I'm not a robot

I have been working with couple of applications built with CosmosDB and one of the things that surprised me was one cannot clear all documents in a collection from the Azure web portal or using the Storage Explorer. As I was struggling to do this while doing some tests on the application I decided to write a blog on the solution I used. There are two ways to achieve the same Using a stored procedureUsing Cosmosdb SDK I came up with a script in Node which can be done with any of the programming languages such as C#,Python supported by the SDK Let's go through the steps: Step 1: Open VScode and Create a file named cosmosdb_helper.js Step 2: Let's install the necessary packages needed. Install documentdb javascript sdk with the following command, npm i documentdb and you will see the output as follows Let's install require to handle the dependencies with the following command, npm i require and you will see the output as follows, Step 3: Let's do some coding. You will be able to understand the following code with the comments added on each line, Suppose if you have partitionKey created with your collection, you need to pass queryoptions with the partitionKey in selectAll as well as deletDocument as follows, Step 4: Let's run the script and see the output, You can run the helper script as follows, if you want to list all documents in the collection, node cosmosdb_helper.js selectAll which will list the output of all documents in the collection. If you want to delete all documents within a collection, you can run the script as, node cosmosdb_helper.js deletAll which will remove all documents in the collection. As mentioned above, 2nd way is to use the stored procecure given by Microsoft employee as mentioned here. Hope the helper script will help someout out there in order to delete all documents in a collection. You can get the whole code from Cosmosd_Helper Azure Cosmos DB is a database service that is globally distributed. It allows you to manage your data even if you keep them in data centers that are scattered throughout the world. It provides the tools you need to scale both global distribution pattern and computational resources, and these tools are provided by Microsoft Azure.Azure Storage offers a NoSQL key-value store for semi-structured data. Unlike a traditional relational database, each entity (such as a row — in relational database terminology) can have a different structure, allowing your application to evolve without downtime to migrate between schema.Food For ThoughtIf your application runs for multiple years. It accumulates lot of data documents on cosmos which are no longer useful. Therefore, we need a way to clean up the obsolete data documents. In this post, let us look at the way to write a stored procedure on cosmos DB for bulk delete and call it using the ASP.NET Core.Citation Note: The bulk delete stored proc is being used from the from Azure documentation. Thanks to Andrew LiuSteps to create stored procRight click on the stored procedure folder to create and give it a proper nameI named the proc as BulkDelete. This is how it looks after creating a proc.NOTE : Stored Procedures on Cosmos are written in JavaScriptStored procedure to bulk delete.Here is the Gist of codeBulk delete proc expects the query which gives it the bulk documents to delete from. Just pass in the query to proc. It will delete the documents.Note: If your collection is partitioned. Then it expects the partition key value to be passed to it. Again, it expects the value not the key name that it is partitioned with.Now we have the proc ready to delete the documents. Lets see how to use it on .NET .If you follow the repository design pattern in your application. Create a method inside the repository and later call it in service.Link for the gistFirst, we have to open the connection by using statement. The using statement is actually a syntactic convenience. At compile time, the language compiler implements the intermediate language (IL) for a try/catch block. To connect, we have to use DocumentClient Class from Microsoft.Azure.Documents. This Client has all the methods to create document, query for documents etc. More documentation for document client class can be found here.Now you connected to the database on the cosmos. Next step is to know where the proc is in that database. So, we can use the CreateStoredProcedureQuery to get proc. This method takes in URI of the database and collection ID, stored proc name and other feed options(we need these during cross partition querying). And, it returns the Query result of type IQueryable.After we have the proc. We can call ExecuteStoredProcedureAsync on document client class to execute the proc. This method takes in the GUID of the proc and NOT the proc name. We will have access to the GUID from the createstoredprocquery method we wrote previously, which is stored in sprocLink variable. How to use the GUID from it? there is property on it '_self' we can pass in sprocLink._self and what ever inputs the proc takes.NOTE: If you have the partition keys on your collection, you should query for the partition keys and pass in the partition key as the request options for the proc. (Let me know if there is any other optimal solution, I'm open to learn.)ConclusionIn this post, we learnt how to write the stored procedures on Azure Cosmos and also how to integrate and use the procedures on .NET.Thank you for reading the post,Something somewhere incredible is waiting to be known! If you are already working on building an Azure Data Engineering solution using Azure Data Factory as an orchestration tool and Azure Cosmos DB in a scenario where you may have to delete documents from a particular SQL container programmatically, then you might have already figured out that there is no easy way to do it.Azure Data Factory, out of the box, provides only data movement activities to/from Cosmos DBData Factory does not (yet) have the activities to execute Cosmos DB stored procedures or delete documents within a SQL container.This post is an attempt to help all the Azure data engineers who love to play with data in Cosmos DB using ADF.Before we dive deep down into the how to, I am assuming that you already know how to provision Azure Data Factory, Azure Cosmos DB (SQL API) and Azure Logic Apps. If not, it's pretty easy to get started.High Level workflow to get this doneCreate a stored procedure in the Cosmos DB container that runs a select query and deletes the required data. There's an excellent git hub source (here) that tries to bulk delete documents in a container and it only makes sense to reuse the code and modify it to your needs.Configure an Azure Logic App to execute the stored procedure when an HTTP request is received.Configure a Data Factory pipeline to use the web activity to invoke the Logic App.Create and Setup sproc in Cosmos DBWe need this stored procedure to bulk deletes documents for a given queryAs an example, I will use some sample data in the container with 'ProductID' as the partition keyCreate a stored procedure, Let's name it as 'BulkDelete. We will try to delete data from partition key value {"ProductID" : "715"}The response of the sproc when executed would be something similar to below. we will use this response to determine if all the documents were deleted for the given query.{ "deleted": 0, "continuation": false } * deleted - contains a count of documents deleted
