FIREBRAND

Microsoft

Azure Solutions Architect

Courseware

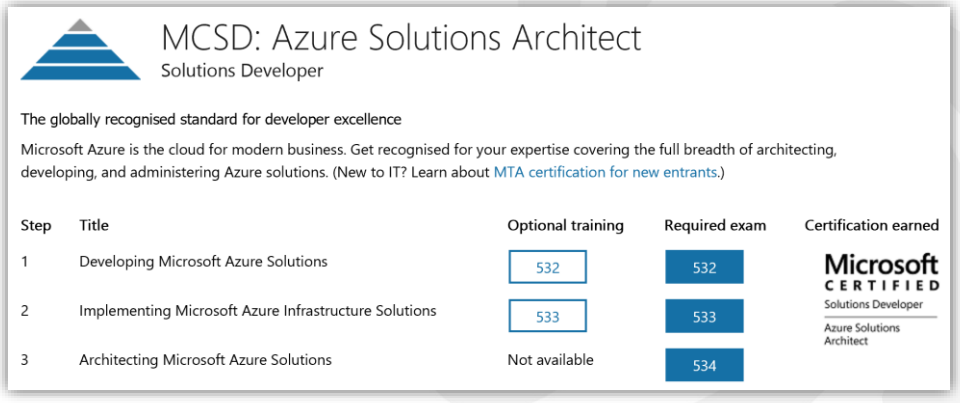
Version 1.0

Module 0
Introduction

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Microsoft Azure
Three tracks, three exams, two official courses



MCSD: Azure Solutions Architect
Solutions Developer

The globally recognised standard for developer excellence

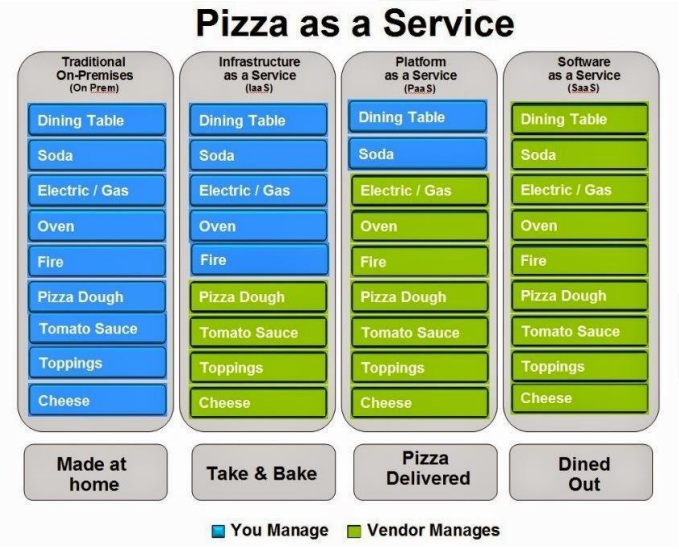
Microsoft Azure is the cloud for modern business. Get recognised for your expertise covering the full breadth of architecting, developing, and administering Azure solutions. (New to IT? Learn about MTA certification for new entrants.)

Step	Title	Optional training	Required exam	Certification earned
1	Developing Microsoft Azure Solutions	532	532	Microsoft CERTIFIED Solutions Developer Azure Solutions Architect
2	Implementing Microsoft Azure Infrastructure Solutions	533	533	
3	Architecting Microsoft Azure Solutions	Not available	534	

- 70-532: 51 questions, 5 case studies
- 70-533: 49 questions, no case studies
- 70-534: 49 questions, 3 case studies

