but it does not have an IIS role for the website. It follows that an opportunity exists instead to attach EBS root volumes to the Windows ECS instances to store the image files and to take routine snapshots of them as backups. They will be replicated automatically within its AZ for durability ideally as General Purpose SSD and can be provisioned with the following CloudFormation in a comparable manner as in the code below from Wittig & Wittig (2019, p. 290):

```
Resources:
  [...]
  EBSBackupVolumeA:
    Type: 'AWS::EC2::Volume'
    Properties:
      AvailabilityZone: !Select [0, !GetAZs '']
      Size: 5
      VolumeType: gp2
  EBSBackupVolumeAttachmentA:
    Type: 'AWS::EC2::VolumeAttachment'
    Properties:
      Device: '/dev/xvdf'
      InstanceId: !Ref EC2InstanceA
      VolumeId: !Ref EBSBackupVolumeA
```

Particularly, the use AWS Lambda could schedule backups of the image files from the EBS volumes to be sent to an S3 bucket. Route 53 DNS service is optional, but could be employed by 'transfer registration' to get health checks on www.printitnow.org. Amazon QuickSite would support BI insight on the database server. Lastly, Amazon SES may be used to draw email data from the database and integrating it with the exchange server on-premise for mail merge marketing. The overall proposed VPC topology appears in Figure 24.

