Microsoft Azure (April 2024)

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***Abstract*— This state-of-the-art paper is intended to set the scene for a special issue of Microsoft Azure. Microsoft Azure is a comprehensive cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services. Azure is a robust solution for businesses seeking scalable cloud storage, powerful computing capabilities and integrated data analytics.**

***Keyword*— Cloud Computing, Integrated Data Analytics, Microsoft Azure, Powerful Computing Capabilities, Scalable Cloud Storage.**

I. INTRODUCTION

In the rapidly evolving world of technology, cloud computing has emerged as a game changer. A comprehensive suite of cloud services; Microsoft Azure is the leaning edge of this revolution. From software as a service (SaaS) to platform as a service (PaaS) and infrastructure as a service (IaaS), Azure's wide range of services cater to diverse needs empowering businesses to efficiency, scalability, and digital transformation in today's fields.

II. AZURE HISTORY

Abandy [1] mentions that the original name Windows Azure was a deliberate response in competition with Amazon EC2 and Google App Engine. First announced on October 28, 2008, Windows Azure was built as an extension of the Windows NT which was the beginning of Microsoft Cloud Platform as a Service (PaaS). Windows Azure was an internal project that went by the code name "Project Red Dog".

A. First-Generation Services

Windows Azure had started with a limited number of services, which it was first launched to enable developers to run the ASP.NET web application and APIs. It also has been designed with Azure service that was running a long process with no user interface for worker roles. A year later after release, SQL Azure relational database and support for other programming languages and some micro related services had been announced.

In early 2010, Windows Azure became ready to be commercialized. Some of the additions are .NET Framework 4, OS Versioning, Content Delivery Network (CDN) and Microsoft Azure Service Bus.

B. Second-Generation Services

Increasing usage of software like Linux VM and some OSS packages due to developers starting to adopt Open-Source Software (OSS) since it was far more cheaper. This has opened a path of Infrastructure as a Service (IaaS) as an approach for consumers to have principal control over the cloud. The competitor; Amazon EC2 on the other hand has been growing linearly as it already had its own version of Linux. In response, Microsoft reform their strategies by renaming their clouds from Windows Azure to Microsoft Azure and making it the pre-eminent way to run Linux Operating System. This reform has turned full operation from bottom to up, PaaS to Iaas.

C. Third-Generation Services

Big Data, Analytics and Internet of Things (IoT) making a debut pushing the giant companies such as Amazon pushing the Elastic Map Reduce (EMR). Amazon EMR in [2] is a managed cluster platform that simplifies running big data frameworks, such as Apache Hadoop and Apache Spark, on AWS to process and analyze vast amounts of data. In return, Microsoft had to take an aggressive approach, partnering with HortonWorks to offer Azure HDInsight. Microsoft also provides an end-to-end Big Data and analytics platform on Azure; Azure Data Lake Store and Azure Data Lake Analytics. They later underwent Revolution Analytics making the R language native to the platform.

Leading the league, Microsoft Azure had it in queue as the first cloud service providers to have an end-to-end connected devices stack powered by Event Hub, IoT Hub, Stream Analytics, SQL Database and Power BI. Foresaw Internet of Things (IoT) as a worthy service to leverage, Microsoft has become the only company that offered the core building blocks of IoT (PaaS) and a white-labeled, multi-tenant, ready-to–use IoT SaaS offered brand as Azure IoT Central.

D. Fourth-Generation Services

Machine learning and Artificial Intelligence had become the new focus for Microsoft as the cloud began to drift away from OSS and OSS packages, Big Data and IoT towards intelligence. Microsoft Azure offered a visual designer named Azure ML Studio for training and deploying Machine Learning Models. It goes on to support deep learning models, NVIDIA GPU, Intel FPGA, enhanced pipelines, Machine Learning Operations (MLOps) and even a drag and drop designer for training neural networks.