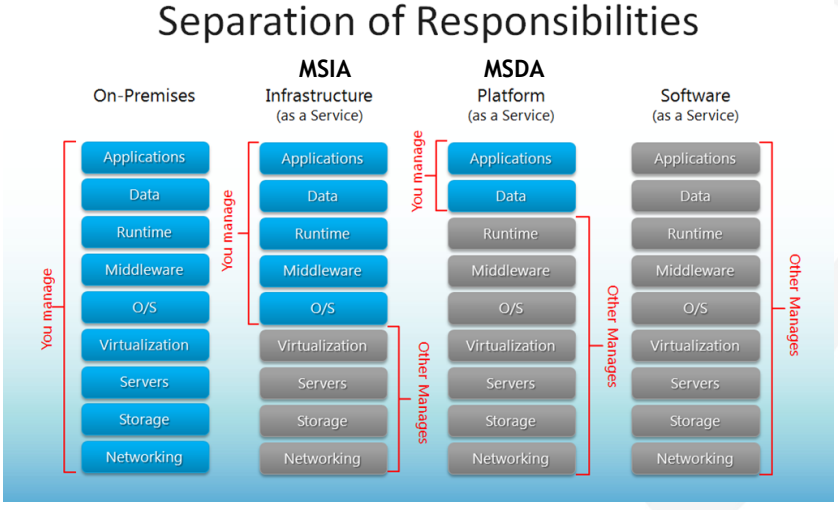
Overview

If I want to eat some pizza I have four options…



Overview

On-Prem, IaaS, PaaS, SaaS



Google, Microsoft, Amazon all offer custom VMs

Google App Engine, Microsoft Azure Web Apps

Google Docs, Microsoft Office 365

Overview
The Cloud

0.5

- What is “the cloud”?
  - The cloud is about moving the IT functions of an organization to cheaper and easier to manage infrastructure to reduce capital and running costs, and improve flexibility and scale
  - Typically moved “off-premise” to public (but secure) servers although there is a concept of a “private cloud”
- Traditionally an organisation directly owns and controls the hardware & software that provides its IT functions
  - Most organisations don’t generate their own electricity, they use the public grid; IT functions are being treated similarly
  - Hospitals or banks or the military might have backup generators if the expensive is worth it; similarly for “private clouds”

Overview
Types of Cloud

0.6

- Consumer cloud
  - Google account (authentication, email, files, apps)
  - Dropbox (files)
  - Apple iCloud (data, backups)
- Enterprise cloud
  - **IaaS**: Microsoft Azure for Solutions Experts: virtual machines, virtual networks, authentication, private cloud
  - **PaaS**: Microsoft Azure for Solutions Developers: web apps, cloud services, API management, storage, push notifications
  - **SaaS**: Microsoft Office 365, SharePoint Online, Exchange Online, Skype for Business
- We will focus on Enterprise cloud

Overview
Internet of Things (IoT)

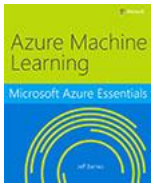
0.7

- Internet of People, meet the Internet of Things
- Home automation, self-driving cars, and so on
- Everything is connected through “the cloud”
  - Your mobile phone
  - Your car
  - Your fridge
  - Your home lighting system
- aka Internet of Threats
  - When everything is connected, everything is a potential vector through which you can be attacked
- Not covered by Microsoft courses or exams

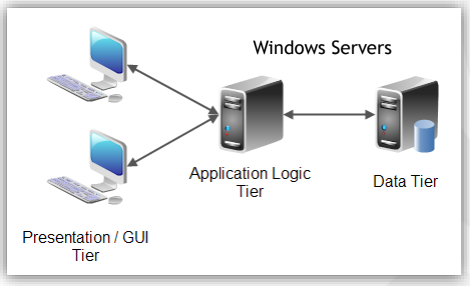
Overview
Machine Learning

0.8

- Once everything is connected through IoT, recording trillions of activities, we need a way to analyse that raw data
- Machine learning can use pattern matching and AI to generate useful information from the data
- Not covered by Microsoft courses (but the 70-534 Architecting exam has some questions)

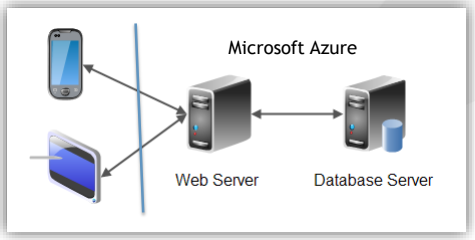


Overview
Application Architecture



The Past
Users need access to systems and data when they are in the office

"On-Prem"
Server-side logic, database, and client-side user interface are all running "on premise"



The Present
Users need access to systems and data from anywhere, all the time

"Mobile-First, Cloud-First"
Server-side logic and data storage running in the cloud; client-side user interface running on mobile and via web browsers

