Azure Adventures with C#

First Steps for C# Developers into Azure Cloud

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I want to dedicate this book to my wife, who has always supported me in my career and encouraged me to never stop learning and growing. Even if my ideas are crazy, she always believes in me and inspires me to follow my dreams.

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About the Author

Michał Świtalik is a Software Engineer with over eight years of experience. Since the beginning of his journey, he always loved to share his knowledge with others. He shares his knowledge through lectures inside his company, for students, or through blog posts and by being a mentor for trainees. Michał has diverse knowledge across Azure, SharePoint, and Microsoft 365 environments. He always loves to develop himself and doesn't avoid hard and complex solutions for his clients.

Currently working as a Principal Software Engineer at Volvo, Michał's main responsibilities are to provide secure and stable solutions for his company. He watches other team members to have the same standards in their projects. Additionally, he brings new technologies or ideas and improves ways of working to stay up to date.

Michał's Microsoft certifications include Azure Solutions Architect Expert and Azure Developer Associate.

About the Technical Reviewers

As a seasoned Full-Stack Engineer at Microsoft with over 12 years of industry experience, **Vamsi Krishna Devulapalli** brings a wealth of expertise in .NET development, Azure PaaS services, and front-end frameworks such as Angular and Vue.js. His current exploration into the latest GenAI technologies reflects his commitment to staying at the forefront of technological advancements.

Vamsi is also an avid technical book reviewer specializing in Azure PaaS services. His reviews are informed by hands-on experience and a deep understanding of cloud architecture and application development. He enjoys distilling complex technical concepts into accessible insights for fellow engineers and enthusiasts.

Beyond his professional endeavors, Vamsi indulges in travel and culinary adventures, finding inspiration in exploring new cultures and cuisines. This diverse set of interests enriches his perspective as a technical reviewer, allowing him to offer holistic evaluations that consider both technical depth and practical application.

Vamsi presents his insights into Azure and C# with a comprehensive review that delves into their practical relevance, technical rigor, and applicability in real-world scenarios.

Kasam Shaikh is a prominent figure in India's artificial intelligence landscape, holding the distinction of being one of the country's first four Microsoft Most Valuable Professionals (MVPs) in AI. Currently serving as a Senior Architect, Kasam boasts an impressive track record as an author, having authored five best-selling books dedicated to Azure and AI technologies. Beyond his writing endeavors, Kasam is recognized as a Microsoft Certified Trainer (MCT) and influential tech YouTuber (@mekasamshaikh). He also leads the largest online Azure AI community, known as DearAzure | Azure INDIA, and is a globally renowned AI speaker. His commitment to knowledge sharing extends to contributions to Microsoft Learn, where he plays a pivotal role.

Within the realm of AI, Kasam is a respected subject matter expert (SME) in generative AI for the cloud, complementing his role as a Senior Cloud Architect. He actively promotes the adoption of No-Code and Azure OpenAI solutions and possesses a strong foundation in hybrid and cross-cloud practices. Kasam Shaikh's versatility and expertise make him an invaluable asset in the rapidly evolving landscape of technology, contributing significantly to the advancement of Azure and AI.

In summary, Kasam Shaikh is a multifaceted professional who excels in both technical expertise and knowledge dissemination. His contributions span writing, training, community leadership, public speaking, and architecture, establishing him as a true luminary in the world of Azure and AI. Kasam was recently recognized as a LinkedIn Top Voice in AI, making him the sole exclusive Indian professional acknowledged by both Microsoft and LinkedIn for his contributions to the world of artificial intelligence!

Introduction

Being only a C# developer limits your opportunities in the job market. It is important to expand your skill set and knowledge in order to stay competitive. In this book, we will learn what Azure is and how to use it to enhance your development skills and open up new possibilities for your career.

I like to learn by looking at specific examples and seeing the results of my work in action without building a big project to see how to do it. In this book, you will find step-by-step instructions and a code.

I have also tried to give examples of the usage of all the components mentioned in the book so that you can easily apply the concepts to your own projects. You will be able to build an API, secure it, and deploy infrastructure. At the beginning of each chapter, I have tried to give a brief overview of what you would learn in that chapter. It is helpful for developers, architects, and project managers to understand the purpose and value of each concept before diving into the technical details.