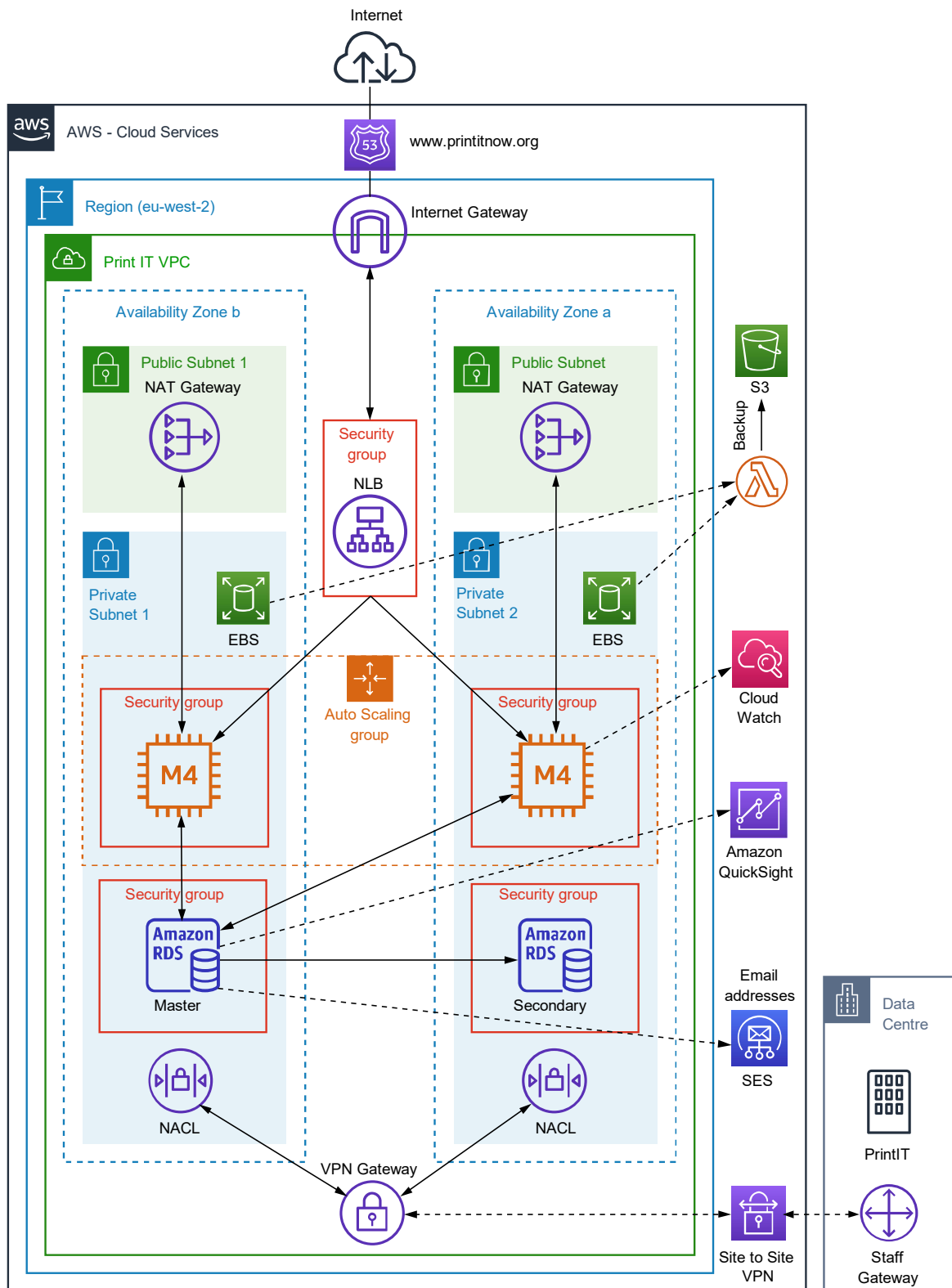


Figure 24 Proposed Topology

5. Amazon SageMaker Survey

5.1 Machine Learning

Released in 2017, ASM is a machine learning (ML) service that is fully-managed in AWS i.e. MLaaS allowing for trained models to be integrated with cloud applications at any scale (Amazon Web Services, Inc., 2020). ASM draws on machine learning as a subset of artificial intelligence (AI) to enable customers to build algorithms that can be trained to improve on the dependence of data occurrences to make a prediction or decision. This may help solve business problems for PrintIT by collecting a set of data and developing a statistical ‘model’ based on it to offer a solution via different types of leaning such as supervised ‘labelled’ and unsupervised ‘unlabelled’ examples (Burkov, 2019). Appropriate use cases and benefits for PrintIT are listed in Table 9.

Table 9 Beneficial Use Cases for PrintIT ML

Use case	Benefit	ASM Algorithm
Image Recognition	To reject uploaded images that may breach PrintIT terms of use policies on appropriate content and intellectual property (Simon, 2018)	Image classification, Apache MXNet RecordIO
Inventory optimisation	PrintIT may want to regulate the quantity of stock to reserve in the most efficient way to keep enough to sell and distribute (Squadex , 2018)	DeepAR
Demand forecasting	To determine future sell-through rate insight and profits from its supply chain which can enable PrintIT to adapt to seasonal change, attract investment (Kenstler, 2019).	XGBoost, Deep Neural Network
Automated Visual Inspection	The quality of print onto garment t-shirts may require check augmentation which can be aided by automated grading and product control (Kenstler, 2019).	Convolutional Neural Network (CNN)
IP address detection	In the event that PrintIT decide to create accounts for users, those logging in with unusual IP addresses can be detected and flagged for investigation documented in Amazon SageMaker: Developer Guide (2020).	IP Insights Algorithm (unsupervised)
Fraud Detection	There is potential for PrintIT to adopt fraud detection in their online payment system before a user pays and processes an order with PayPal (Adeshina, et al., 2019)	Random Cut Forest, XGBoost,

5.2 AWS ML Stack

Akin to the abstractions of cloud service offerings (Ruparelia , 2016, p. 29), the ASM is part of a four level AWS ML stack shown in Figure 25. At the top layer there are AI application services, which are

driven by APIs. Second below, a platform accommodates ASM as a service that draws on common provisioned optimised algorithms to develop learning models. The third layer beneath the platform relates to frameworks and interfaces. Then, lowermost, infrastructure services govern compute and storage on servers (Simon & Faerman, 2017).