* continuation - a boolean whether you should execute the sproc again Configure Azure Logic App to invoke the stored procedureOpen the Logic Apps Designer and select the Blank logic app templateAdd the trigger "When a HTTP request is received"Add a New step and Chose "Execute stored procedure" actionBrowse current subscription and connect to the cosmos db. Enter 'Database ID', 'Collection ID', 'Sproc ID', 'Partition key value', 'parameters'Add a new step "Response" request action and add dynamic content in the Body. This body will return the response of the sproc when executed (refer to the response sample above)Now save the app. After saving, a HTTP POST URL will be generated in the trigger, copy that URL for usage in ADFBuild Azure Data Factory PipelineProvision an Azure Data Factory Service and create a pipelineTo run the logic app from Azure Data Factory we have to send a HTTP request to the app and this is possible using the web activity.You may need to execute BulkDelete sproc multiple times (depending whether the sproc is able to delete every document within the execution timeout limit)To ensure we delete all the documents, we will run this web activity inside an Until activity till the condition (response of sproc should be "deleted : 0") is metAdd an Until activity to the pipeline and name it "UntilAllDocsDeleted"Add a Web activity inside the Until activity and name it "Delete"Paste the URL copied from logic app in the settings of the web activity, use the POST method and the body contains {}Now let's add the condition in the Until activity so that web activity executes multiple times till the condition is met.@equals(0,activity('Delete').output.deleted) Now you can publish the pipeline and run it.Validate the pipelineBefore we run the pipeline, let's get the count of the documents in the container for ProductID = 715Start the pipeline and observe the execution if all documents are deleted within execution time or the sproc is required to run multiple times to delete all.As you can see, the delete activity is executing multiple times as the first delete activity was able to delete only 624 records within the execution time. It will continue to execute till the deleted : 0To be sure, check the count in the Cosmos DB data explorer after successful execution of the pipelineWhile there are many ways to delete documents through Azure Data Factory such as using Azure Functions or using custom activities, I found using Logic App was the simplest of all.Hope this helps you! Cosmos is Microsoft's NoSQL database offering on the Azure Cloud platform. If your application data needs are relatively simple, then Cosmos is an excellent choice.Scenario and motivation for this articleYou have a Customers collection. You want to delete all records using a simple DELETE statement. Sorry, thats not possible. Cosmos does not support DELETE statements.Wish list!! This does not workLack of support for DELETE and UPDATEUnfortunately Cosmos does not support the DELETE statement. In a traditional SQL world you would have done the following:DELETE FROM Customers c WHERE c.Country="USA"Why is this a problem?You now need to write some custom code! Yes! This would have been a one-liner in RDBMS world. But for Cosmos, this entails significant code writing.Option 1 — Javascript stored proceduresCosmos supports stored procedures stored proc for bulk deletionHow to execute a stored procedure?Drawbacks with stored procedures?I find them hard to develop and debugDifficult to automate the execution of Cosmos stored proces via CI/CDOption 2 — PowerShell to the rescueFortunately, the community has come to the rescue. Here is a very cute PowerShell module that interacts with Cosmos via the REST interfaceWiki documentation on various cmdletsHow to install the module?I always recommend using the CurrentUser scope. This is the path of least resistance.Install-Module -Scope CurrentUser -Name CosmosDBExample JSON{"id": "1002","firstName": "John1002","lastName": "Doe1002"}This will delete all records in the specified Cosmos collection. Useful in a dev-test scenario. You want to clean up the dev-test system to be free of any noisy data that might have crept in from previous test runs.Set-StrictMode -Version "latest"Clear-Host. $PSScriptRoot\common.ps1Write-Host "Getting Cosmos context"$CosmosContext=New-CosmosDbContext -Database $Global:CustomersManagementDatabase -ResourceGroupName $Global:CosmosResourceGroup -Account $Global:CosmosAccountNameWrite-Host ("Got Cosmos context for Cosmos account: '{0}' and database: '{1}'" -f $CosmosContext.Account, $CosmosContext.Database)function GetAllDocuments {#Remember to include Partition key path in field list$allDocs = Get-CosmosDbDocument -CollectionId $Global:CustomersMasterContainer -QueryEnableCrossPartition $true -Query "SELECT c.id FROM c" -Context $CosmosContextif ($null -eq $allDocs){return ,@()}return $allDocs}function DeleteDocuments {param ($documents)foreach ($doc in $documents) {#Remember to specify Partition keyRemove-CosmosDbDocument -Context $CosmosContext -CollectionId $Global:CustomersMasterContainer -Database $Global:CustomersManagementDatabase -Id $doc.id -PartitionKey $doc.id}}$documents=GetAllDocumentsWrite-Host ("Found {0} documents in the Container {1}" -f $documents.length,$Global:CustomersMasterContainer)DeleteDocuments -documents $documentsWrite-Host "Deletion complete"Scenario — Seed a Collection with documentsThis will pre-populate a Collection with JSON documents. This is helpful when you want to prepopulate your dev-test database with good quality baseline dataSet-StrictMode -Version "latest"Clear-Host. $PSScriptRoot\common.ps1Write-Host "Getting Cosmos context"$CosmosContext=New-CosmosDbContext -Database $Global:CustomersManagementDatabase -ResourceGroupName $Global:CosmosResourceGroup -Account $Global:CosmosAccountNameWrite-Host ("Got Cosmos context for Cosmos account: '{0}' and database: '{1}'" -f $CosmosContext.Account, $CosmosContext.Database)$jsonFiles=Get-ChildItem -Path $PSScriptRoot\json\ -Filter *.json -RecurseWrite-Host ("Found {0} json files" -f $jsonFiles.Length)foreach ($jsonFile in $jsonFiles) {$docContents=[system.io.file]::ReadAllText($jsonFile)$jsonObject=$docContents | ConvertFrom-JsonNew-CosmosDbDocument -Context $CosmosContext -CollectionId $Global:CustomersMasterContainer -DocumentBody $docContents -PartitionKey $jsonObject.idWrite-Output "Created document from file $jsonFile"}Advantages of PowerShell approach over Stored procesEasy to debug. All you need is Visual Studio Code and PowerShell CorePowerShell core is cross OSVery easy to automate via CI/CD.You will find accompanying PowerShell scripts in this repo: to run the accompanying PowerShell scripts?Clone this repositoryNavigate to the folder which contains this README.MD fileLaunch PowerShell CoreEnsure you have the core modules installedChange the variables in Common.ps1 to point to your Cosmos accountCreate a Cosmos account by runnning the script CreateCosmos.ps1Create a database and a collection (refer variables in Commons.ps1)Run PopulateCollection.ps1 You should now see 2 documents createdPurge all documents in the containerRun DeleteAllRecords.ps1PowerShell modules neccessaryAz.AccountsAz.ResourcesAz.CosmosDbCosmosDbChange the following variables in the file Common.ps1 