As for this partnership with Intel, NVIDIA and Qualcomm make Azure IoT edge the best platform to work with. Looking towards the investment made in databases, Big Data, IoT made Microsoft Azure platform hosting a substantial cloud service that has vision of Intelligence Cloud and Intelligence Edge which in return set the standards for running compute, storage and analytics at the edge.

E. The Present and Beyond

Azure Arc in [3] simplifies governance and management by delivering a consistent multi cloud and on-premises management platform are an advantage taken by Microsoft concerning the

adoption of Kubernetes. In addition, Microsoft Azure with over 600 services has transformed the cloud service landscape. This holistic approach from a combination of different technologies and services fosters strong customer relationships.

III. MICROSOFT AZURE SERVICES

Microsoft Azure offers a diverse array of services tailored to meet the demands of modern Enterprise Information Systems (EIS) of its various, global customers. These services can be broadly categorized into compute, storage, networking, databases, analytics, artificial intelligence (AI), Internet of Things (IoT), developer tools, security, and management solutions. Each category encompasses a range of specialized tools and platforms designed to address specific needs and challenges encountered in the development, deployment, and management of enterprise-grade applications and systems. Discussing all of Azure's roster of services in this paper will not be ideal, so the following are some of Azure's most popular services, which are also used in the case study that we will elaborate on in the next chapter.

A. Azure DevOps

Azure DevOps was formerly known as Visual Studio Team Services (VSTS) up until 2018 when Microsoft launched Azure DevOps Services in a broader shift to cloud services [4]. DevOps is Microsoft's Software as a Service (SaaS) platform tailored to provide a comprehensive toolkit for developing and deploying software projects. This platform is designed to cater to the needs of development teams, offering specialized tools and services for programmers, analysts, testers, and project managers. Besides boasting a wide selection of services, Azure DevOps integrates seamlessly with a variety of other tools, thereby expanding the toolsets available in DevOps and customizing them to suit the specific requirements of each development team and organization.

Bigelow [5] explains that Azure DevOps serves as an end-to-end software development platform, offering a wide range of capabilities aimed at organizing and accelerating development efforts across the entire application lifecycle. These capabilities include requirements management, project management for both Agile and waterfall methodologies, version control using Team Foundation Version Control (TFVC) or Git, automated builds, reporting for test results and development metrics, testing, and release management.

The platform is intended for use with native development environments such as Microsoft's Visual Studio and Eclipse, while also supporting integration with other popular integrated development environments (IDEs). Azure DevOps provides a suite of focused services, each related to a key aspect of the development lifecycle. These services include Azure Boards for project management, Azure Repos for version control, Azure Test Plans for testing, Azure Pipelines for delivery, integration, and deployment management, and Azure Artifacts for component management and sharing. Both Azure Pipelines and Azure Artifacts can be individually bought instead of as part of DevOps Services albeit with a different pricing structure.

Azure DevOps services are open and extensible, compatible with various applications regardless of the framework, platform, or cloud environment. The platform offers built-in cloud-hosted agents for Windows, macOS, and Linux, and supports workflows for native container support, Kubernetes deployment options, virtual machines, and serverless environments. Additionally, Azure DevOps allows for extensions and integrations with a wide range of popular services e.g. Campfire, Trello, Slack and UserVoice, enabling users to tailor their development environment to their specific needs

While utilizing all five Azure DevOps services provides users with an integrated suite offering end-to-end DevOps functionalities, the platform also offers flexibility for organizations to select and utilize only the services that meet their requirements. For example, organizations hosting their code in a Git repository on GitHub can choose to use only the Azure Pipelines service for building and deploying their applications.

Azure DevOps is utilized by analysts, software testers, programmers, and IT project managers, enabling improved collaboration, decreased maintenance costs, access to up-to-date DevOps features, and enhanced stakeholder involvement. However, potential drawbacks include setup complexity especially regarding the individual major toolsets, strong ties to Microsoft products and platforms as the favored vendor, a challenging user interface with a myriad of options, and considerations regarding data location for organizations with specific requirements.