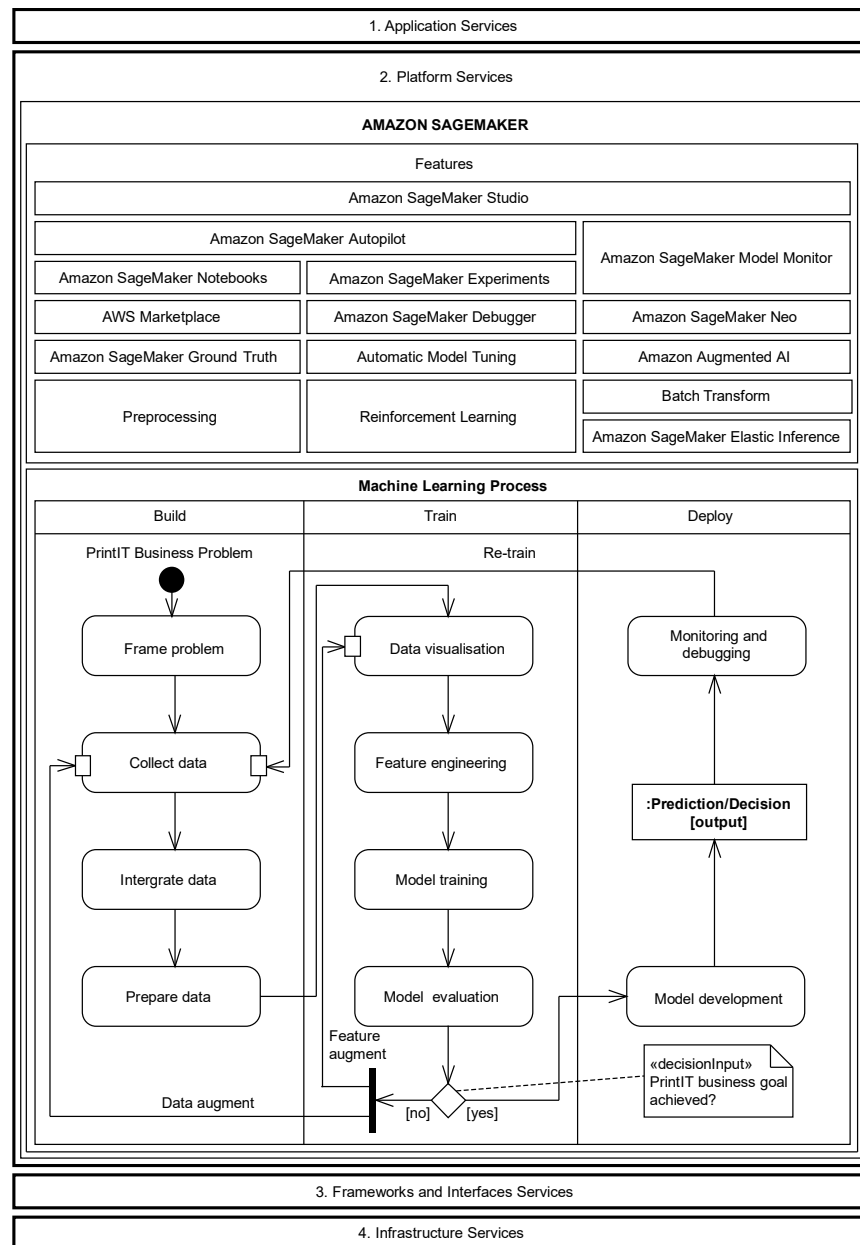


Figure 25 ML Stack Features Aligned With Process – adapted from Pang & Jorissen (2017) and Simon & Faerman (2017)

According to AWS developer documentation (2020), the aim of ASM as a platform service is to provide a business solution from a machine learning process that launches a trained model into a cloud production environment supporting a smart application. It also states that the cost for the service is billable by the second for hosting and training, excluding minimum fees and commitments upfront

PrintIT should be able to access the platform via the ASM console with an IAM administrator user. The console, at current, contains fifteen features (Figure 25), one-third of which can also be managed in a web oriented integrated development environment (IDE) called ‘Amazon SageMaker Studio’ shown in Table 10.

Table 10 Amazon SageMaker Studio Features - adapted from (Amazon Web Services, Inc., 2020, p. 42)

Features	Function
Notebooks	Where Jupyter Notebook can be created to program SageMaker with integrated Single Sign-On.
Experiments	Tracking data to resume, compare, and assesses experiments.
Autopilot	To automatically train and change models to search for best use of algorithms.
Debugger	Check parameter values and tensor data, and has detection alerts.
Model Monitor	Endpoint (production models) quality monitoring

The studio is an extension of the JupyterLab interface (Project Jupyter, 2018) and, at the time of writing, it is only available in US East (Ohio) us-east-2 region. However, it has been met with some criticism for being undeveloped (Li, 2019). Alternatively, the ASM environment can be managed via the console with an AWS Cloud9 IDE (Alteen, et al., 2019) and Jupyter Notebook.