Chapter 1 is an introduction to the Azure cloud platform and covers key concepts and benefits.

Chapter 2 shows how to build an API using Azure Functions with example scenarios.

Chapter 3 shows monitoring for your Azure environment using Application Insights.

Chapter 4 demonstrates how to work with Azure Storage and implement advanced features like blob storage, table storage, and file storage.

Chapter 5 shows how to use Event Grid to build event-driven applications and automate workflows.

Chapter 6 shows how to use Service Bus to build reliable messaging solutions and integrate applications across different services.

In Chapter 7, we will use SQL Server with Azure Functions.

In Chapter 8, we will use the Key Vault service to securely store and manage sensitive information and keys.

In Chapter 9, we will use Managed Identity to authenticate and authorize our applications to access Azure resources securely. We will also define some basic roles for the services and define their permissions and access levels accordingly using RBAC.

Chapter 10 shows how to integrate a virtual network into our Azure resources for increased security and isolation.

I am sure that after reading this book, you will be a better developer and can take full advantage of Azure's capabilities.

CHAPTER 1

Introduction to Azure

Cloud computing is a concept used to describe the distribution of computing services over the Internet, including networking, software, storage, databases, analytics, and artificial intelligence. Cloud computing can be chosen over on-premise solutions for several reasons, depending on the needs and goals of the organization. In this chapter, the main advantages of using cloud computing will be described.

One of the major benefits of cloud computing is that it eliminates the hardware maintenance overhead for individual organizations. Unlike on-premise solutions, where the organization has to purchase, install, and manage its own servers, storage devices, and network equipment, cloud computing allows the organization to access these resources as a service from a cloud provider. This means that the cloud provider is responsible for maintaining, upgrading, and securing the hardware, as well as providing technical support and troubleshooting. This can save the organization time, money, and resources, as well as reduce the risk of hardware failure or downtime. It also helps to mitigate the impact of both natural and man-made disasters, such as fires, earthquakes, deliberate equipment destruction, or theft.

Another advantage of cloud computing is that it enables the organization to create a data copy in different places, not only different countries but also different continents. This is also known as data redundancy or backup. Data redundancy is important for ensuring data availability and reliability, as well as protecting data from natural disasters, cyberattacks, or human errors. By using cloud computing, the organization

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can store its data in multiple locations across the globe and access it from any device or location. This can also improve the performance and speed of data access, as well as comply with data regulations and laws in different regions.

A third advantage of cloud computing is that it offers easily scalable services. Scalability refers to the ability of a system to adapt to increasing or decreasing demand for resources. Cloud computing provides scalability by allowing the organization to adjust its resource usage according to its needs. For example, if the organization experiences a spike in traffic or workload, it can easily increase its cloud capacity by adding more servers, storage, or bandwidth. Conversely, if the organization experiences a drop in demand, it can reduce its cloud usage and save costs. This way, cloud computing can help the organization optimize its performance and efficiency, as well as avoid overprovisioning or underutilization of resources. Developers and architects need to be vigilant on the scaling of cloud resources and ensure that only the required amount of resources is provisioned to avoid unnecessary costs.

SaaS, PaaS, IaaS

It is worth knowing that there are three different layers in cloud computing. Some of the layers may require more work to maintain and develop a complex solution. This depends on the requirements for the solution; it will increase or decrease the amount of job and price required to create software for the business. So it is crucial to choose the correct layer for the specific solution. There are three layers: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS).

With the Software as a Service (SaaS) delivery model, customers can access cloud-hosted apps online. SaaS applications are usually subscription based or pay per use and do not require installation or maintenance by the users. Examples of SaaS applications are Microsoft 365 applications (which include Teams, Word, and SharePoint), Dynamics 365, and Power BI.

Developers can create, test, deploy, and manage applications on a platform provided by PaaS (Platform as a Service) in the cloud without worrying about the cloud hardware. PaaS offers tools and frameworks for various programming languages, databases, and web servers. Examples of PaaS services are Azure App Service, Azure Functions, Event Grid, Service Bus, and Azure SQL Database.

IaaS is a cloud layer that provides basic computing resources, such as servers, storage, network, and virtualization. IaaS allows users to have full control and flexibility over their infrastructure, but also requires more responsibility for security, backup, and maintenance. Examples of IaaS services are Azure Virtual Machines, Azure Storage, and Azure Virtual Network.

