Ma & Pa's Cloud Implementation

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Summary

Ma & Pa's was a small-town retailer that had been serving its local rural community for decades with products designed to improve the everyday lives of its customers. Previously, a new product was developed that goes above and beyond all other products created to that point. The new product had the potential for exponential growth if a marketing and advertisement campaign, along with supporting infrastructure, were properly planned and deployed successfully. This required something that *Ma & Pa's* never had before, a modern retail website where products could be advertised and sold to its consumers.

There needed to be more than the current on-site infrastructure to support this initiative, as it predated the Internet age. Another issue was that the existing infrastructure lacked the required computing resources and data center floor space to house any newly purchased equipment. The problems were easily overcome by deploying the retail website in the cloud. This allowed *Ma & Pa's* to pool computational resources and network backbone with a Cloud Service Providers (CSP)s rather than purchasing and maintaining the hardware equipment internally. With the use of a CSP to deploy this solution in the cloud, responsibilities for maintaining the underlying hardware and networking infrastructure have been provided by the chosen CSP. This eliminated *Ma & Pa's* need to provision and maintain any hardware. Focus is now directed toward product development and updating the retail web page with specific and individualized content instead of administrative and operational tasks.

Ma & Pa's contracted with CJEYS LLC to architect, build, & deploy a new retail website utilizing a 3-tier architecture in the cloud. The supporting solution built by CJEYS LLC is loosely coupled, allowing for high availability and scalability, and has kept costs to a minimum for *Ma & Pa's*. The major CSPs were researched and vetted. It was determined that Amazon

Web Services (AWS) was the best fit for this solution based on available resources, features, functionality, and due to the discount and overall cost savings associated with the partnership between AWS and CJEYS LLC.

CJEYS LLC designed a solution consisting of the following 3-tiers, Presentation, Application, and Database. The architecture build began when an AWS Virtual Private Cloud (VPC) was provisioned and divided into nine subnets. By deploying the various resources making up this solution in different subnets, the solution scales across those subnets while isolating them so that when a failure occurs in one subnet, it will not affect any other subnets. Build out of the three tiers commenced with the VPC provisioned as mentioned and when the non-overlapping IP addresses and CIDR ranges were configured.

The Presentation tier made use of AWS EC2 instances to run WordPress. The EC2 instances provided the virtual servers for this solution, while WordPress was a free and open-source program commonly used to build small and medium size websites. With the WordPress software running on the EC2 instances, customers were able to view and purchase the latest products available from *Ma & Pa's* anywhere in the world that has public internet access. This exponentially increased the potential for new customer outreach during the previous advertisement and marketing campaign.

One feature of AWS that was used at the Presentation tier is Auto Scaling Groups (ASGs). With ASGs, the number of EC2 instances and computing power can now scale in or out based on system utilization associated with changing customer traffic flow. During high customer traffic and system utilization periods, additional EC2 instances are now deployed and terminated as that traffic and system usage return to normal. The security of this tier uses

network Access Control Lists (ACLs) and Security Groups to only allow required traffic while restricting all other traffic that falls outside of these set parameters.

The Application tier utilized Amazon Elastic File System (EFS) as a network-attached filesystem that mounted to the EC2 instances. The EFS service stores files and media content for the WordPress application. The benefits achieved by using EFS in this solution included the ability to span the filesystem across multiple availability zones, provide scalability based on the filesystem size, and the options to enable default encryption at rest and automatic backups. For security measures, EFS was placed in a private subnet to restrict internet traffic. In addition, ACL & Security Groups were configured only to allow access between EFS, staged EC2 instances, and the Database tier.

The Database tier took advantage of the fully managed database service Amazon Relational Database Service (Amazon RDS). High availability was achieved at this database tier by using the Amazon RDS Multi-AZ deployment method to ensure multiple database instances were used in a passive/failover scenario.

The data stored in Amazon RDS includes WordPress-generated metadata, information about *Ma & Pa's* web advertisements, social media tags, users, and comments. This metadata has been tremendously valuable for the organization's growth. In-depth analytics was performed by querying this metadata to gain more significant insights into the current customer base, the products they purchased or were interested in, and the successful marketing strategies from the previous advertisement and marketing campaign that can now be easily reused in future campaigns.

An application load balancer (ALB) was used to evenly spread the internet connections across the EC2 instances to make this solution fully elastic and scalable. Another great feature

of ALBs used is Health Checks to monitor the EC2 instances. With Health Checks, consumer traffic is now redirected to another EC2 instance if there are any HW issues on an instance or as the ASG scales in or out with overall user traffic.