5.3 Operations

PrintIT will need a problem to solve with ML to justify the need for operating the ASM service under a specific business domain. For instance, Makkar, et al. (2019) claim that supply chain management is a popular domain for many ML solutions. A common supply solution for PrintIT could use ML predictive analytics to forecast sales (Bodenstab , 2018). It could achieve this by developing a model outside AWS and running it on ASM, with a bespoke algorithm using ASM, or with one from the platform. It would use *.csv file datasets stored in S3 to leverage stocks like ink and t-shirts particularly during peak demand. This data may provide the basis on which to build the training model i.e. supervised learning, which is explored in the next three subsections. Features of ASM are aligned with a continuous ML operations cycle. As per Figure 25, in basic terms, this is ‘Build, Train, and Deploy’ (Pang & Jorissen, 2017).

5.3.1 Build

A prerequisite of the build process involves setting up the ASM environment. A rudimentary example would be using IAM on Amazon S3 to work with ASM. To explain further, because ASM uses S3 as a low-cost storage location, a globally unique bucket can be created to act as a data lake for training data (AWS Quick Start Team, 2018). The bucket would be populated with datasets uploaded by a Notebook instance that has access to it via an IAM role. Notebook instances are hosted on EC2, the default type of which is `ml.t2.medium`. When creating a notebook instance, a new IAM role can be enabled with any S3 bucket or a specific bucket that has been created, which the console names ‘AmazonSageMaker-ExecutionRole-*’. Once the notebook is ‘InService’, a Jupyter Notebook can be opened with a programming language like ‘conda_python3’ to work with throughout the ML process. Python libraries can be imported and PrintIT’s data can be downloaded from S3 to be cleaned in the right format for training, as AWS tutorials (2020) guide.

5.3.2 Train

PrintIT sales data could be ‘shuffled’ and divided into test and training data gradient-optimised groups using code before applying training programs to prevent failures in learning. To forecast PrintIT sales data, ASM’s pre-built training XGBoost algorithm version 0.90 can be used. In addition, PrintIT sales training data from an S3 bucket may need to be reformatted with code to work with XGBoost. Using this algorithm will require an ASM ‘session’, with an instantiated XGBoost model that has defined values in a block of written code called ‘hyperparameters’ of which there are many documented (XGBoost Developers, 2020). This is required for model tuning to avoid overfitting the dataset with ‘noise’, such that the efficacy of the predictions might underperform (Burkov, 2019). For example `xgb_model_printit.set_hyperparameters(max_depth =)` #add value stops overfitting with step size shrinkage. As Developer Guidance (2020) explains, training channels can be defined before finally calling a fitting method `.fit()` to output training logs. At this stage PrintIT may evaluate the trained model with Python libraries or Boto SDK to check whether inferences are accurate enough to have met its business goal.

5.3.3 Deploy

A trained model can be either deployed to production for obtaining a PrintIT sales prediction in two ways. Either ad-hoc for a whole dataset with a ‘Batch Transform’, by creating a

`sagemaker.transformer.Transformer` object, or from a continuous HTTPS endpoint with Hosting Services using either SDK: Amazon SageMaker Python or Python (Boto 3). In the case of the former, as an exemplar, the trained model could be hosted on a t2.medium EC2 instance to hold *.csv files that could large over time by calling a deploy function to create an API endpoint as shown in the following Amazon SageMaker Developer Guide code (2020, p. 54):

```
xgb_predictor = xgb_model.deploy(initial_instance_count=1,
                                content_type='text/csv',
                                instance_type='ml.t2.medium'
                                )
```

A generic deployment framework for this is represented in Figure 26. The diagram shows how ML is a continuous cycle which would commence with training data stored in S3 and loop with statistical ‘ground truth’ to evaluate the metric performance of the model inferences in contrast with actual values. In between, the deployment framework interacts with Docker containers derived from static instantiated images stored automatically in an Elastic Container Registry. The registry provides a container to run training code on a server drawing S3 bucket data and outputs results (model artefacts) in a job to another bucket. Another container executes inference code on a deployment server based on the artefacts to get predictions requested by a PrintIT client via the endpoint. Each server could have container helper configuration code specifying hyperparameters and S3 bucket locations.