Overview
Mobile-First, Cloud-First

- Microsoft CEO Satya Nadella talks about the company's "mobile-first, cloud-first" strategy
  - "To me, when we say mobile first, it's not the mobility of the device, it's actually the mobility of the individual experience."
  - "The only way you are going to be able to orchestrate the mobility of these applications and data is through the cloud… That's why the juxtaposition of cloud infrastructure and mobile experiences is where the world is going."
- Microsoft's "cloud" is called Azure
  - Microsoft Azure is not one thing
  - Microsoft Azure is *every* IT product running in the cloud

Overview

"Lift and Shift" vs. "Cloud Native"

0.11

- Azure provides services for "lift and shift" scenarios that require minimal re-writing of applications
  - **Virtual Machines**: for custom any OS compute workloads
  - **Cloud Services**: for up-to-date Windows compute workloads
  - **Web Apps**: for existing ASP.NET web applications and services
  - **SQL Database**: for existing SQL Server databases
- Azure provides services for "cloud native" platforms that require re-writing of applications
  - **Service Fabric**: infinite, flexible compute
  - **Service Bus**: safe, scalable communication
  - **Storage**: Blob, Table, Queue
  - **DocumentDb**, **Redis**, **Data Lake**: data storage and analysis

Microsoft Azure

Certifications

0.12

- Three exams → three Specialist certifications

Microsoft Specialist
Developing Microsoft Azure Solutions

MSDA
- **Developing** Microsoft Azure Solutions

MSIA
- **Implementing** Microsoft Azure **Infrastructure** Solutions
- **Architecting** Microsoft Azure Solutions

- Pass all three to earn MCSD Azure Solutions Architect

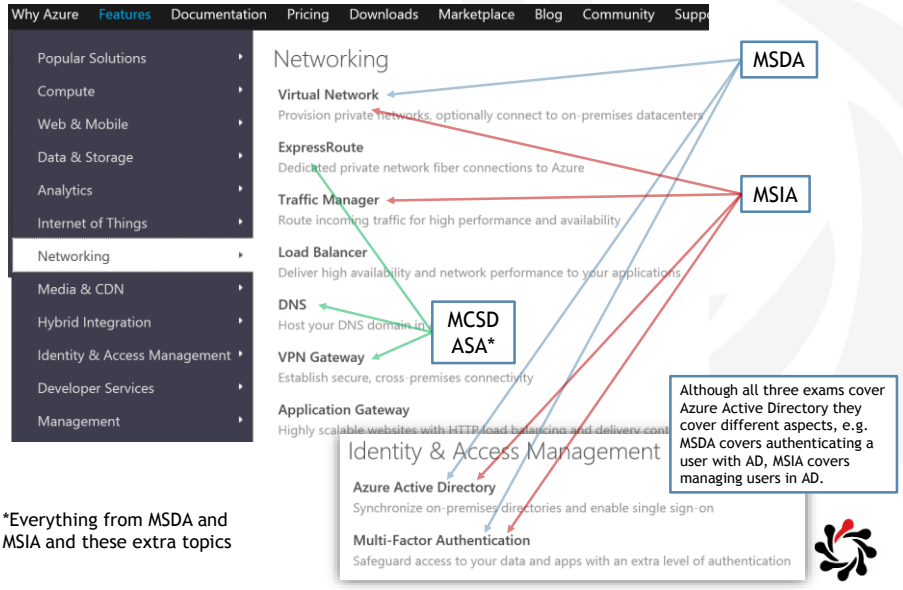
MCSD ASA
- "This is an interesting certification because you have to be comfortable with the Developer, IT Pro, DevOps and Design/Architecture aspects of the Azure platform and can't just stay within your traditional technology silos." – Sidney Andrews, author of 20532B: Developing Microsoft Azure Solutions
- Microsoft made this an MCSD certification but they really need a new category: Microsoft Certified Solutions Architect

Microsoft CERTIFIED Solutions Developer
Azure Solutions Architect

MCSD: Azure Solutions Architect—Study Resources You Need To Know
https://borntolearn.mslearn.net/b/weblog/archive/2015/05/18/mcsd-azure-solutions-architect-study-resources-you-need-to-know