B. Azure Boards

Azure Boards have features such as Kanban boards, project backlogs, customized reporting, and issue tracking to be able to support Agile and Scrum methodologies as in [6]. This allows developers to follow user stories/bugs/features, access interactive backlogs, boards and lists, create worklists and charts, develop delivery plans and maintain traceability throughout the development lifecycle, which is crucial for Agile development.

C. Azure Repos

Azure Repos provides version control tools, managing and tracking code changes across multiple teams over time. It is a powerful tool to save work progress and coordinate changes across an entire team. Azure Repos also supports Git repositories and TFVC integration for pull requests and advanced file management as in [5].

D. Azure Pipelines

Azure Pipelines is mentioned by Roberts [7] as a pivotal component of Azure DevOps' toolkits, revolutionizing the software deployment process by automating the build, test and deployment workflows. Trusted to power over 150,000 websites, Azure Pipelines ensures efficiency and reliability. Part of the reason is, it supports a wide array of programming languages e.g. Python, Java, Javascript, .NET and more. It also integrates with source control systems like Azure Repos, Subversion and Github.

Embracing both Continuous Integration and Continuous Delivery principles, it facilitates consistent testing and deployment, the former aiding in early error detection and consistent code compilation while the latter ensures compliance and faster bug fix deliveries by integrating code with infrastructure. Pipelines allows for deploying applications to different targets i.e. Virtual Machines (VMs), cloud platforms, Azure services and container registries while maintaining customizable deployment controls. Azure Pipelines offers a robust framework for automating and managing software deployment processes, using key concepts like tasks, templates, parameters, variables, secrets, and triggers.

E. Azure Artifacts

Azure Artifacts allows development teams to share and manage code efficiently using software packages controlled from

a unified platform. The package being referred to here is a collection of files and resources that are bundled together for distribution and use. These packages typically contain libraries, modules, or components that provide specific functionality and can be easily imported or included in a software project.

Azure Artifacts boasts several key features and functionalities as listed in [8]: Firstly, it offers a secure platform for hosting various package types such as NuGet (for .NET), npm (for JavaScript), Maven (for Java) and Python. Secondly, organizations can create private feeds to manage internal packages, controlling access and keeping them confidential. Thirdly, it acts as a proxy and cache for public repositories, reducing network latency and enhancing build times. Additionally, it provides robust versioning and lifecycle management capabilities, allowing control over package availability and status. Developers can use Azure Artifacts to publish packages to feeds and share them within a team, across the organization, or publicly. Developers can also consume packages from multiple public registries like NuGet.org and npmjs.com. Azure Artifacts' seamless integration with DevOps suites of services allows for package management as part of the CI/CD (Continuous Integration/Continuous Deployment) pipelines.

F. Azure Test Plans

Azure Test Plans is a feature-rich suite of tools that helps in planning, tracking, and managing software testing activities seamlessly all within Azure DevOps. It allows for creating and managing test cases, test suites, test configurations and test runs [9].

Before proceeding with the actual testing, it is best practice to create Test Plans to define a testing strategy, assign testers and tracking progress. Then the Test Plans can be grouped into Test Suites based on suitable criterias e.g. user stories, priority, etc. Test Cases then define steps and expected outcomes to judge the application's functionality. Creating Shared Steps also allows for reusable common testing procedures across multiple cases, minimizing redundancies. Test Configurations facilitate running test cases across different environments and setups e.g. browsers or devices, ensuring thorough testing coverage. Lastly, Test Execution can be divided into Test Runs and Test Results. During manual testing, you can collect comprehensive diagnostic data using the web-based Test Runner and Test Runner client. Test Runs execute test cases or suites, enabling tracking of execution status, defect logging, and report generation while Test Results records and displays test results, facilitating identification of passed and failed tests, with the option to attach detailed artifacts for failed tests.