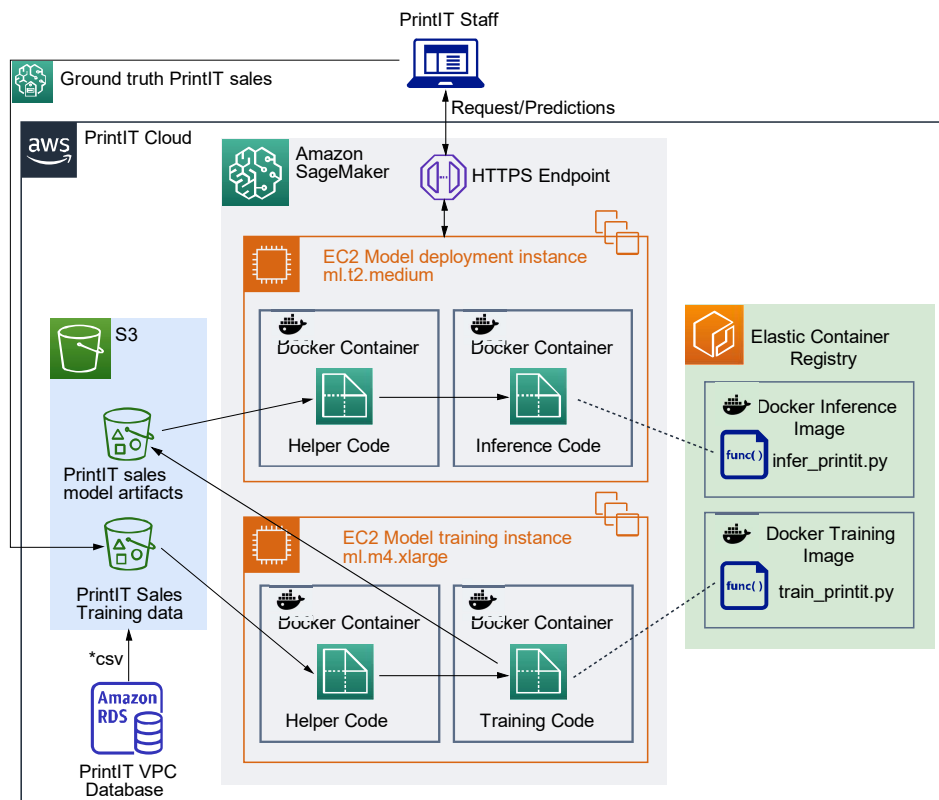


Figure 26 Hosting Service - adapted from Amazon SageMaker: Developer Guide (2020, p. 9)

5.4 Business Cases

Four years up till now, uptake of ASM has been growing around the world as companies turn to ML to power their business solutions in the cloud. According to Apps Run The World (2020), most of those enterprises are in the United States, occupying just over 70% of the ASM market, followed by the United Kingdom at around 8%. Organisations use ASM in many ways, from utilising the frameworks of the ML stack for deployment, like Advanced Microgrid Solutions applying the Keras framework, to combining it with AWS such as Amazon Textract seen by Intuit (Table 11).

Table 11 Business Cases

Company	ASM benefits
Axial 3D	Removing bottlenecks in print process by enhancing and automating segmentation of two-dimensional image for three-dimensional object conversion using ML algorithms. Autoscaling means more images can be processed and uploaded to S3 (Moinpour, 2020).
Intuit	Implemented in 2017, ASM has been used to deploy in faster time several ML models in series and combined them with AWS offerings such as Amazon Textract which personalises client's financial management. A tax refund model, 'TurboTax', was also built with ASM to maximise customer tax refunds with a trained algorithm using data from the US tax code (Wired, 2019).
Advanced Microgrid Solutions	Use of Amazon TensorFlow and Keras framework on ASM for deep learning neural networks - on the third level stack of Figure 26. Hyperparameter tuning is relied on to automatically to obtain best model versions in short periods for predicting national electricity spot market demand (Simon, et al., 2018).
ProQuest	Video user experience optimisation to avoid 'bounce' by implementing a content recommendation system similar to Netflix from a large video corpus. A factorisation model was trained as a regressor, deployed, and tested until a desired inference was sought on how likely customers view a title (Lawlor, 2019).
Thomson Reuters	An undertaking of many deep learning configuration iterations to deploy a natural learning processing function in ASM for a question and answer application. ASM is also used to scale existing AI projects (Peranandam, 2020).
GenY Labs	ASM was chosen to deploy ML based NLP models for the Auris software platform to decipher real-time insights into root cause and sentiments from marketing data around brands and products sourced across many social channels. ASM made it possible to run custom web framework code and models on the platform with one scalable endpoint and less round-tripping (Apparusu, 2018) (GenYmedium, 2019).
Formosa Plastics	Product quality measures were amplified for petrochemical manufacture and vertically integrated plastic resin by enhancing defect checks with selectable ML models in ASM. This resulted in inspection time being halved, reduced labour, and continuous optimisation during production changes (The News Lens, 2018).
DigitalGlobe	S3 stores circa 100 petabytes of image library data for inferences on the odds of particular images requests made by customers based on usage patterns. This helps to organise its library to allow for satellite imagery to be reserved for immediate accessibility in S3 and Amazon Glacier (Russell, 2017).
Kinect Energy Group	Energy modelling was developed with ASM to predict how well disparate energy sources perform by tracking Nordic weather fluctuations from over seven-hundred stations stored in S3 months ahead in time. This reduces uncertainty in the energy costs allowing clients to hedge against cost increases or price decline (Wired, 2019)
SmartNews	Specific knowledge of NLP and pre-processing was not required for CNN in the ASM environment to deliver information to users globally with algorithms. ASM set up the containers and notebook configuration enabling focus on logic. Crowdsourcing is integrated to prepare the training data (Developers.IO, 2019).