Microsoft Azure Features
Networking

0.13



*Everything from MSDA and MSIA and these extra topics

Microsoft Azure Features
Web & Mobile

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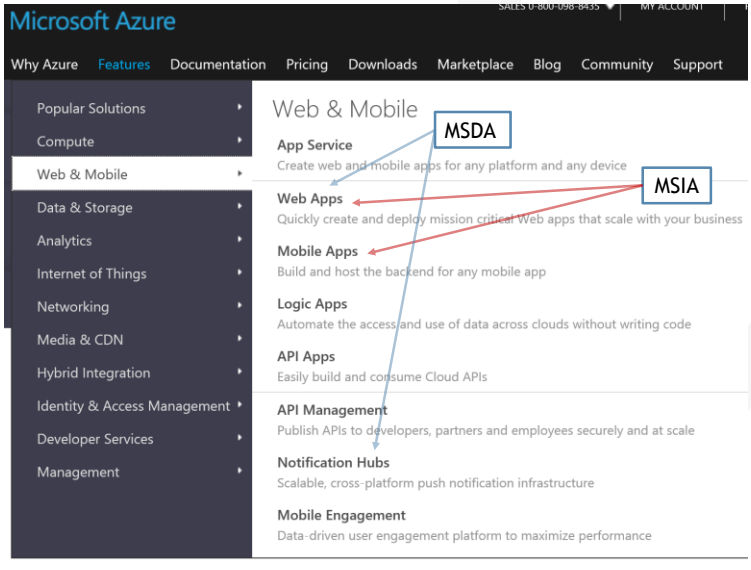

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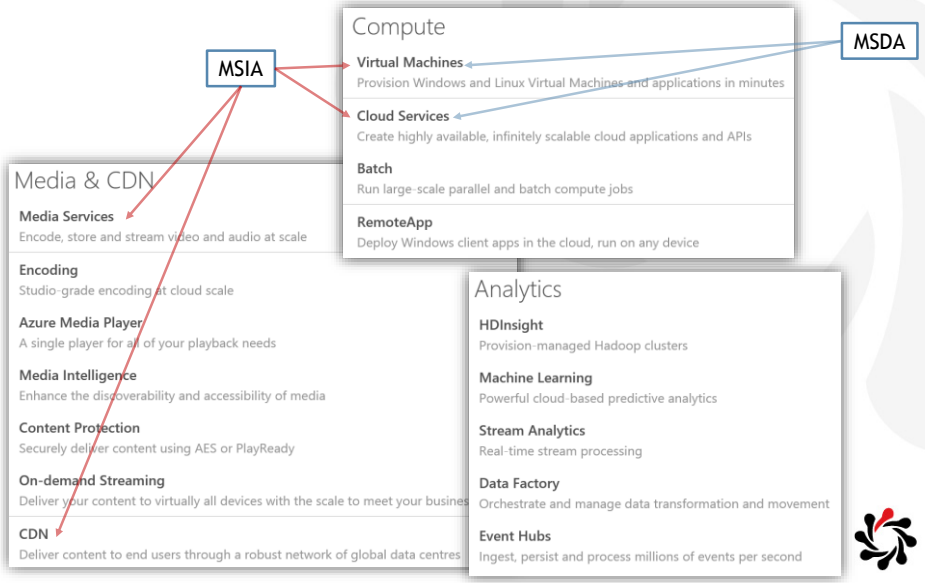
Microsoft Azure Features
Compute, Media & CDN, Analytics



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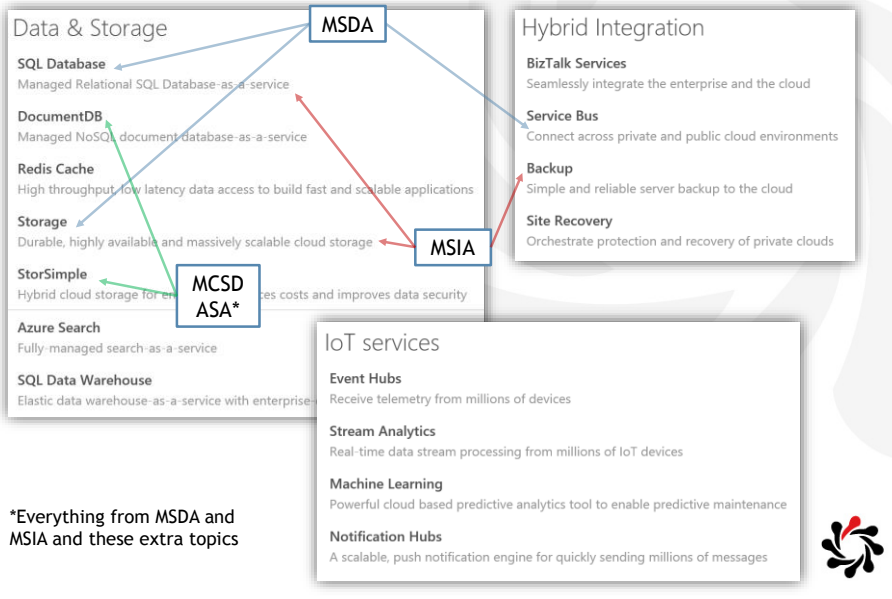
Microsoft Azure Features
Data & Storage, Hybrid Integration, IoT services