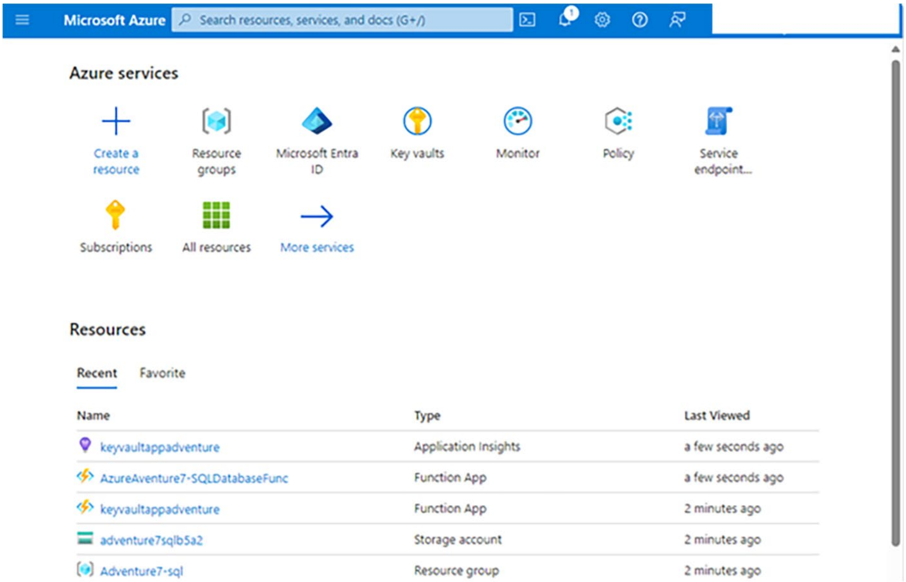
The amount of work required to maintain or create an application or solution in each layer depends on the level of abstraction and customization. SaaS offers the highest level of abstraction and the lowest level of customization, meaning that users do not have to worry about the infrastructure or the platform, but also have limited options to modify the application. PaaS offers a balance between abstraction and customization, meaning that users can focus on the application logic and features, but also have some control over the platform configuration. IaaS offers the lowest level of abstraction and the highest level of customization, meaning that users have to manage everything from the infrastructure to the application, but also have the most freedom to customize their solution.

Azure Portal

The Azure Portal is a web-based application that allows users to access and manage various Azure services and resources. Users can create, configure, monitor, and troubleshoot cloud applications and infrastructure using either a command-line interface (CLI) or a graphical user interface (GUI). Some of the tasks that can be done in the Azure Portal include

- Creating and deploying virtual machines, containers, web apps, databases, and other cloud services
- Managing subscriptions, billing, and resource groups
- Setting up identity and access management (IAM), role-based access control (RBAC), and security policies
- Checking up on the availability, performance, and health of cloud apps and resources
- Troubleshooting issues using diagnostics tools, logs, and alerts
- Integrating with other Azure services and third-party tools

The Azure Dashboard from Figure 1-1 is a highly adaptable interface that enables users to generate and oversee diverse lists and visual representations of their resources, including resource groups and functions. The dashboard may be accessed by users using the Azure Portal, enabling them to customize its settings and configurations based on their individual tastes and requirements. The dashboard has the capability to present information from the monitor as well as other statistical measures, including metrics, alarms, logs, and health status. Through the utilization of the dashboard, individuals can obtain a concise summary of their resources and effectively track their performance and accessibility.



Name	Type	Last Viewed
keyvaultappadventure	Application Insights	a few seconds ago
AzureAventure7-SQLDatabaseFunc	Function App	a few seconds ago
keyvaultappadventure	Function App	2 minutes ago
adventure7sqlb5a2	Storage account	2 minutes ago
Adventure7-sql	Resource group	2 minutes ago

Figure 1-1. *Azure Portal*

The dashboard has been intentionally built to possess a high degree of flexibility and user-friendliness, allowing users to personalize it by incorporating various widgets, layouts, filters, and themes. Individuals have the ability to incorporate widgets into their interface by either selecting from a preexisting collection or generating their own using JSON or ARM templates. Widgets have the capability to exhibit several forms of data, including charts, tables, maps, photos, or text. Users have the ability to modify the size, position, or removal of widgets according to their preferences. The dashboard possesses the capability to accommodate many tabs, hence enabling users to systematically categorize their widgets into various groupings or situations. Additionally, users have the capability to distribute their dashboards to other users or convert them into PDF format.