to suit your environment.Set-StrictMode -Version "2.0"$ErrorActionPreference="Stop"$Global:CosmosResourceGroup="rg-demo-cosmos-serverless"$Global:CosmosAccountName="saudemocosmosserverless"$Global:CustomersManagementDatabase="CustomerManagement"$Global:CustomersMasterContainer="customers"$Global:Location="uksouth" While working on a project, I came across a use case to bulk delete documents in Azure Cosmos DB Container using Azure Data Factory (ADF). There are few approaches, however it mainly involves either implementing a stored procedure or a function. This article provides the steps to implement bulk delete of documents in Cosmos DB entirely in a ADF flow. Azure Cosmos DB SQL API has a large quantity of documents. The Azure Data Factory pipeline requires to bulk delete documents before loading new set of documents Access to Azure CloudA data source, either a csv file or excel file with the dataA data sink, Cosmos DB SQL API instanceADF pipeline that extracts the source, transforms the data from the source and loads into Cosmos DB sink i. Add source pointing to the Cosmos DB container that has records to be deleted ii. Go to the 'Source options' for the source and select 'Query' so you can enter the SQL query that will retrieve the documents to delete. In the example here, I am selecting all 3 bedroom home listing so those can be deleted from Cosmos DB iii. Add 'Alter Row' transformation to the source and go to 'Alter row settings'. Select 'Delete if' under 'Alter row conditions' and enter 'true()' in the expression iv. Add sink pointing to the same Cosmos DB container v. Go to sink settings and select 'Allow delete' under 'Update method'. If Cosmos DB has a large set of documents to delete, provide 'Batch size' to split the deletion To bulk delete documents in Azure Cosmos DB, Azure Data Factory provides easier approach because the flow is entirely in the data factory and it does not call external stored procedures or functions. This also allows better control over the data flow and provides better troubleshooting mechanism in case of any errors , the free encyclopedia that anyone can edit. 117,922 active editors 6,999,732 articles in English The first UK Phantom on a test flight in 1968 From 1968 to 1992, the United Kingdom used the McDonnell Douglas F-4 Phantom II as one of its principal combat aircraft. The Phantom was procured to serve in both the Royal Navy's Fleet Air Arm and the Royal Air Force (RAF) in several different roles. Most Phantoms operated by the UK were built as a special batch containing a significant amount of British technology. Two variants were initially built: the F-4K was a carrier-based air-defence interceptor for the Fleet Air Arm, while the F-4M was initially used by the RAF for tactical strike and reconnaissance, before transitioning to an air defence role in the 1970s. In the mid-1980s, a third Phantom variant was obtained when fifteen former US Navy F-4J aircraft were purchased to augment the UK's air defences. Although the Fleet Air Arm ceased using the Phantom in 1978, the RAF retained it until 1992, when it was withdrawn as part of a series of post-Cold War defence cuts. (Full article...) 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Ongoing: Gaza war M23 campaign Russian invasion of Ukraine timeline Sudanese civil war timeline Recent deaths: Charles Rangel Jim Irsay Yury Grigorovich Yuri Vladimirov Colton Ford Werenoi Nominate an article May 27 Manchu Prince Dorgon 1644 – Manchu regent Dorgon (depicted) defeated rebel leader Li Zicheng of the Shun dynasty at the Battle of Shanhai Pass, allowing the Manchus to enter and conquer the capital city of Beijing. 1799 – War of the Second Coalition: Austrian forces defeated the French Army of the Danube, capturing the strategically important Swiss town of Winterthur. 1954 – The security clearance of American nuclear physicist J. Robert Oppenheimer, head of Project Y, was revoked. 1967 – Australians voted overwhelmingly to include Indigenous Australians in population counts for constitutional purposes and to allow the federal government to make special laws affecting them in states. 1997 – A destructive F5-rated tornado tracked through a subdivision of homes northwest of Jarrell, Texas, killing 27 people. Diego Ramírez de Arellano (d. 1624)Julia Ward Howe (b. 1819)Cilla Black (b. 1943)Gérard Jean-Juste (d. 2009) More anniversaries: May 26 May 27 May 28 Archive By email List of days of the year About Anemonoides blanda, the Balkan anemone, Grecian windflower, or winter windflower, is a species of flowering plant in the family Ranunculaceae. The species is native to southeast Europe and the Middle East. It grows up to 10 to 15 centimetres (4 to 6 inches) tall and is valued for its daisy-like flowers, which appear in early spring, a time when little else is in flower. The flowers are found in various colors and are radially symmetrical, containing seven or more sepals and petals. This purple A. blanda flower was photographed in Bamberg, Germany. Photograph credit: Reinhold Möller Recently featured: Bluespotted ribbontail ray Black Lives Matter art Germanicus Archive More featured pictures Community portal – The central hub for editors, with resources, links, tasks, and announcements. Village pump – Forum for discussions about Wikipedia itself, including policies and technical issues. Site news – Sources of news about Wikipedia and the broader Wikimedia movement. Teahouse – Ask basic questions about using or editing Wikipedia. Help desk – Ask questions about using or editing Wikipedia. Reference desk – Ask research questions about encyclopedic topics. Content portals – A unique way to navigate the encyclopedia. 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Unsourced material may be challenged and removed.Find sources: "1644" – news · newspapers · books · scholar · JSTOR (August 2016) (Learn how and when to remove this message) Calendar year Years Millennium 2nd millennium Centuries 16th century 17th century 18th century Decades 1620s 1630s 1640s 1650s 1660s Years 1641 1642 1643 1644 1645 1646 1647 vte July 1: The Battle of Colberger Heide is fought between Sweden and Denmark-Norway off of the German coast. July 2: Parliament wins control of northern England from King Charles in the Battle of Marston Moor. 1644 by topic Arts and science Architecture Art Literature Music Science Leaders State leaders Colonial governors Religious leaders Birth and death categories Births – Deaths Establishments and disestablishments categories Establishments – Disestablishments Works category Works vte 1644 in various calendarsGregorian calendar1644MDCXLIVAb urbe condita2397Armenian calendar1093ԹՎ ՌՂԳAssyrian calendar6394Balinese saka calendar1565–1566Bengali calendar1050–1051Berber calendar2594English Regnal year19 Cha. 1 – 20 Cha. 1Buddhist calendar2188Burmese calendar1006Byzantine calendar7152–7153Chinese calendar癸未年 (Water Goat)4341 or 4134 — to —甲申年 (Wood Monkey)4342 or 4135Coptic calendar1360–1361Discordian calendar2810Ethiopian calendar1636–1637Hebrew calendar5404–5405Hindu calendars - Vikram Samvat1700–1701 - Shaka Samvat1565–1566 - Kali Yuga4744–4745Holocene calendar11644Igbo calendar644–645Iranian calendar1022–1023Islamic calendar1053–1054Japanese calendarKan'ei 21 / Shōhō 1(正保元年)Javanese calendar1565–1566Julian calendarGregorian minus 10 daysKorean calendar3977Minguo calendar268 before ROC民前268年Nanakshahi calendar176Thai solar calendar2186–2187Tibetan calendar阴水羊年(female Water-Goat)1770 or 1389 or 617 — to —阳木猴年 (male Wood-Monkey)1771 or 1390 or 618 1644 (MDCXLIV) was a leap year starting on Friday of the Gregorian calendar and a leap year starting on Monday of the Julian calendar, the 1644th year of the Common Era (CE) and Anno Domini (AD) designations, the 44th year of the 17th century, and the 5th year of the 1640s decade. As of the start of 1644, the Gregorian calendar was 10 days ahead of the Julian calendar, which remained in localized use until 1923. Calendar year It is one of eight years (CE) to contain each Roman numeral once (1000(M)+500(D)+100(C)+(-10(X)+50(L))+(-1(I)+5(V)) = 1644). Kolumna Zygmunta erected. January 22 – The Royalist Oxford Parliament is first assembled by King Charles I of England.