*Everything from MSDA and MSIA and these extra topics

IaaS
Cloud Virtual Machines

- Microsoft, Amazon, and Google all allow a customer to create virtual machines
- Those VMs could run Windows Server, Linux, etc.
  - A PHP web programmer could choose to deploy her application to a Microsoft Azure VM running Linux
  - A C# programmer could choose to deploy his web service to an Amazon VM running Microsoft Windows Server
  - A Ruby on Rails programmer could choose to deploy her web site to a Google VM running Linux
- All these developers need hundreds of hours of training in their language and platform, but only need an hour or two of training on their cloud platform of choice
  - And then the deployment can be automated with scripts too!

IaaS
Gartner Reports

"Spending on infrastructure-as-a-service will rise to $16.5 billion in 2015, according to Gartner, a whopping increase of 32.8% over 2014 as more companies move workloads out of their own data centers and into the public cloud."

AWS named as a leader in the IaaS Magic Quadrant for the 5th consecutive year*
http://aws.amazon.com/resources/gartner-2015-mq-learn-more/

IaaS

Microsoft vs Amazon vs Google vs Apple

- Cloud (enterprise, not consumer)
  - 1st Amazon Web Services
    (Gartner says it is 10x its next 14 competitors *combined*)
  - 2nd Microsoft Azure (twice as big as Google)
  - 3rd Google (trailing badly)
  - 4th Apple (only to support iOS and Mac OS X consumer apps)

> "In previous estimates, Gartner has illustrated how Amazon Web Services is outstripping its IaaS competitors by saying it has five times the capacity of the 14 largest competing services combined. In the update, it revised that estimate by doubling it, saying AWS has ten times the cloud server capacity of those same 14 competitors. Those rivals include the likes of Microsoft, IBM, and Google."

Gartner Doubles Estimate Of Amazon Cloud Dominance
http://www.informationweek.com/cloud/infrastructure-as-a-service/gartner-doubles-estimate-of-amazon-cloud-dominance/d/d-id/1320497

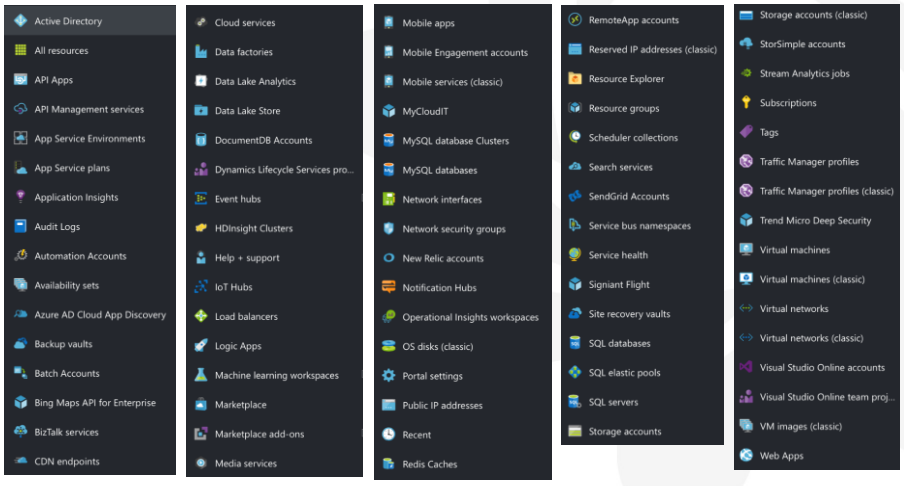
Courses

How Much Cloud Content?