The Azure Portal also provides the availability to open Cloud Shell. In order to run it, you will need to create or use any existing Account Storage. It can run any of the Azure CLI command in order to manage, create, or delete resources or permissions. More about the Azure CLI will be described later in this chapter.

Azure Resources

Azure is a cloud computing platform that offers a variety of services and solutions for different needs. One of the key concepts to understand when working with Azure is how its resources are structured and organized. In this section, we will explain the four main levels of the Azure resource hierarchy: management groups, subscriptions, resource groups, and resources. The relation is shown in Figure 1-2.

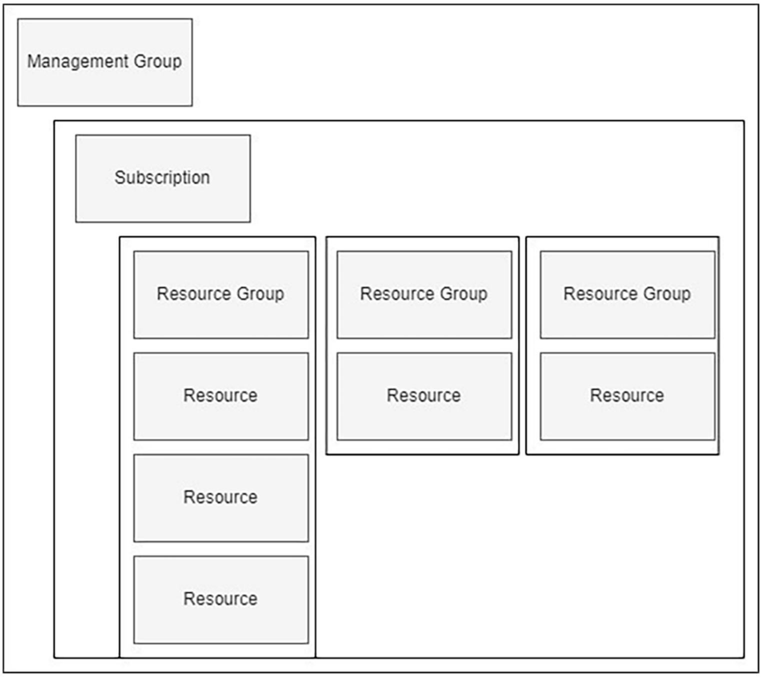


Figure 1-2. *Microsoft Azure resource hierarchy*

Management groups in Azure have the highest level of scope above subscriptions. They are containers that help organize subscriptions and resources into hierarchies, allowing for more efficient management of access, policies, and compliance across multiple subscriptions. With the management groups, you can apply policies and access controls across multiple subscriptions simultaneously. This structure is particularly useful for large organizations with complex resource arrangements, as it simplifies governance and provides a clear hierarchy for managing various subscriptions and resources. For instance, you can assign different levels of access and permissions to different teams or departments within the organization or limit regions of resources based on compliance requirements. A subscription is the second level of the Azure resource hierarchy. It is a logical container that holds all the Azure services, data, and applications that you use. A subscription is associated with a billing account, which determines how you pay for the Azure services you consume. You can have multiple subscriptions under one billing account, and you can use them to separate different environments, projects, or teams.

A resource group is the second level of the Azure resource hierarchy. It helps to logically place the resources together that are similar in terms of life cycle, access, and policies. It can contain resources from different Azure services, such as virtual machines, databases, storage accounts, web apps, etc. A resource group helps you manage, monitor, and deploy your resources as a unit. You can have multiple resource groups under one subscription, and you can use them to organize your resources by function, location, or any other criteria.

A resource is the lowest level of the Azure resource hierarchy. It is an individual instance of an Azure service or application that you create and use. For example, a virtual machine, a database, a network interface, etc., are all resources. A resource has a unique name and ID within its resource group, and it has properties and settings that you can configure and modify. You can have multiple resources under one resource group, and you can use them to perform specific tasks or functions.