[1] January 26 – First English Civil War: Battle of Nantwich – The Parliamentarians defeat the Royalists, allowing them to end the 6-week siege of the Cheshire town.[2] January 30 Dutch explorer Abel Tasman departs from Batavia in the Dutch East Indies (modern-day Jakarta in Indonesia) on his second major expedition for the Dutch East India Company, to map the north coast of Australia. Tasman commands three ships, Limmen, Zeemeeuw and Braek, and returns to Batavia at the beginning of August with no major discoveries. Battle of Ochmatów: Polish–Lithuanian Commonwealth forces under hetman Stanisław Koniecpolski secure a substantial victory over the horde of Crimean Tatars under Tugay Bey. February 5 – The first livestock branding law in America is passed in Connecticut.[3] March 24 – Roger Williams is granted an official grant for his Rhode Island Colony from the Parliament of England, allowing the establishment of a general assembly. April 18 – Opchanacanough leads the Powhatan Indians in an unsuccessful uprising against the English at Jamestown. Although 300 of the English colonists are slain, the settlers pursue Opchanacanough, who is imprisoned in Jamestown for the rest of his life.[4] This is the last such Indian rebellion in the region. April 25 – A popular Chinese rebellion led by Li Zicheng sacks Beijing, prompting Chongzhen, the last emperor of the Ming dynasty, to commit suicide. May 6 – Johan Mauritius resigns as Governor of Brazil.[3] May 25 – Ming general Wu Sangui forms an alliance with the invading Manchus and opens the gates of the Great Wall of China at Shanhaiguan Pass, letting the Manchus through towards the capital Beijing. May 26 – Battle of Montijo: The Kingdom of Portugal is victorious over Habsburg Spain, in the first major action between the two nations during the Portuguese Restoration War. May 27 – Battle of Shanhai Pass: The Manchu Qing dynasty and Wu Sangui gain a decisive victory over Li Zicheng's Shun dynasty. June 3 – Li Zicheng proclaims himself emperor of China. June 6 – The invading Qing army, with the help of Ming general Wu Sangui, captures Beijing in China, marking the beginning of Manchu rule over China proper. June 11 – During the English Civil War, Prince Rupert and his men take Liverpool Castle.[5] Liverpool is later reclaimed by Sir John Moore. July 1 – Torstenson War: Battle of Colberger Heide – The Dano-Norwegian and Swedish fleets fight a naval battle off the coast of Schleswig-Holstein. The battle is indecisive but represents a minor success for the Dano-Norwegian fleet. July 2 – English Civil War: Battle of Marston Moor – The Parliamentarians crush the Royalists in Yorkshire, ending Charles I's hold on the north of England.[6] September 1 – English Civil War: Battle of Tippermuir – Montrose defeats Lord Elcho's Covenanters, reviving the Royalist cause in Scotland. September 2 – English Civil War: Second Battle of Lostwithiel (in Cornwall) – Charles I and the Royalists gain their last major victory.[7] September 15 – Pope Innocent X succeeds Pope Urban VIII, becoming the 236th pope.[8] October 1 – The Jews of Mogilev, Polish–Lithuanian Commonwealth, are attacked during Tashlikh. November 8 – The Shunzhi Emperor, the second emperor of the Qing dynasty, is enthroned in Beijing after the collapse of the Ming dynasty as the first Qing emperor to rule over China proper. November 23 Battle of Jüterbog (December 3 New Style): Sweden's forces defeat those of the Holy Roman Empire. Areopagitica, an appeal for freedom of speech written by John Milton, is published in London. November – The Castle of Elvas in Portugal resists a 9-day siege by the Spanish during the Portuguese Restoration War. December 8 (December 18 New Style) – As Christina comes of age, she is made ruling queen of Sweden. December – Bubonic plague breaks out in Edinburgh (Scotland). A Spanish officer is murdered in St. Dominic's Church, Macau during mass by colonists loyal to Portugal during the Portuguese Restoration War. Sigismund's Column is erected in Warsaw to commemorate King Sigismund III Vasa, who moved the capital of Poland from Kraków to Warsaw in 1596. Philosopher René Descartes publishes Principia Philosophiae (Principles of Philosophy) in Amsterdam. The opera Ormindo is first performed in Venice (music by Francesco Cavalli, and libretto by Giovanni Faustini). The West India Company[which?] displays greater interest in profit than in colonization.[vague] Thomas Britton Veit Hans Schnorr von Carolsfeld Otto Mencke Henry Winstanley Henrietta of England January 9 – Robert Gibbes, English-born landgrave in South Carolina (d. 1715) January 10 Louis François, duc de Boufflers, Marshal of France (d. 1711) Celestino Sfondrati, Italian Catholic cardinal (d. 1696) January 11 – Hayashi Hōkō, Japanese philosopher (d. 1732) January 14 – Thomas Britton, English concert promoter (d. 1714) January 18 – John Partridge, English astrologer (d. 1708) January 23 – Jonas Budde, Norwegian army officer (d. 1710) January 25 – Antoine Thomas, Jesuit missionary priest and astronomer (d. 1709)[9] January 26 – Thomas Boylston, American colonial doctor (d. 1695) February 2 Isaac Chayyim Cantarini, Italian rabbi (d. 1723) Johannes Hancke, German writer (d. 1713) February 7 – Nils Bielke, member of the High Council of Sweden (d. 1716) February 8 – Pierre de La Broue, American bishop (d. 1720) February 12 – Jakob Ammann, Swiss founder of the Amish sect (d. 1712) February 24 – Maria Elisabeth Lämmerhirt, German mother of Johann Sebastian Bach (d. 1694) March 1 – Simon Foucher, French polemicist (d. 1696) March 15 – Veit Hans Schnorr von Carolsfeld, German iron and cobalt magnate (d. 1715) March 21 – Sir Walter Bagot, 3rd Baronet, English politician (d. 1704) March 22 Otto Mencke, German philosopher and scientist (d. 1707) Sir James Rushout, 1st Baronet, English politician (d. 1698) March 25 – Heinrich von Cocceji, German jurist from Bremen (d. 1719) March 31 – Henry Winstanley, English engineer (d. 1703) April 6 – António Luís de Sousa, 2nd Marquis of Minas, Portuguese general, governor-general of Brazil (d. 1721) April 7 Nathaniel Johnson, American politician (d. 1713) François de Neufville, duc de Villeroy, French soldier (d. 1730) April 11 – Marie Jeanne Baptiste of Savoy-Nemours, Duchess of Savoy (d. 1724) April 17 – Abraham Storck, Dutch painter (d. 1708) April 21 – Conrad von Reventlow, Danish statesman, first Grand Chancellor of Denmark (d. 1708) May 2 – Robert Cotton, English politician (d. 1717) May 4 – Juan Caballero