To complete this architecture, Amazon CloudWatch was used at each layer to collect and analyze resource and application data. This helped *Ma & Pa's* team improve system performance with the use of alarms and associated automated actions, troubleshoot issues from the generated logs or metrics, and maintain the system's supportability as it grew and developed over the length of the project.

This project and cloud architecture was critical to *Ma & Pa's* successful journey in the Internet age. The Implementation Plan began with CJEYS LLC meeting with stakeholders to understand the existing business, its history, and the final goals of the project. This information was documented in a Project Plan, so all parties stayed up to date and aligned toward the common goals and objectives. CJEYS LLC Solution Architects then reviewed the project requirements and performed research to choose the right CSP for this solution. The CSP was chosen, and Solution Architects then designed and created an architectural diagram for the 3-tier cloud application. CJEYS LLC SysOps administrators then built and deployed the retail website and supporting cloud infrastructure. Next, security measures were implemented, along with the installation of audit and compliance tools. The security measures were vetted, and reports were generated that demonstrate the solution complied with all auditing guidelines and regulatory compliance. The Implementation Plan was finished approximately 30 days from the 'go-live' date. This allowed for Project and system analysis to be completed to ensure that all objectives, goals, and deliverables were met and for mutual agreement to close the project.

Review of Other Work

To build the website, WordPress software was utilized based on the requirement to use an open-source product. Typically, CJEYS LLC uses enterprise-grade software for all implementations. This forced the SysOps administrators to step out of their comfort zone for this project. To complete their work, research was performed, and the team quickly found how easy it was to implement on EC2 instances and even discovered that the WordPress can also be hosted on Amazon S3 (Noor, 2022). This knowledge will prove to be beneficial for future project implementations.

While the project objectives were completed within the agreed upon timeline, the deployment of Amazon EFS proved to be trickier than expected. There were a few issues during the first attempts of implementing EFS. The issues were researched, discovered, and addressed with the help of an EFS implementation guide (Simple File Manager for Amazon EFS, n.d.). This documentation will be saved and noted for future reference.

As noted in the upcoming portion of this report, *Ma & Pa's* does not have an existing database and therefore lack the knowledge to support and operate it. CJEYS LLC has shared a user guide for Amazon RDS with *Ma & Pa's* admin team (Amazon Relational Database Service User Guide, n.d.). This will provide operational guidelines, recommendations, and best practices to the team. If there are any questions or need for further assistance, CJEYS LLC can be engaged for a minimal fee to assist in this area if the need occurs.

Changes to the Project Environment

Ma & Pa's original environment was based in the pre-Internet age and desperately needed to be modernized to support future advertisement and marketing campaigns. As it stood,

the original infrastructure included a single brick-and-mortar building with a basic landline and fax machine, computer, mouse, and printer. There was no room for additional hardware in the retail office and no budget available to expand by adding additional office space.

Prior marketing and advertisement campaigns utilized radio ads, newspaper posts, & simple word-of-mouth. While this was suitable for previous decades, this severely limited new customer outreach and *Ma & Pa's* growth potential. A unique and modern approach was needed to grow the existing customer base and company revenue to stay relevant in the Internet age.

The deployment of a 3-tier architecture provided *Ma & Pa's* with a future-proof solution that is fully elastic, scalable, and highly available. This was a much-needed and dynamic shift that brought *Ma & Pa's* retail business into the 21st century.

A significant component that was not present in *Ma & Pa's* original infrastructure was a database and analytical environment. A robust analytical environment was required to grow and compete in the aggressive retail market strategically. This would allow *Ma & Pa's* marketing team to create a comprehensive and insightful campaign that targets the right consumer demographic using their preferred form of media. The proposed solution recommended the use of Amazon RDS. This would provide *Ma & Pa's* marketing team with a data warehouse to store and analyze large data sets in a highly available, scalable, and fully managed analytical environment.

The purpose and nature of *Ma & Pa's* products are designed and built to help people of all ages. With the success of this project, *Ma & Pa's* have had the need to expand their existing retail space to add additional offices since the Marketing and IT teams have grown to meet the new business and consumer demands. With the increased awareness of these products, more consumers are now taking advantage of *Ma & Pa's* products to help overcome some of their

typical daily struggles and challenges. This has significantly improved the consumer's quality of life and potentially increased their life expectancy. This has been a win-win scenario for all parties.