How to Create Resources

You can use Bicep, Azure Portal, Azure CLI, or another library to build a resource in the Azure cloud. These are the widely utilized methods in modern solutions for creating and managing all resources. Bicep and Azure CLI are easy to use and can be easily integrated with continuous deployment pipelines to create or update many environments and resources at once.

In order to create a resource group, follow these steps:

- Go to `www.portal.azure.com`.

- Log in, if you have to – start with a new subscription.
- Click the Create a resource tile.
- A Marketplace will open up with all available resources.
- Search for Resource Group and click Create.
- Decide which subscription to choose, enter a new resource group name, select Region, then click the Review + create button.
- Click the Create button, and you can go now to your newly created resource group.

After these steps, you will have created a resource group. Inside it, you can create many resources like Azure Function, SQL Server, Storage Account, and many, many more resources. Microsoft is expanding its cloud with more features every year. You can easily find a suitable resource for your solution and create, configure, and manage it in the future.

Pricing

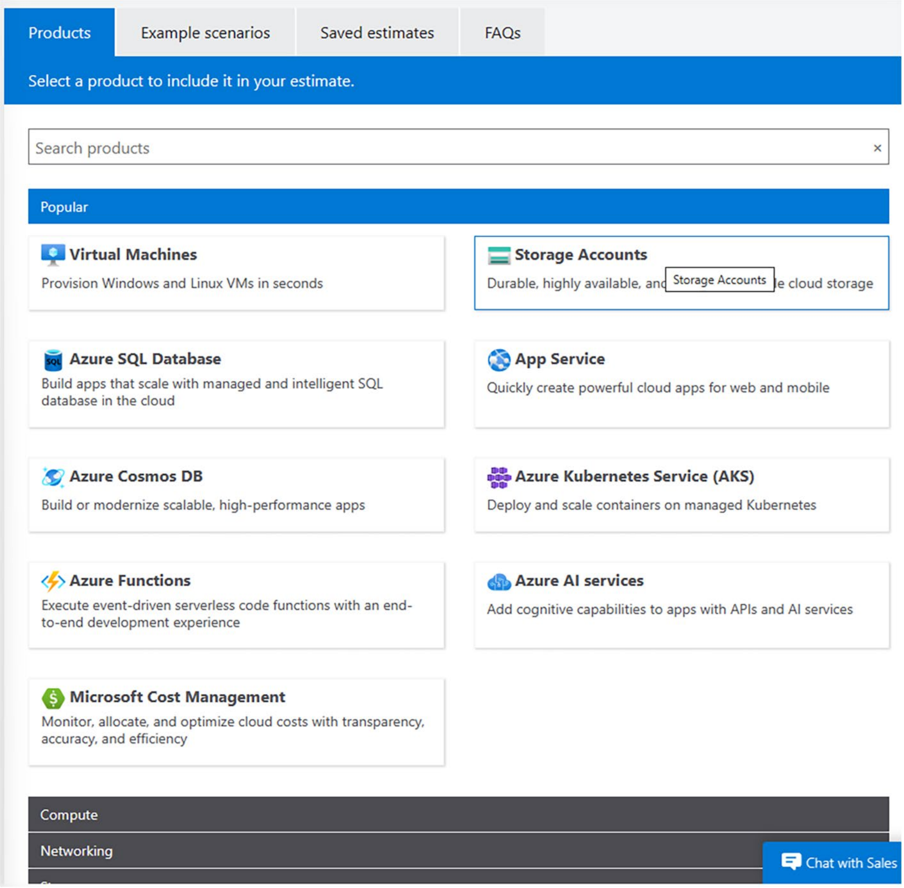
It is always difficult to estimate the total cost of resources that your solution will require in order to comply with all required and gathered business requirements. You can estimate the Azure pricing with the following options:

- Use the pricing calculator to find out how much cost the Azure services would incur on an hourly or monthly basis. You can customize the parameters, choose the services you require, and view the anticipated cost. Additionally, you may export your estimate as a PDF file and compare costs with those of different cloud providers.