y Ocio, Spanish priest remarkable for lavish gifts to the Catholic Church and charity (d. 1707) May 5 – Sir Richard Newdigate, 2nd Baronet, English landowner (d. 1710) May 26 – Michael Ettmüller, German physician (d. 1683) June 2 – William Salmon, English medical writer (d. 1713) June 7 – Johann Christoph Volkamer, German botanist (d. 1720) June 16 – Henrietta Anne Stuart, Princess of Scotland, England and Ireland and Duchess of Orléans (d. 1670)[10] June 17 – Johann Wolfgang Franck, German baroque composer (d. 1710) July 2 – Abraham a Sancta Clara, German Augustinian friar (d. 1709) July 4 – Josceline Percy, 11th Earl of Northumberland, English noble (d. 1670) July 7 – Joan Geelvinck, Dutch politician (d. 1707) July 10 – Miguel Bayot, Spanish Catholic prelate, Bishop of Cebu (from 1697) (d. 1700) July 22 – Peter Drelincourt, Irish chaplain (d. 1722) August 6 Christian Ernst, Margrave of Brandenburg-Bayreuth (1655–1712) (d. 1712) Louise de La Vallière, French mistress of Louis XIV of France (d. 1710)[11] August 12 – Heinrich Ignaz Franz Biber, Bohemian composer and violinist (d. 1704) August 28 (bapt.) – Gilles Schey, Dutch admiral (d. 1703) August 29 – Anne Bourdon, nun in New France (d. 1711) August 30 – Thomas Tufton, 6th Earl of Thanet, English politician (d. 1729) September 3 – Richard Newport, 2nd Earl of Bradford, English politician (d. 1723) September 6 – Juan Bautista Cabanilles, Spanish composer (d. 1712) September 11 – Jacob Rotius, Dutch painter (d. 1681) September 22 – Jacques Échard, French Dominican, historian of the Order (d. 1724) September 25 – Ole Rømer, Danish astronomer (d. 1710) October 1 – Jean Rousseau, French viol player (d. 1699) October 2 – François-Timoléon de Choisy, French abbé, author and cross-dresser (d. 1724) October 3 – Adriaen Frans Boudewijns, landscape painter (d. 1719) October 12 – Christopher Sandius, Dutch Arian writer (d. 1680) October 13 – Sipihr Shikoh, Mughal Emperor (d. 1708) October 14 – William Penn, English Quaker and founder of Pennsylvania (d. 1718) October 26 – Mathias Steuchius, Swedish archbishop (d. 1730) November 23 (bapt.) – Cornelia van der Gon, Dutch art collector (d. 1701) December 8 – Maria d'Este, Italian noble (d. 1684) December 9 – Robert Kirk, Scottish folklorist, Bible translator, Gaelic scholar (d. 1692) December 23 – Tomás de Torrejón y Velasco, Spanish composer, musician and organist (d. 1728) December 25 – Walter Scott, Earl of Tarras, Scottish nobleman (d. 1693) December 29 – Philips van Almonde, Dutch Lieutenant Admiral (d. 1711) Matsuo Bashō, Japanese poet (d. 1694) Pietro Erardi, Maltese chaplain and painter (d. 1727)[12] Antonio Stradivari, Italian violin maker (d. 1737)[13] Pope Urban VIII Johannes Wtenbogaert January 20 – Stefano Amadei, Italian painter (b. 1580) January 30 – William Chillingworth, controversial English churchman (b. 1602) January 31 – Georg II of Fleckenstein-Dagstuhl, German nobleman (b. 1588) February 28 – Guru Har Gobind, the Sixth Sikh Guru (b. 1595) March 15 – Countess Louise Juliana of Nassau, Regent of Bohemia (b. 1576) March 24 – Cecilia Renata of Austria, Queen of Poland (b. 1611) March 29 – Lord John Stewart, Scottish aristocrat, Royalist commander in the English Civil War (b. 1621) April 2 – Diego Salcedo, Spanish bishop (b. 1575) April 10 – Reverend William Brewster, English Pilgrim leader (b. 1567) April 25 – Chongzhen, last Ming Emperor of China (suicide) (b. 1611) April 28 – Zsófia Bosnyák, Hungarian noblewoman (b. 1609) May 26 – Alfonso III d'Este, Duke of Modena, Italian noble (b. 1591) June 17 Anne de Montafié, Countess of Clermont-en-Beauvaisis, French countess (b. 1577) John of St. Thomas, Portuguese philosopher (b. 1589) July 4 – Brian Twyne, English archivist (b. 1581) July 7 – Hedwig of Hesse-Kassel, countess consort of Schaumburg (b. 1569) July 16 – Giovanni Biliverti, Italian painter (b. 1585) July 25 – Amar Singh Rathore, Rajput nobleman affiliated with the royal house of Marwar (b. 1613) July 29 – Pope Urban VIII (b. 1568)[14] August 25 – Johann Heinrich Alting, German Lutheran theologian (b. 1583) September 4 – Johannes Wtenbogaert, Dutch leader of the Remonstrants (b. 1557) September 7 Guido Bentivoglio, Italian statesman and historian (b. 1579)[15] Ralph Corbie, Irish Jesuit (b. 1598) September 8 John Coke, English politician (b. 1563)[16] Francis Quarles, English poet (b. 1592)[17] October 6 – Elisabeth of France, queen of Philip IV of Spain (b. 1602) October 19 – Johann Friedrich, Count Palatine of Sulzbach-Hilpoltstein (b. 1587) October 30 – Jorge de Cárdenas y Manrique de Lara, Spanish noble (b. 1584) November 6 – Thomas Roe, English diplomat (b. c. 1581) November 10 – Luis Vélez de Guevara, Spanish writer (b. 1579) November 20 – Nathaniel Foote, American colonist (b. 1592) November 24 – Deodat del Monte, Flemish painter, architect (b. 1582) December 20 – Albert IV, Duke of Saxe-Eisenach (from 1640) (b. 1599) December 23 – Sir Alexander Carew, 2nd Baronet, English politician (b. 1609) December 28 – John Bankes, Attorney General and Chief Justice to King Charles I of England (b. 1589) December 30 – Jan Baptist van Helmont, Flemish chemist (b. 1577) ^ Braddick, Michael J. 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Defeating the parliamentarians at Stockport, he forced his way into Lancashire, stormed Bolton on 28 May, and captured Liverpool on 11 June", quoting Ormerod, Civil War Tracts of Lancashire, p. 187) ^ Levene, Mark (1999). The massacre in history. New York: Berghahn Books. p. 93. ISBN 9781571819345. ^ Jeremy Black (1996). The Cambridge Illustrated Atlas of Warfare: Renaissance to Revolution, 1492-1792. Cambridge University Press. p. 80. ^ Levillain, Philippe (2002). The papacy : an encyclopedia. New York: Routledge. p. 801. ISBN 9780415922289. ^ Walle, Willy (2003). The history of the relations between the Low Countries and China in the Qing era (1644-1911. Leuven, Belgium: Leuven University Press Ferdinand Verbiest Foundation. p. 90. ISBN 9789058673152. ^ Lowther, Kenneth (1979). Dartmoor, Exeter... London: Ward Lock. p. 35. ISBN 9780706357929. ^ Dumas, Alexandre (1998). The Vicomte de Bragelonne. Oxford New York: Oxford University Press. p. 674. 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Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "16th century" – news · newspapers · books · scholar · JSTOR (September 2022) (Learn how and when to remove this message) Millennia 2nd millennium Centuries 15th century 16th century 17th