Methodology

The ADDIE model is commonly used by CJEYS LLC and was a perfect fit for this project. The ADDIE model is comprised of five phases: Analysis, Design, Development, Implementation, and Evaluation. While there were many alternatives available, the ADDIE model is commonly used, globally accepted, and provides several advantages to this project's implementation (Budoya et al., 2019). Some of those advantages were the clearly defined phases of the model, the ability to document and align with goals and objectives throughout the project, and the encouragement of feedback and evaluation at each stage. With the use of the ADDIE model, CJEYS LLC successfully completed this project on time.

During the analysis phase, CJEYS LLC met with *Ma & Pa's* stakeholders to ensure that all parties were aligned with the same project goals, objectives, and deliverables. This occurred through several meetings and investigative sessions over a month. Once those goals were identified, various CSPs were vetted based on the available services that best fit the solution and cloud architecture.

The design phase took direct input from *Ma & Pa's* stakeholders, and in partnership with the chosen CSP vendor, CJEYS LLC began the new cloud architecture design, ensuring that it was highly available, scalable, and supported the project with room for system growth. All parties thoroughly examined the design to ensure agreement before moving to the next phase.

In the development phase, CJEYS LLC Solution Architects built an infrastructure diagram and network chart for the implementation. This included a 3-tier application architecture consisting of a Presentation, Application, and Database layers utilizing security safeguards, least-privilege best practices, and auditing for government and regulation compliance.

During the implementation phase, the CJEYS LLC SysOps team built the solution following the infrastructure diagram and network charts developed in the previous phase. This included the setup and configuration of AWS resources, network & subnet design, audit tools, and reporting. Additional internal testing was conducted during this phase to verify that security measures were in place and that the solution's scalability was vetted. Also, during this phase, the solution went through an extensive review with all stakeholders to ensure that testing results met the project's goals and objectives. When all parties agreed during this review, the solution was fully deployed and closely monitored during the first few weeks after the go-live date. System metrics were also collected and reviewed in the next phase.

Finally, in the evaluation phase, CJEYS LLC consolidated the metrics, generated reports, and presented them to *Ma & Pa's* stakeholders for review. This review included lessons learned during the project's implementation, consumer feedback, and financial analysis to determine the short-term return on investment (ROI) and trajectory for long-term ROI. CJEYS LLC offered the ability to request minor configuration changes to the current solution. This offer stood for 30 days after project closure and change requests ultimately must be approved by CJEYS LLC; therefore, implementing the change requests was at the sole discretion of CJEYS LLC. *Ma & Pa's* were satisfied with the project results since the solution availability was 100% and product sales have increased by 150% from the previous two months.

Project Goals and Objectives

Goal	Supporting Objectives	Deliverables
A modern retail website and supporting infrastructure	1.a. Determine and agree on the project scope	1.a.i. Project plan with clearly stated goals, objectives, and deliverables so all parties are aware of and are working toward the same
	1.b. Cloud architecture design	1.b.i. Architecture and network diagram to guide the deployment of the retail webpage and supporting infrastructure
	1.c. Retail website and supporting cloud infrastructure built and deployed	1.c.i. Cloud resources are provisioned, and networking configured
	1.d. Security measures and least-privilege access implemented	1.d.i. Network ACLs and Security groups are configured only to allow required access between resources
	1.e. Audit and compliance tools installed	1.e.i. Audit report and tabulated analysis of the results from the campaign

The main goal of this project was to create a retail website and supporting infrastructure to conduct advertisement and marketing campaigns. This was achieved with a 3-tier architecture that's loosely coupled to enable scalability, ease of maintenance and support, and extensibility for future growth. The new advertisement and market campaigns now facilitate revenue growth and have helped modernize *Ma & Pa's* retail strategy to keep the organization relevant.

- Objective 1.a: Understanding the need for this project was critical to ensuring that CJEYS LLC were in sync with *Ma & Pa's* stakeholders. Meetings were conducted so that all stakeholders determined and agreed on the project scope which allowed CJEYS LLC to gather information and gain an understanding of the original environment. This objective was met when the project plan was generated to provide guidance throughout implementation.