- Acquire knowledge pertaining to the several procurement alternatives available for Microsoft Azure. There are two payment options available: pay-as-you-go and prepayment for reserved instances. The pay-as-you-go option allows users to pay solely for the resources they utilize. On the other hand, prepaying for reserved instances entails committing to a specific duration of usage, either one or three years, in exchange for discounted rates. Individuals can also derive advantages from exclusive promotions, incentives, and initiatives that have the potential to reduce their expenses.
- Please evaluate the cost information pertaining to each Azure service and its corresponding features. The pricing table for each service can be located on either its respective product page or the Pricing Details page. The pricing table displays the unit price for each service, denoted by metrics such as hourly rates, gigabyte charges, or per-request fees. The pricing structure is subject to variation based on factors such as geographical location, service tier, and performance level.
- The utilization and expenditure of resources can be effectively tracked and managed through the utilization of Azure Cost Management and Billing capabilities. Users have the ability to access their billing account, where they may monitor invoices and payments, evaluate expenses based on specific services or resource groups, establish budgets and alerts, and optimize expenditure through the utilization of recommendations.

- This tool aims to investigate the sophisticated methodologies for cost estimation utilizing Azure tools and resources. The Total Cost of Ownership (TCO) Calculator can be utilized to do a comparative analysis of the expenses associated with operating applications either on-premises or on other cloud platforms, such as AWS or Google Cloud. The Azure Pricing API can be utilized to programmatically retrieve the most up-to-date pricing data for all Azure services. The Azure retail price sheet can be downloaded to get the pricing information for all Azure regions and currencies.

In Figure 1-3, the screenshot displays the pricing calculator that Microsoft offers to its customers in order to provide an estimate of the future expenses of Azure resources. It is possible to select a number of resources all at once, and those resources may be altered and adjusted according to the needs of the solution. You can also find many configuration examples for Azure cloud in the next tab. These examples will show you the various types of configurations that are available.



Select a product to include it in your estimate.

Virtual Machines
Provision Windows and Linux VMs in seconds

Storage Accounts
Durable, highly available, and Storage Accounts e cloud storage

Azure SQL Database
Build apps that scale with managed and intelligent SQL database in the cloud

App Service
Quickly create powerful cloud apps for web and mobile

Azure Cosmos DB
Build or modernize scalable, high-performance apps

Azure Kubernetes Service (AKS)
Deploy and scale containers on managed Kubernetes

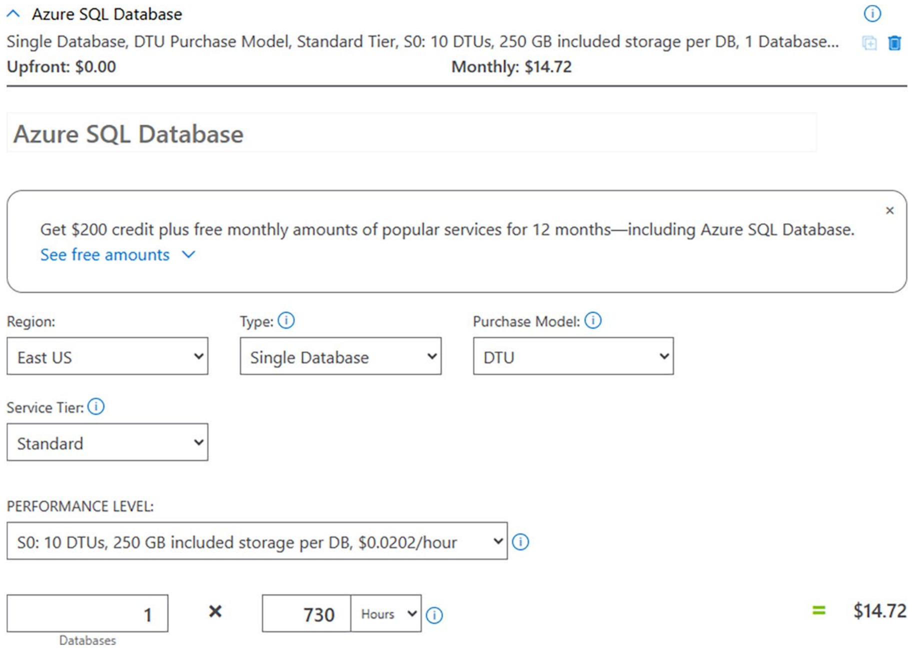
Azure Functions
Execute event-driven serverless code functions with an end-to-end development experience