By integrating testing teams into the Azure DevOps Platform, developers can seamlessly combine testing into their workflow, making use of Azure Boards and Azure Pipelines to track items and automate build and release processes respectively. The customizable test configurations and robust analytics also provide comprehensive diagnostics insights into testing progress and quality. Not to mention, Azure Test Plans open every step of the testing process for collaboration with testers, developers and stakeholders, their contribution will greatly inform the software development.

G. Microsoft Entra ID

Microsoft Entra ID was previously named Azure Active Directory but all the features and pricing stayed the same. It is Microsoft's cloud-based identity and access management similar to AWS' Identity and Access Management (IAM). Entra ID stores user information and access permissions, facilitating secure authentication and authorization for employees accessing IT resources, including internal assets like corporate data and external services such as Microsoft 365 and SaaS applications.

Unlike on-premises Active Directory (database and set of services that connect users with the network resources), Entra ID operates solely in the cloud but can coexist with on-premises AD in hybrid environments as well. These resources encompass both internal assets like corporate intranet data and tools, as well as external resources such as Microsoft 365 and various SaaS applications. Organizations with subscriptions to Microsoft's online business services automatically gain access to Entra ID, with advanced features available through upgraded licenses.

Entra ID is commonly used by IT administrators for user and group management, application developers for seamless integration with Entra ID credentials in applications, and business end users for accessing Microsoft cloud resources e.g. Teams or SharePoint while ensuring security and authorization [10].

H. Azure OpenAI

Microsoft Azure OpenAI and OpenAI are oftentimes confused with each other by the general public due to their similar names. In [11] is explained, while both are key players in the realm of artificial intelligence, each offers distinct features and benefits, a difference that can heavily impact your business depending on how often you use these technologies. OpenAI is a renowned research laboratory focused on developing advanced AI models such as GPT-4, Whisper, DALL-E, and Jukebox, aiming to create safe and beneficial AI applications across various domains. In contrast, Azure OpenAI is a collaboration between Microsoft and OpenAI, leveraging Microsoft's cloud computing resources and OpenAI's expertise. Azure OpenAI provides a secure ecosystem for utilizing OpenAI models, ensuring compliance with ethical AI usage policies. Ultimately, while OpenAI focuses on developing cutting-edge AI models, Azure OpenAI provides a secure and enterprise-ready platform for leveraging these models within the Microsoft Azure ecosystem.

Azure OpenAI [12] empowers developers to create advanced applications that automate tasks, process data efficiently and interact with users naturally. OpenAI's language models allow for new opportunities in leveraging AI solutions to their operations be it in the back end like detecting fraud or front end like chatbots for example.

Azure OpenAI operates in three ways [12], generating custom models, text prompt processing and prompt examination. Azure OpenAI can customize models based on training data of various formats (e.g. .txt, .md., .html., .docx, .pdf) that can be sourced from either REST API, via SDK or web-based interface in Azure OpenAI Studio which is useful for developers to connect, ingest and ground their enterprise data to create personalized copilots (preview) rapidly. Businesses can opt to fine tune their own models or utilize advanced AI models such as GPT-35-Turbo and GPT 4 without the need to train enterprise data and just discover insights through text prompts. In processing the text prompts, the resulting fine-tune models are stored in Azure Storage encrypted and logically isolated with the user's subscription and credentials. Azure OpenAI's built-in prompt examination can detect instances of abuse, misuse, or creation of harmful content while still maintaining data control (not shared with Microsoft for more than 30 days).

Azure OpenAI offers a range of other capabilities, including content generation, summarization, code generation and semantic search. It becomes very useful for businesses that want to automate and improve tasks like generating content (e.g. ideation, design and content writing), summarizing information, transforming code and enhancing search function functionality (based on trusted source documents like the company's internal documentation, not generated out of thin air).

IV. CASE STUDY: E-mart Enhancing Customer Experience with AI Chatbots

Leading retail chain, E-Mart has consistently been the magazine cover for innovation and customer service excellence. In 2022, the company has embarked on a digital transformation journey to revolutionize the way it interacts with customers. Recognizing the potential of Artificial Intelligence, E-Mart implemented AI chatbot consultation services to enhance customers engagement. This initiative to deliver superior service has spanned across various stores including E-Mart, E-Mart Traders, and No Brand, which Microsoft covered in [13].