- Objective 1.b: Research was conducted on the various cloud vendors and compute resources available. A cloud architecture was designed to support the deployment of a retail website. This objective was marked as complete when the cloud architecture and networking diagram were generated.
- Objective 1.c: CJEYS LLC partnered with the chosen CSP, AWS, and built the required cloud infrastructure and deployed the retail website. This objective was marked as complete when the cloud resources were provisioned, and network connections established between them.
- Objective 1.d: This objective put security measures in place and implemented least-privilege access throughout the solution. This helps prevent security threats and data breaches. This objective was marked as complete when the network ACLs and Security groups were configured for each tier of the solution and subsequent penetration testing of the resources were performed.
- Objective 1.e: This objective installed the audit and compliance tools required for this solution to comply with all industry standards and government regulations. This objective was marked as complete when the audit and compliance reports were successfully generated and reviewed proving functionality, verifying regulatory compliance.

Project Timeline

Milestone or Deliverable	Planned Duration (days)	Actual Duration (days)	Actual Start Date	Actual End Date
Project plan with clearly stated goal, objectives, and RACI diagram	14 days	13 days	12/26/2022	1/8/2023
Architecture and network diagram	14 days	13 days	1/9/2023	1/22/2023

AWS resources are provisioned, and networking configured	7 days	5 days	1/23/2023	1/27/2023
Network ACLs and Security groups are configured	3 days	3 days	1/30/2023	2/1/2023
Audit report and tabulated analysis of the sales campaign results	3 days	2 days	2/2/2023	2/3/2023

The project implementation was able to complete all milestones and deliverables within the planned timeframe allotted. In fact, most timeline objectives were completed early. This was achieved with the help of *Ma & Pa's* stakeholders being clear and articulate in their goals for this project. This allowed for CJEYS LLC to utilize extensive industry knowledge and expertise to remain focused on the project objectives and subsequent timeline.

Unanticipated Requirements

CJEYS LLC did not anticipate the lack of operational knowledge held by *Ma & Pa's* admin team. Additional time was spent by CJEYS LLC to bring the admin team up to speed on some of the latest technologies and best practices. Luckily this is not the first time CJEYS LLC has been in this type of situation. The additional time spent on education was streamlined thanks to some educational material that has been developed and consolidated during previous project engagements.

Conclusions

The new retail website and cloud-based infrastructure have met the needs of *Ma & Pa's* stakeholders. The potential for rapid company growth and profits has been achieved thanks to the proper utilization and management of this project. The cloud infrastructure built for this

project has led to a successful marketing and advertisement campaign for current products and will prove to be beneficial for future products not yet developed.

The success and effectiveness of this project was measured at the one-month mark. Two elements were measured at this juncture. The first is that system availability remained above 99.9% throughout the new marketing and advertisement campaign. The second is that the new marketing and advertisement campaign was to generate a 100% increase in product sales from the previous two months. Both elements were confirmed with system availability remaining at 100% throughout the project and product sales increased by 150%. *Ma & Pa's* stakeholders have confirmed the success and effectiveness of this project and have agreed to marked it as closed. CJEYS LLC appreciates *Ma & Pa's* partnership with this project and looks forward to helping with other projects in the future.

Project Deliverables

Appendix A shows the architectural diagram created by CJEYS LLC Solution Architects. The diagram shows the placement of all AWS resources provisioned for *Ma & Pa's* solution and their deployment location. This helps give stakeholders a basic understanding of the solution, and its functionality, and will be useful in case there is a need to further develop the implemented solution by CJEYS LLC or other potential contractors *Ma & Pa's* may employ in the future.

Appendix B is the IP address plan that was developed for this project. The IP address ranges identified in the plan provide enough IP addresses for the project and leaves room for future growth. This information should be documented and saved for future reference to prevent using these IP address ranges. It is critical that these IP addresses do not overlap with any other within *Ma & Pa's* network otherwise the solution will begin to display strange behaviors and

ultimately fail in time.