Azure AI services
Add cognitive capabilities to apps with APIs and AI services

Microsoft Cost Management
Monitor, allocate, and optimize cloud costs with transparency, accuracy, and efficiency

Figure 1-3. *Total Cost of Ownership screenshot*

During selection, it might be strange that some resources can be displayed with high cost at the beginning, for example, the default Azure SQL Database with vCore, which can cost up to $375, as shown in Figure 1-4. However, most small projects do not need such big size and fast data center. If the solution is being used by limited users, it is worth considering the appropriate Database Transaction Unit (DTU) model and choose 100 or even 10 DTUs.



Azure SQL Database

Single Database, DTU Purchase Model, Standard Tier, S0: 10 DTUs, 250 GB included storage per DB, 1 Database...

Upfront: $0.00 Monthly: $14.72

Azure SQL Database

Get $200 credit plus free monthly amounts of popular services for 12 months—including Azure SQL Database.

See free amounts

Region: East US

Type: Single Database

Purchase Model: DTU

Service Tier: Standard

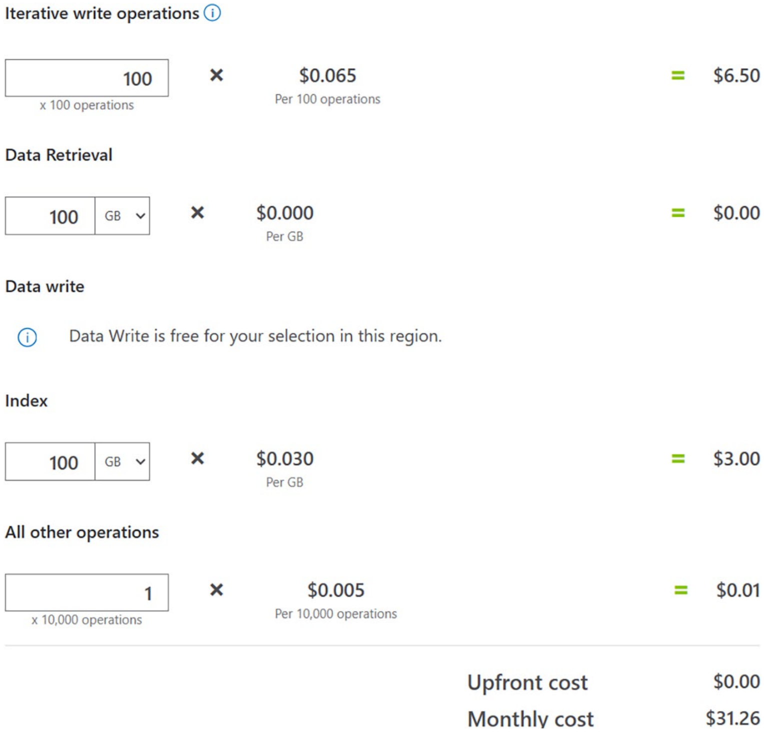
PERFORMANCE LEVEL: S0: 10 DTUs, 250 GB included storage per DB, $0.0202/hour

1 Databases × 730 Hours = $14.72

Figure 1-4. *Azure SQL Database price example*

The price also depends on the region, so it is worth checking other regions as well, if it is not critical or required to create them in this specific data center.

For a small project example, we may select using Account Storage to store files, we assume we use only 100GB for data retrieval and index, and we do around 10,000 operations in a month; it may cost only $32. Example costs are shown in Figure 1-5.



Iterative write operations ⓘ

100 x 100 operations × $0.065 Per 100 operations = $6.50

Data Retrieval

100 GB × $0.000 Per GB = $0.00

Data write

ⓘ Data Write is free for your selection in this region.