Further findings indicate that companies in professional services employ ASM considerably the most at circa 45% of the market share. While the chart presents no tally on the ‘printing’ industry, there is some division on what it denotes (Printbusiness, 2015). To wit, there is a 2.6% ‘manufacturing’ category which PrintIT’s garment printing may include in its service-oriented processes (Sarkar, 2015, p. 39). Conversely, in Table 11, Axial 3D control print services with ASM for additive ‘manufacturing’, which may lend itself to that category.

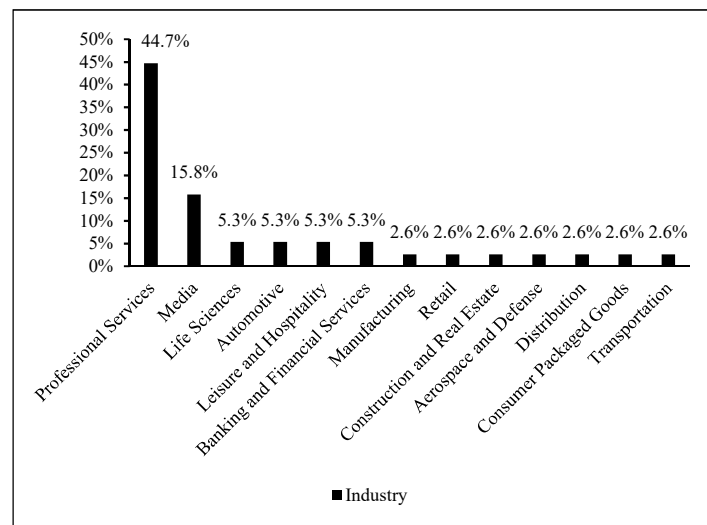


Figure 27 Amazon SageMaker Industry Customers
Adapted from Apps Run The World (2020)

6. Conclusion

PrintIT is an SME with a strategic goal for commercial growth having developed a successful niche online print service. However, interviews reveal that PrintIT is beset with sixteen IT related problems thereby affecting its growth plans. Adopting cloud services as a solution requires a strategy proportionate to the personnel size and SLA’s of the business while considering a range of impacts with security being one of the most important. On an assessment of benefits and risks, migration is favoured for transitioning to AWS given its penchant for elasticity, speed, and cost savings. A ‘lift and shape’ approach suits PrintIT’s migration approach enabling current assets to be kept while enhancing the cloud infrastructure with AWS offerings. Mapping existing problems to AWS gives potential solutions for a new cloud application architecture. This is made possible via a bespoke VPC, borrowing from the Reliability Pillar of the AWS Well-Architected Framework to provide high availability via ELB, Multi AZ’s, database replication, and Auto Scaling.