Castilian War of 1578. 1579: The Union of Utrecht unifies the northern Netherlands, a foundation for the later Dutch Republic. 1579: The Union of Arras unifies the southern Netherlands, a foundation for the later states of the Spanish Netherlands, the Austrian Netherlands and Belgium.The Irish Gaelic chieftain's feast, from The Image of Ireland 1579: The British navigator Sir Francis Drake passes through Maluku and transit in Ternate on his circumnavigation of the world. The Portuguese establish a fort on Tidore but the main centre for Portuguese activities in Maluku becomes Ambon.[16] The fall of Spanish Armada 1580: Drake's royal reception after his attacks on Spanish possessions influences Philip II of Spain to build up the Spanish Armada. English ships in Spanish harbours are impounded. 1580: Spain unifies with Portugal under Philip II. The struggle for the throne of Portugal ends the Portuguese Empire. The Spanish and Portuguese crowns are united for 60 years, i.e. until 1640. 1580–1587: Nagasaki comes under control of the Jesuits. 1581: Dutch Act of Abjuration, declaring abjuring allegiance to Philip II of Spain. 1581: Bayinnaung dies at the age of 65. 1582: Oda Nobunaga commits seppuku during the Honnō-ji Incident coup by his general, Akechi Mitsuhide. 1582: Pope Gregory XIII issues the Gregorian calendar. The last day of the Julian calendar was Thursday, 4 October 1582 and this was followed by the first day of the Gregorian calendar, Friday, 15 October 1582 1582: Yermak Timofeyevich conquers the Siberia Khanate on behalf of the Stroganovs. 1583: Denmark builds the world's first theme park, Bakken. 1583: Death of Sultan Babullah of Ternate. 1584–1585: After the siege of Antwerp, many of its merchants flee to Amsterdam. According to Luc-Normand Tellier, "At its peak, between 1510 and 1557, Antwerp concentrated about 40% of the world trade...It is estimated that the port of Antwerp was earning the Spanish crown seven times more revenues than the Americas."[17] 1584: Ki Ageng Pemanahan died. Sultan Pajang raised Sutawijaya, son of Ki Ageng Pemanahan as the new ruler in Mataram, titled "Loring Ngabehi Market" (because of his home in the north of the market). 1585: Akbar annexes Kashmir and adds it to the Kabul SubahPortuguese fusta in India from a book by Jan Huygen van Linschoten 1585: Colony at Roanoke founded in North America. 1585–1604: The Anglo-Spanish War is fought on both sides of the Atlantic. 1587: Mary, Queen of Scots is executed by Elizabeth I. 1587: The reign of Abbas I marks the zenith of the Safavid dynasty. 1587: Troops that would invade Pajang Mataram Sultanate storm ravaged the eruption of Mount Merapi. Sutawijaya and his men survived. 1588: Mataram into the kingdom with Sutawijaya as Sultan, titled "Senapati Ingalaga Sayidin Panatagama" means the warlord and cleric Manager Religious Life. 1588: England repulses the Spanish Armada. 1589: Spain repulses the English Armada. 1589: Catherine de' Medici dies at aged 69. Abu'l-Fazl ibn Mubarak presenting Akbarnama to Mughal Azam Akbar, Mughal miniature 1590: Siege of Odawara: the Go-Hojo clan surrender to Toyotomi Hideyoshi, and Japan is unified. 1591: Gazi Giray leads a huge Tatar expedition against Moscow. 1591: In Mali, Moroccan forces of the Sultan Ahmad al-Mansur led by Judar Pasha defeat the Songhai Empire at the Battle of Tondibi. 1592–1593: John Stow reports 10,675 plague deaths in London, a city of approximately 200,000 people. 1592–1598: Korea, with the help of Ming dynasty China, repels two Japanese invasions. 1593–1606: The Long War between the Habsburg monarchy and the Ottoman Turks. 1594: St. Paul's College, Macau, founded by Alessandro Valignano. 1595: First Dutch expedition to Indonesia sets sail for the East Indies with two hundred and forty-nine men and sixty-four cannons led by Cornelis de Houtman.[18] 1596: Birth of René Descartes. 1596: June, de Houtman's expedition reaches Banten the main pepper port of West Java where they clash with both the Portuguese and Indonesians. It then sails east along the north coast of Java losing twelve crew to a Javanese attack at Sidayu and killing a local ruler in Madura.[18] 1597: Romeo and Juliet is published. 1597: Cornelis de Houtman's expedition returns to the Netherlands with enough spices to make a considerable profit.[18] 1598: The Edict of Nantes ends the French Wars of Religion. 1598: Abbas I moves Safavids capital from Qazvin to Isfahan in 1598. 1598–1613: Russia descends into anarchy during the Time of Troubles. 1598: The Portuguese require an armada of 90 ships to put down a Solorese uprising.[12] (to 1599) 1598: More Dutch fleets leave for Indonesia and most are profitable.[18]Edo period screen depicting the Battle of Sekigahara 1598: The province of Santa Fe de Nuevo México is established in Northern New Spain. The region would later become a territory of Mexico, the New Mexico Territory in the United States, and the US State of New Mexico. 1598: Death of Toyotomi Hideyoshi, known as the unifier of Japan. 1599: The Mali Empire is defeated at the Battle of Jenné. 1599: The van Neck expedition returns to Europe. The expedition makes a 400 per cent profit.[18] (to 1600) 1599: March, Leaving Europe the previous year, a fleet of eight ships under Jacob van Neck was the first Dutch fleet to reach the 'Spice Islands' of Maluku.[18] 1600: Giordano Bruno is burned at the stake for heresy in Rome.Siege of Filakovo castle during the Long Turkish War 1600: Battle of Sekigahara in Japan. End of the Warring States period and beginning of the Edo period. 1600: The Portuguese win a major naval battle in the bay of Ambon.[19] Later in the year, the Dutch join forces with the local Hituese in an anti-Portuguese alliance, in return for which the Dutch would have the sole right to purchase spices from Hitu.[19] 1600: Elizabeth I grants a charter to the British East India Company beginning the English advance in Asia. 1600: Michael the Brave unifies the three principalities: Wallachia, Moldavia and Transylvania after the Battle of Șelimbăr from 1599. For later events, see Timeline of the 17th century. Polybius' The Histories translated into Italian, English, German and French.[20] Mississippian culture disappears. Medallion rug, variant Star Ushak style, Anatolia (modern Turkey), is made. It is now kept at the Saint Louis Art Museum. Hernan Cortes (1485–1547) Henry VIII, (1491–1547) King of England and Ireland Don Fernando Álvarez de Toledo (1507–1582) Suleiman the Magnificent, Sultan of the Ottoman Empire (1520–1566) Ivan IV the Terrible (1530–1584) Oda Nobunaga (1534–1582) Sir Francis Drake (c. 1540 – 1596) Alberico Gentili, (1552–1608) the Father of international law Philip II of Spain, King of Spain (1556–1598) Akbar the Great, Mughal emperor (1556–1605) Related article: List of 16th century inventions. The Columbian Exchange introduces many plants, animals and diseases to the Old and New Worlds. Introduction of the spinning wheel revolutionizes textile production in Europe. The letter J is introduced into the English alphabet. 1500: First portable watch is created by Peter Henlein of Germany.The Iberian Union in 1598, under Philip II, King of Spain and Portugal 1513: Juan Ponce de León sights Florida and Vasco Núñez de Balboa sights the eastern edge of the Pacific Ocean. 1519–1522: Ferdinand Magellan and Juan Sebastián Elcano lead the first circumnavigation of the world. 1519–1540: In America, Hernando de Soto expeditions map the Gulf of Mexico coastline and bays. 1525: Modern square root symbol (√) 1540: Francisco Vásquez de Coronado sights the Grand Canyon. 1541–42: Francisco de Orellana sails the length of the Amazon River. 1542–43: Firearms are introduced into Japan by the Portuguese. 1543: Copernicus publishes his theory that the Earth and the other planets revolve around the Sun 1545: Theory of complex numbers is first developed by Gerolamo Cardano of Italy. 1558: Camera obscura is first used in Europe by Giambattista della Porta of Italy. 1559–1562: Spanish settlements in Alabama/Florida and Georgia confirm dangers of hurricanes and local native warring tribes. 1565: Spanish settlers outside New Spain (Mexico) colonize Florida's coastline at St. Augustine. 