References

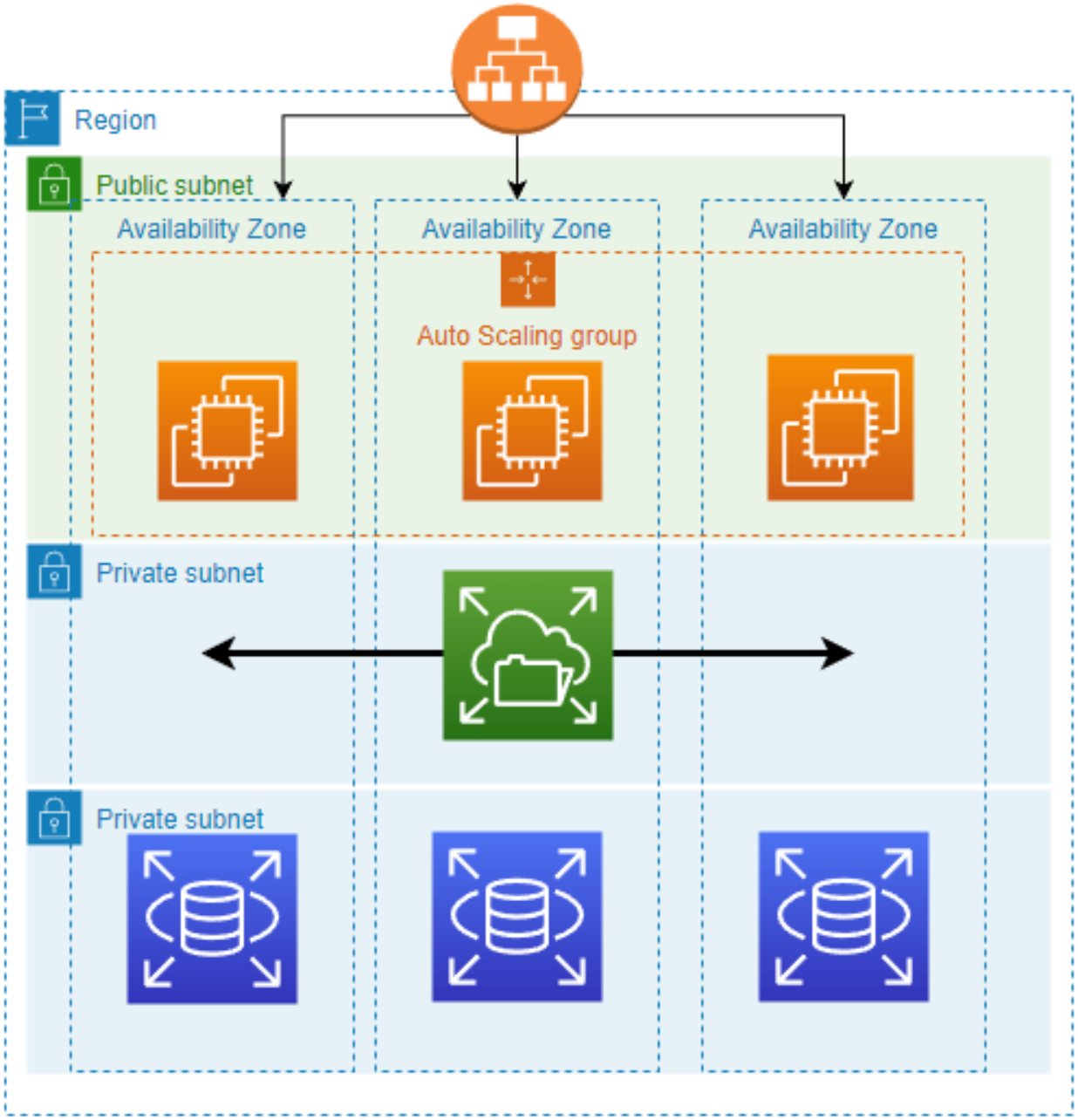
Amazon Relational Database Service User Guide. (n.d.). Retrieved from AWS: https://docs.aws.amazon.com/AmazonRDS/latest/UserGuide/CHAP_BestPractices.html

Noor, M. (2022, August 2). *How to Host your WordPress Website on Amazon EC2 and S3*. Retrieved from Vizteck Solutions: https://www.vizteck.com/post/how-to-host-your-wordpress-website-on-amazon-ec2-and-s3

Simple File Manager for Amazon EFS. (n.d.). Retrieved from AWS: https://docs.aws.amazon.com/solutions/latest/simple-file-manager-for-amazon-efs/automated-deployment.html

Appendix A

Ma & Pa's Cloud Architecture Diagram



Appendix B

Ma & Pa's IP Address Plan

10.X Network	Availability Zone	Resource	Region	Zone
10.64	A	EC2	1	Public
10.65	B	EC2	1	Public
10.66	C	EC2	1	Public
10.67	A	EFS	1	Private
10.68	B	EFS	1	Private
10.69	C	EFS	1	Private
10.70	A	RDS	1	Private
10.71	B	RDS	1	Private
10.72	C	RDS	1	Private