The advent of ASM now means that AWS customers can integrate their cloud applications

seamlessly with ML services to predict or decide from a collection of data examples based on a business trend. Thus, records from the PrintIT VPC database can be routed to a designated S3 bucket as part of a ML workflow on the ASM platform which forms a distinct layer of four-tier service stack. There are a variety of ways in which PrintIT may wish to employ ASM for its services including sales forecasts. ASM in its essence comprises Jupyter notebooks, training and inference API's, and GroundTruth. Customers may use their own algorithms, those from ASM, or the platform to run a model built offline. Since its inception, ASM has been growing in global popularity due its scalable fully-managed capabilities, feasibilities, and expeditious deployment. Resources put the UK as the second largest consumer of ASM, but occupies only circa one-tenth of the market compared to the US having almost three-quarters as the biggest. PrintIT will likely be among a minority of British e-commerce print companies to embrace ASM should it decide to employ MLaaS.

A. Appendix

A.1 Interview With PrintIT

Table 12 Interview - Business

Question	Answer
What type of company are you e.g. limited by shares, charitable, sole trader?	Single Owner
What do you mean by currently doing well? E.g. profit increase, turnover, user base growth &c	This is a combination of all factors they are having increased sales which gives an creased turnover
In what sense are you hoping to 'expand' i.e. open another office? Offer more of the same service?	The expansion at the moment will be increased sales though having a better infrastructure – in the future though additional offices could be a good idea to off load some of the work
After to listening to the talk on Amazon SageMaker, why would you like to consider it for the future? i.e. what was it that you thought would be beneficial or useful for your business?	We are after more information on Sagemaker – we are not a very technical organisation and the talk was interesting. We would simply like to know more about this and potentially how it fits with our company
How many IT staff are there at PrintIT?	We do not have any dedicated IT staff and instead really we have people who seem good at one or two elements. We are finding that if we do have a problem when someone is off other people will try and resolve the problem but usually without success in our experience
What 'different elements' are the staff responsible for?	This is various things from keeping the database working, through to desktop support and backup of our data.
How many corporate and individual users make orders on average per day / per year? And how many orders do you receive a day and per year on average?	We are finding that this doer change over the year and during the football season and Christmas is our peak. At the peak we process about 600 orders a day with t-shirts leaving our facilities. This does drop from here though at other time and in January we could be lucky to get a single order per day so most staff take leave during this time
At what point in time do you receive the highest and lowest amount of orders e.g. Christmas, in the mornings, on the day of football games at the Stoke-on-Trent grounds.	I have answered this in the above answer
Background states '...niche in terms of printing names and pictures onto photographs of the Stoke City ground.' Please clarify this sentence as PrintIT claims to print uploaded photographs onto ordered t-shirts. But the sentence says prints 'names and pictures', which may not be photographs, 'onto photographs', which reads as if printing occurs on photographs, of 'Stoke City ground'. What is happening here exactly?	Well this is a t-shirt with the Stoke ground on and then you can put your name and a number or the name of the customers favourite player and number i.e. if it was Manchester United and the Favourite player was Beckham and number 23 as this was his playing number
Could you describe a use case of an order?	Birthday, general present, wearing at the ground, bragging rights
How many people are employed at PrintIT?	We have 12 people at the moment and will expand in the future on this with the growth
How many people actually do the 'one or two' IT jobs?	Really this is difficult to say as directly people do no have two jobs, they just end up helping out. I would say that 3 people really help out the most with IT issues
How many computers are connected to the switch and network share?	We have 15 computers which are connected – some of these are quite old though and rarely used
Do all members of staff have office computers that are connected to the switch and network share?	Each member of staff can log into any of these desktops to use them