1565: Invention of the graphite pencil (in a wooden holder) by Conrad Gesner. Modernized in 1812. 1568: Gerardus Mercator creates the first Mercator projection map. 1572: Supernova SN 1572 is observed by Tycho Brahe in the Milky Way. 1582: Gregorian calendar is introduced in Europe by Pope Gregory XIII and adopted by Catholic countries. c. 1583: Galileo Galilei of Pisa, Italy identifies the constant swing of a pendulum, leading to development of reliable timekeepers. 1585: earliest known reference to the 'sailing carriage' in China. 1589: William Lee invents the stocking frame. 1591: First flush toilet is introduced by Sir John Harrington of England, the design published under the title 'The Metamorphosis of Ajax'. 1593: Galileo Galilei invents a thermometer. 1596: William Barents discovers Spitsbergen. 1597: Opera in Florence by Jacopo Peri. Entertainment in the 16th century ^ a b Modern reference works on the period tend to follow the introduction of the Gregorian calendar for the sake of clarity; thus NASA's lunar eclipse catalogue states "The Gregorian calendar is used for all dates from 1582 Oct 15 onwards. Before that date, the Julian calendar is used." For dates after 15 October 1582, care must be taken to avoid confusion of the two styles. ^ de Vries, Jan (14 September 2009). "The limits of globalization in the early modern world". The Economic History Review. 63 (3): 710–733. CiteSeerX 10.1.1.186.2862. doi:10.1111/j.1468-0289.2009.00497.x. JSTOR 40929823. S2CID 219969360. SSRN 1635517. ^ Singh, Sarina; Lindsay Brown; Paul Clammer; Rodney Cocks; John Mock (2008). Pakistan & the Karakoram Highway. Vol. 7, illustrated. Lonely Planet. p. 137. ISBN 978-1-74104-542-0. Retrieved 23 August 2010. ^ Babur (2006). Babur Nama. Penguin Books. p. vii. 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An Encyclopedia of World History (5th ed. 1973); highly detailed outline of events online free Media related to 16th century at Wikimedia Commons Timelines of 16th century events, science, culture and persons Retrieved from " 4 The following pages link to 16th century External tools (link count transclusion count sorted list) · See help page for transcluding these entries Showing 50 items. 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Please help improve it by replacing them with more appropriate citations to reliable, independent sources. (July 2015) (Learn how and when to remove this message) Azure Cosmos DBDeveloper(s)MicrosoftInitial release2017; 8 years ago (2017)Available inEnglishTypeMulti-model databaseWebsitelearn.microsoft.com/en-us/azure/cosmos-db/introduction Azure Cosmos DB is a globally distributed, multi-model database service offered by Microsoft. It is designed to provide high availability, scalability, and low-latency access to data for modern applications. Unlike traditional relational databases, Cosmos DB is a NoSQL (meaning "Not only SQL", rather than "zero SQL") and vector database,[1] which means it can handle unstructured, semi-structured, structured, and vector data types.[2] Internally, Cosmos DB stores "items" in "containers",[3] with these two concepts being surfaced differently depending on the API used (these would be "documents" in "collections" when using the MongoDB-compatible API, for example). Containers are grouped in "databases", which are analogous to namespaces above containers. Containers are schema-agnostic, which means that no schema is enforced when adding items. By default, every field in each item is automatically indexed, generally providing good performance without tuning to specific query patterns. These defaults can be modified by setting an indexing policy which can specify, for each field, the index type and precision desired. Cosmos DB offers two types of indexes: range, supporting range and ORDER BY queries spatial, supporting spatial queries from points, polygons, and line strings encoded in standard GeoJSON fragments Containers can also enforce unique key constraints to ensure data integrity.[4] Each Cosmos DB container exposes a change feed, which clients can subscribe to in order to get notified of new items being added or updated in the container.[5] As of 7 June 2021, item deletions are currently not exposed by the change feed. Changes are persisted by Cosmos DB, which makes it possible to request changes from any point in time since the creation of the container. A "Time to Live" (or TTL) can be specified at the container level to let Cosmos DB automatically delete items after a certain amount of time expressed in seconds. This countdown starts after the last update of the item. If needed, the TTL can also be overloaded at the item level. The internal data model described in the previous section is exposed through: a proprietary SQL API. five different compatibility APIs, exposing endpoints that are partially compatible with the wire protocols of MongoDB, Gremlin, Cassandra, Azure Table Storage, and etcd; these compatibility APIs make it possible for any compatible application to connect to and use Cosmos DB through standard drivers or SDKs, while also benefiting from Cosmos DB's core features like partitioning and global distribution. API Internal mapping Compatibility status and remarks Containers Items MongoDB Collections Documents Compatible with wire protocol version 6 and server version 3.6 of the MongoDB.[6] Gremlin Graphs Nodes and edges Compatible with version 3.2 of the Gremlin specification. Apache Cassandra Table Row Compatible with version 4 of the Cassandra Query Language (CQL) wire protocol. Azure Table Storage Table Item etcd Key Value Compatible with version 3 of etcd.[7] The SQL API lets clients create, update and delete containers and items. Items can be queried with a read-only, JSON-friendly SQL dialect.[8] As Cosmos DB embeds a JavaScript engine, the SQL API also enables: Stored procedures. Functions that bundle an arbitrarily complex set of operations and logic into an ACID-compliant transaction. They are isolated from changes made while the stored procedure is executing and either all write operations succeed or they all fail, leaving the database in a consistent state. Stored procedures are executed in a single partition. Therefore, the caller must provide a partition key when calling into a partitioned collection. Stored procedures can be used to make up for the lack of certain functionality. For instance, the lack of aggregation capability is made up for by the implementation of an OLAP cube as a stored procedure in the open sourced documentdb-lumenize[9] project. Triggers. Functions that get executed before or after specific operations (like on a document insertion for example) that can either alter the operation or cancel it. Triggers are only executed on request. User-defined functions (UDF). Functions that can be called from and augment the SQL query language making up for limited SQL features. The SQL API is exposed as a REST API, which itself is implemented in various SDKs that are officially supported by Microsoft and available for .NET Framework, .NET,[10] Node.js (JavaScript), Java and Python. Cosmos DB added automatic partitioning capability in 2016 with the introduction of partitioned containers. Behind the scenes, partitioned containers span multiple physical partitions with items distributed by a client-supplied partition key. Cosmos DB automatically decides how many partitions to spread