- MCSDWA (9 days), *MCSD: Web Applications*, 20% cloud
  - Note: Two of the three exams have questions about developer features of Microsoft Azure but they only make up about 20% of the total questions in the exams.
- MSDA (3 days), *Microsoft Specialist: Developing Microsoft Azure Solutions*, 100% cloud
- MSIA (3 days), *Microsoft Specialist: Implementing Microsoft Azure Infrastructure Solutions*, 100% cloud
- MCSDASA (7 days), *MCSD: Azure Solutions Architect*, 100% cloud
  - This course is a combination of MSDA and MSIA and one day for architecture topics.

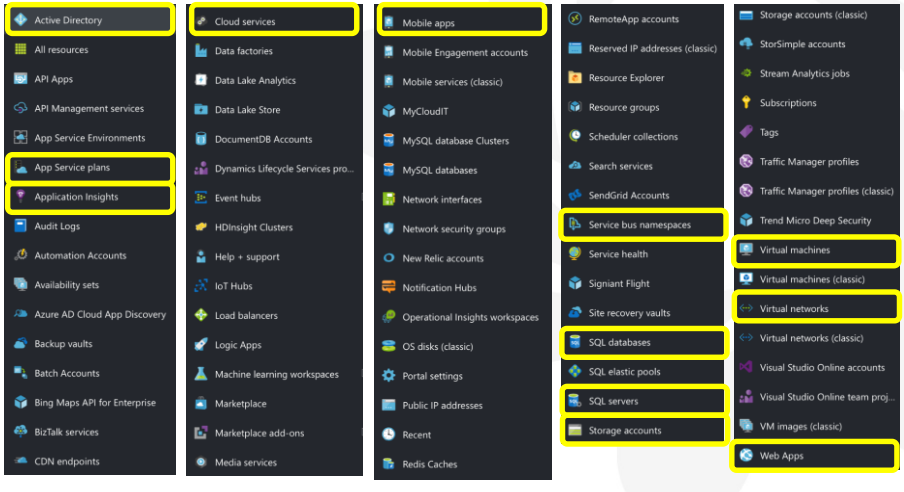
Developing Microsoft Azure Solutions

Things You Can Create In Azure in 2015



Developing Microsoft Azure Solutions

What MOC 20532B Covers



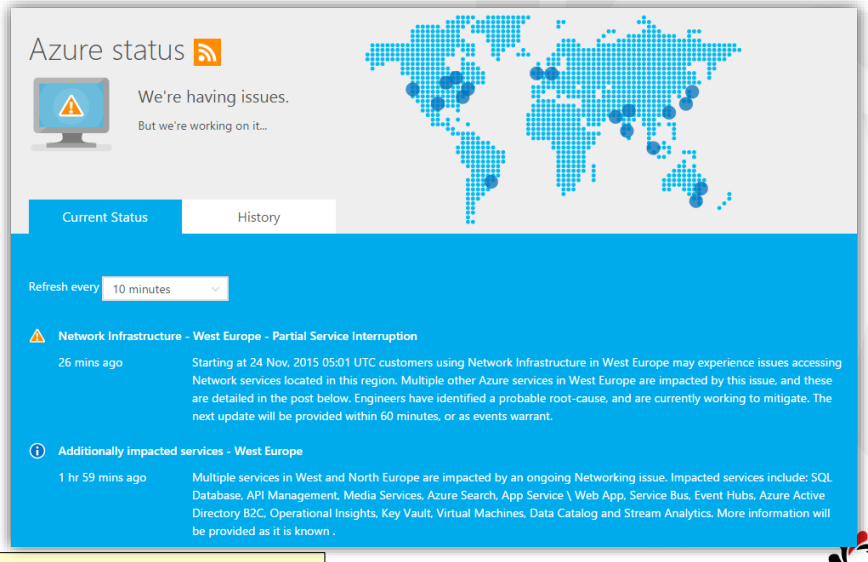
Note: Items suffixed with (classic) do not support Resource Groups for grouping related resources.