As a competitive retail company, E-Mart faced the challenge of providing quick efficient customer service. Traditional customer support channels were not meeting the growing expectations of customers who seek immediate and accurate response to their queries. It is always perceived as lagging, with delays and lack of personalized attention. The challenge was twofold: reduce response times and provide accurate information, helpful information to customer inquiries.

By addressing this challenge, E-Mart introduced chatbots infused with AI capable of providing instant accurate consultation service. These digital assistants were engineered to deliver instant and precise service. The design pillars were centered around accessibility, thus being available via smartphone ensuring convenience, ease of use for consumers. The AI chatbot was designed to provide accurate information and handle a wide range of customer queries with minimal waiting times. Whether it was store hours, product availability, or service offered, the chatbots prepared to handle the queries. Internally, with generative AI issues, there is still an option to a live agent if the chatbot wasn’t able to provide appropriate answers.

The development and deployment of these AI chatbots were streamlined through the integration of Azure DevOps, development tools that support agile development processes. This platform facilitated collaboration among the development teams and provided tools for efficient management of the development lifecycle. Key components of Azure DevOps, Repos and Pipelines were extensively utilized to manage the chatbot development process to facilitate continuous integration and delivery. Azure DevOps Repos were used for code storage and version control. It allows developers to collaborate on code changes, track revisions and maintain a history of the project evolution. Developers also use branching strategies to work on new features or fixes without disrupting the main codebase. Once changes are tested and approved, it will be merged back into the main branch. As developers commit their part, using Azure DevOps Pipelines, it automatically builds the code and runs tests to ensure new changes integrate well with existing code. Each chatbot is packaged into a container to encapsulate the environment needed to run the service. The package will be sent to the pre-production area called staging for final testing and verification. Once the chatbot passes all the tests, CD pipeline automates the deployment of the service to the chatbot model. The use of Repos and Pipelines streamlines the development lifecycle, from writing code to implementation of the chatbot. It enhances collaboration, improves speed and reliability and ensures the chatbot remains responsive to the user's needs.

As a result, customers now enjoy a seamless experience when seeking information, leading to increased satisfaction and loyalty. The use of Azure DevOps has accelerated the development speed, allowing E-Mart to rapidly adapt and improve the chatbot services. These chatbots built with AI can handle a surge in inquiries, providing better customer experiences that deliver quick and accurate responses. This has contributed to more user-friendly services with enhanced accessibility in personalized content that improve engagement.

E-Mart strategic implementation of AI chatbots represent a successful application of technology in industry in providing a better customer service. By leveraging Azure DevOps for development and deployment, E-Mart has established a more efficient communication channel that aligns with consumer expectations. This serves as an inspiring example for other organizations looking to enhance their customer service and efficient operations through technology.

V. CONCLUSIONS

This paper has provided a comprehensive overview of Microsoft Azure’s evolution and its current state as a leading cloud computing service. From the establishment of Windows Azure to its present Microsoft Azure, it has consistently expanded its addition to meet the needs of modern computing. The response that Azure had taken throughout the year of its revolution highlights the commitment to innovation and its foresight in embracing future technologies.

The case study of E-Mart’s implementation of AI chatbots illustrates the practical application in enhancing customer experience. The brave steps that E-mart have taken underscores the potential of Azure DevOps in the development and deployment phase. Microsoft's comprehensive suite of development tools, provided E-Mart with various platforms for managing the entire development process. Furthermore, Azure DevOps enabled E-Mart to adopt agile methodologies to produce a better collaboration among organizations and make a smoother efficient management.

As technology continues to evolve, Azure integration of diverse technologies and services make them a pivotal platform for any organization that seeks to leverage the power of cloud computing. Azure’s continued evolution and innovation will undoubtedly play a crucial role in driving technology adoption across industries.

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