data across depending on the size and throughput needs. When partitions are added or removed, the operation is performed without any downtime so data remains available while it is re-balanced across the new or remaining partitions. Before partitioned containers were available, it was common to write custom code to partition data and some of the Cosmos DB SDKs explicitly supported several different partitioning schemes. That mode is still available but only recommended when storage and throughput requirements do not exceed the capacity of one container, or when the built-in partitioning capability does not otherwise meet the application's needs. Developers can specify desired throughput to match the application's expected load. Cosmos DB reserves resources (memory, CPU and IOPS) to guarantee the requested throughput while maintaining request latency below 10ms for both reads and writes at the 99th percentile. Throughput is specified in Request Units (RUs) per second. The cost to read a 1 KB item is 1 Request Unit (or 1 RU). Select by 'id' operations consume lower number of RUs compared to Delete, Update, and Insert operations for the same document. Large queries (e.g. aggregations like count) and stored procedure executions can consume hundreds to thousands of RUs depending on the complexity of the operations needed.[11] The minimum billing is per hour. Throughput can be provisioned at either the container or the database level. When provisioned at the database level, the throughput is shared across all the containers within that database, with the additional ability to have dedicated throughput for some containers. The throughput provisioned on an Azure Cosmos container is exclusively reserved for that container.[12] The default maximum RUs that can be provisioned per database and per container are 1,000,000 RUs, but customers can get this limit increased by contacting customer support. As an example of costing, using a single region instance, a count of 1,000,000 records of 1k each in 5s requires 1,000,000 RUs At $0.008/h, which would equal $800. Two regions double the cost. Cosmos DB databases can be configured to be available in any of the Microsoft Azure regions (54 regions as of December 2018), letting application developers place their data closer to where their users are.[13] Each container's data gets transparently replicated across all configured regions. Adding or removing regions is performed without any downtime or impact on performance. By leveraging Cosmos DB's multi-homing API, applications don't have to be updated or redeployed when regions are added or removed, as Cosmos DB will automatically route their requests to the regions that are available and closest to their location. Data consistency is configurable on Cosmos DB, letting application developers choose among five different levels:[14] Eventual does not guarantee any ordering and only ensures that replicas will eventually converge Consistent prefix adds ordering guarantees on top of eventual Session is scoped to a single client connection and basically ensures a read-your-own-writes consistency for each client; it is the default consistency level[15] Bounded staleness augments consistent prefix by ensuring that reads won't lag beyond x versions of an item or some specified time window Strong consistency (or linearizable) ensures that clients always read the latest globally committed write The desired consistency level is defined at the account level but can be overridden on a per request basis by using a specific HTTP header or the corresponding feature exposed by the SDKs. All five consistency levels have been specified and verified using the TLA+ specification language, with the TLA+ model being open-sourced on GitHub.[16] Cosmos DB's original distribution model involves one single write region, with all other regions being read-only replicas. In March 2018, Microsoft announced a new multi-master capability for Azure Cosmos DB, allowing multiple regions to serve as write replicas. This feature introduced a significant improvement to its original single write-region model, where other regions were read-only. With multi-master, concurrent writes from different regions can lead to potential conflicts, which can be resolved either using the default "Last Write Wins" (LWW) policy or a custom conflict resolution mechanism, such as a JavaScript function. The LWW policy relies on timestamps to determine the winning write, while the custom option enables developers to handle conflicts through application-defined rule. [17] This feature, announced in May 2020,[18] is a fully isolated column store for enabling large scale analytics against operational data in the Azure Cosmos DB, without any impact to its transactional workloads. This feature addresses the complexity and latency challenges that occur with the traditional ETL pipelines required to have a data repository optimized to execute Online analytical processing by automatically syncing the operational data into a separate column store suitable for large scale analytical queries to be performed in an optimized manner, resulting in improving the latency of such queries. Using Microsoft Azure Synapse Link[19] for Cosmos DB, it is possible to build no-ETL Hybrid transactional/analytical processing solutions by directly linking to Azure Cosmos DB analytical store from Synapse Analytics. It enables to run near real-time large-scale analytics directly on the operational data. Gartner Research positions Microsoft as the leader in the Magic Quadrant Operational Database Management Systems in 2016[20] and calls out the unique capabilities of Cosmos DB in their write-up. Microsoft utilizes Cosmos DB in many of its own apps,[21] including Microsoft Office, Skype, Active Directory, Xbox, and MSN. In building a more globally-resilient application / system, Cosmos DB combines with other Azure services, such as Azure App Services and Azure Traffic Manager.[22] The Cosmos DB Profiler cloud cost optimization tool detects inefficient data queries in the interactions between an application and its Cosmos DB database. The profiler alerts users to wasted performance and excessive cloud expenditures. It also recommends how to resolve them by isolating and analyzing the code and directing its users to the exact location.[23] SQL is limited. Aggregations limited to COUNT, SUM, MIN, MAX, AVG functions but no support for GROUP BY or other aggregation functionality found in database systems. However, stored procedures can be used to implement in-the-database aggregation capability.[24] SQL joins between "tables" are not possible, Support only for pure JSON data types. Most notably, Cosmos DB lacks support for date-time data requiring that you store this data using the available data types. For instance, it can be stored as an ISO-8601 string or epoch integer. MongoDB, the database to which Cosmos DB is most often compared, extended JSON in their BSON binary serialization specification to cover date-time data as well as traditional number types, regular expressions, and Undefined. However, many argue [who?] that Cosmos DB's choice of pure JSON is actually an advantage as it's a better fit for JSON-based REST APIs and the JavaScript engine built into the database. ^ "Vector Database". learn.microsoft.com. 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