Table 13 Interview - Infrastructure

Question	Answer
What is the name or url of your website?	printITNow.org
What kind of website is it? Dynamic, static &c	at the moment is it is static with example t-shirts and picture to inspire customers with the only aspect being dynamic being the order page. On the dynamic page they can place there order and see a quick preview of what it will look like. The payment handing is done by a thuird party provider which at the moment is PayPal
It says that All of the IT infrastructure has developed over the years with new servers being added as they are required. For what purpose are the servers being added?	The servers are simply doing our work as an example the website server, the database server, the file server which contains the pictures and details uploaded to us, the file storage server which our computers work on for general administration, the print server where the jobs are sent before sent to the printer, mail server for general usage
Please list all your current assets and quantities thereof: • Servers: e.g. e-commerce, file, firewall print, communications, application, web, mail, authentication, DNS, DHCP, domain controllers • The manufacture/make: e.g. Windows Server • Type: physical or virtual, • The platform, framework, or runtime installed on them e.g. JRE, .NET • Software: installed applications, web services, and API's if any • CPU/RAM worth knowing • Routers, bridges, and switches	There are one of each these servers at the moment a. These are all Windows based at the moment and the website is running using IIS b. The different servers have different processors and RAM and have never changed since the installation/purchase c. The router was provided by the ISP and this acts as the firewall as well d. The switch is a 52 gigabit port Netgear which we thought would solve all of our problems when we purchase but made no difference
Please provide a component diagram of your current infrastructure e.g. connectivity, logical, or deployment	We do not have this as these are all connected in a standard star topology in a flat structure – All devices are in the same address range
What is being queried i.e. table name, item, when the database timeouts	This is items such as sending out the emails to all customers with offers. In addition we have tried running Business Intelligence queries to figure out spending patterns to optimise resources but again these rarely (If ever) actually complete
What is being queried i.e. table name, item, when the database timeouts	This is a simple FTP transfer to the remote site
How often is the data backed up?	Each night starting at 10pm
Do high mounts of orders prevent backups completing before xmas?	Yes as we have more data this has been an issue moving the data before we start again in the morning a. In addition if anything fails on this then the backup will be missed for that day
What printing equipment is used e.g. electronic direct to garment printer, transfer, cut vinyl	Electronic direct to garment printer
How do users pay for their orders or what servers are used? E.g. merchant services, payment gateway, by phone, direct transfer?	This is done via the website using PayPal who deal with all of this and then transfer the money to us at a later stage. This was the easiest way for us and the most secure
Where are files of the uploads stored?	These are stored on the dedicated server discussed in question 13
Who or what is deleting the files due to not enough storage space?	We are not 100% sure but the belief is that this is human error to clear space when we have older orders
How much storage space do you currently have and what percent is currently being used?	800 Gbytes on the server which contains the photographs a. Checking today we are running at about 85% of the space being used on this disc
What method is used to 'clean' storage?	We just use the OS delete functionality

Table 14 Interview - Processes

Question	Answer
What sort of advertising occurs on the website? E.g. General offers, PPC, Video Ads, Remarketing besides email campaigns if any?	We advertise in the Fanzine which is at the Stoke-City ground which is how we started and still do today. In addition we are trying to send out adverts to various mailing lists which we have. The website though found through Google we believe is the best advertising medium. We do not have direct evidence of this, we are basing this purely on the fact that orders are now coming from a lot more places than in the past
Why is it that the printer cannot work to the level of 1920 X 1080?	The printer simply does not have the physical capability
What is meant by 'lessen the impact upon storage' when the quality of the picture file?	As we can not deal with pictures beyond a certain size a member of staff carries out compression and reduces the size/quality to the level we can use. As a consequence of this the physical storage needed for the picture is reduced
How are customers contacted when wrong pictures are deleted or lost?	This is initially by phone as we want this resolved quickly, but if we are unable to contact them we then follow up with an email.
What is meant by lost pictures cannot be uploaded if they are already lost? What mechanism is being used to stop the picture being reuploaded?	This will generate a new job and as such our administration system is built around a single upload. In our current system to upload again through the site is considered a new order and as such the customer will pay again.

A.2 Default VPC

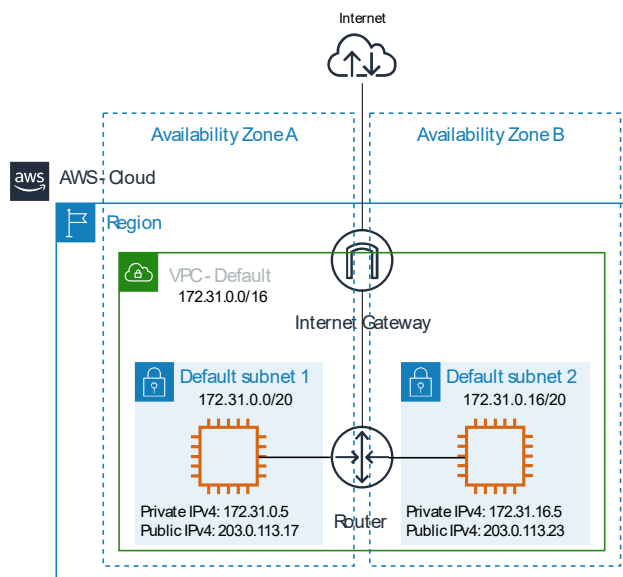


Figure 28 AWS Default VPC

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