Index

100 GB × $0.030 Per GB = $3.00

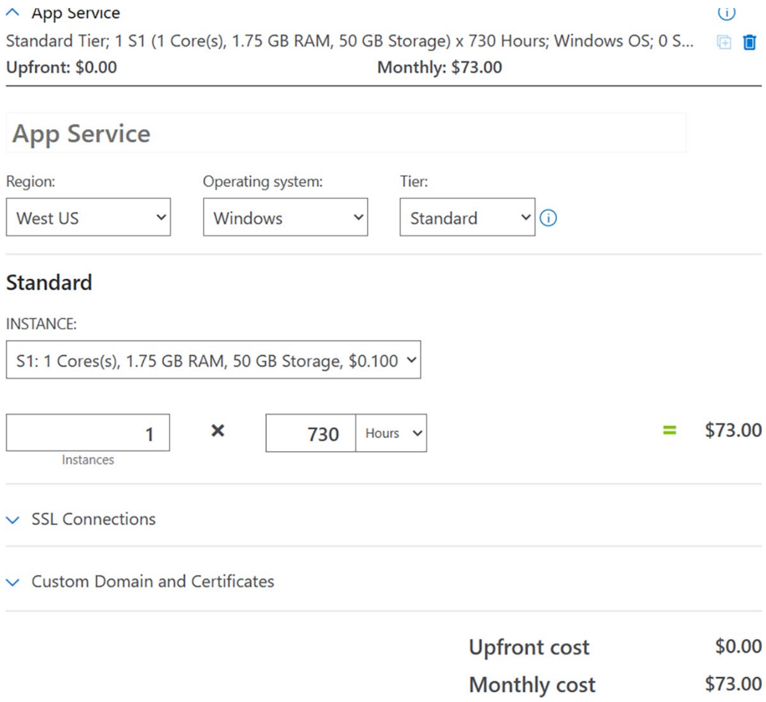
All other operations

1 x 10,000 operations × $0.005 Per 10,000 operations = $0.01

Upfront cost	$0.00
Monthly cost	$31.26

Figure 1-5. *Azure Storage cost example*

Then we add the Azure Function with the Consumption tier. We assume we won't have more than 1,000,000 requests to the API per month – it might be free. On the other hand, hosting the Azure Function on the Standard tier of the App Service plan may cost $73, as shown in Figure 1-6. It is worth noting that the Premium tiers have more features for more complex and advanced solutions. The App Service plan can host many applications.



App Service

Standard Tier; 1 S1 (1 Core(s), 1.75 GB RAM, 50 GB Storage) x 730 Hours; Windows OS; 0 S...

Upfront: $0.00 Monthly: $73.00

App Service

Region: West US

Operating system: Windows

Tier: Standard

Standard

INSTANCE: S1: 1 Cores(s), 1.75 GB RAM, 50 GB Storage, $0.100

1 Instances × 730 Hours = $73.00

SSL Connections

Custom Domain and Certificates

Upfront cost $0.00

Monthly cost $73.00

Figure 1-6. *App Service cost example*

Last but not least, the cost of selecting a SQL Database instance that has only 20 DTU units could be close to $30. The total amount that will be spent each month on the project comes to approximately $134. Naturally, this is just one possible outcome for a straightforward and not complex project. The Azure platform pricing calculator can be found at this URL: `https://azure.microsoft.com/en-us/pricing/calculator/`.

Azure CLI

In addition to the website, a command-line tool can also be used to manage Azure resources. This can be useful for developers or administrators to automate daily tasks, perform operations, or manage resources. You can create and manage Azure resources using the Azure CLI, which is a set of commands. It may be accessed via Docker, Windows, macOS, Linux, and Azure Cloud Shell. You can install Azure CLI by following instructions for your operating system from this link: `https://learn.microsoft.com/en-us/cli/azure/install-azure-cli`. To use Azure CLI, you need to sign in with your Azure account credentials using the command az login.

Azure CLI has many modules that correspond to different Azure services. You can list all the available modules using the command az --help. Some of the modules that are useful for this book are as follows:

- az functionapp – This module is allowing to create, manage, and deploy Azure functions, which are serverless applications that run on demand in response to events.
- az network – This module is allowing to create, manage, and configure Azure virtual networks (vnets), which are isolated networks that connect your Azure resources and provide secure communication.
- az keyvault – This module is allowing to create, manage, and access Azure key vaults, which are secure storage for your secrets, keys, and certificates.
- az group – This module is allowing to create, manage, and delete Azure resource groups, which are logical containers for your Azure resources that help you organize and manage them.
- az bicep – This module is allowing to create, build, and deploy Azure Resource Manager (ARM) templates using Bicep language, which is a declarative syntax for describing your Azure resources.