Spending Limits

- To protect you from accidentally incurring charges for usage beyond the included offer amount, we have introduced the Spending Limit feature.
  - All new customers have a Spending Limit of £0. It isn't available for pay-as-you-go subscriptions and commitment plans.
  - When your usage exhausts the monthly amounts included in your offer, we will disable your service for the remainder of that billing month, which includes removing any hosted services that you may have deployed. The data in your storage accounts and databases will be accessible in a read-only manner.
  - At the beginning of the next billing month, your subscription will be re-enabled and you can re-deploy your hosted service(s) and have full access to your storage accounts and databases.

Azure Spending Limit
https://azure.microsoft.com/en-gb/pricing/spending-limits/

Microsoft Azure Status



Azure Status
https://azure.microsoft.com/en-us/status/

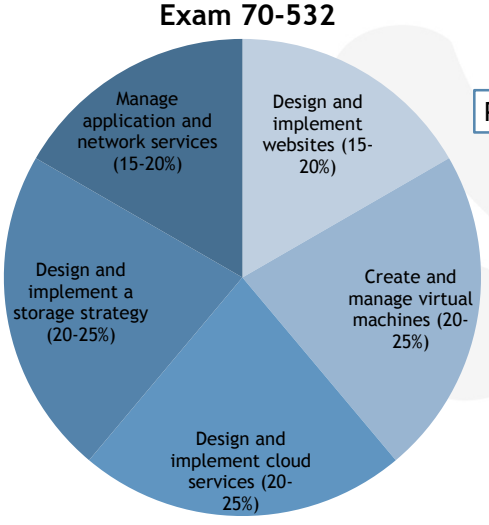
Developing Microsoft Azure Solutions

Microsoft Azure Compliance Certifications

Microsoft Azure Trust Center: Compliance
https://azure.microsoft.com/en-gb/support/trust-center/compliance/

Developing Microsoft Azure Solutions

Course and Exam Contents

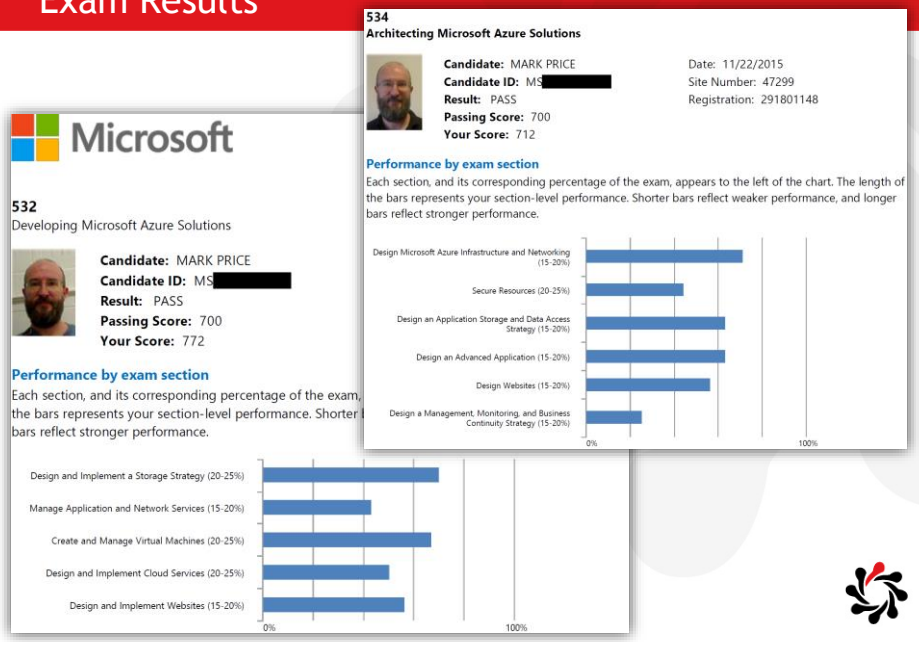


Pass = 59% = 30/51 = 700/1000

Since November 2015
150 minutes total
51 questions in total
26 in main section
5 case studies (3, 4, 5, 6, 7)

Exam 70-532 Developing Microsoft Azure Solutions
https://www.microsoft.com/learning/en-gb/exam-70-532.aspx

Developing Microsoft Azure Solutions
Exam Results



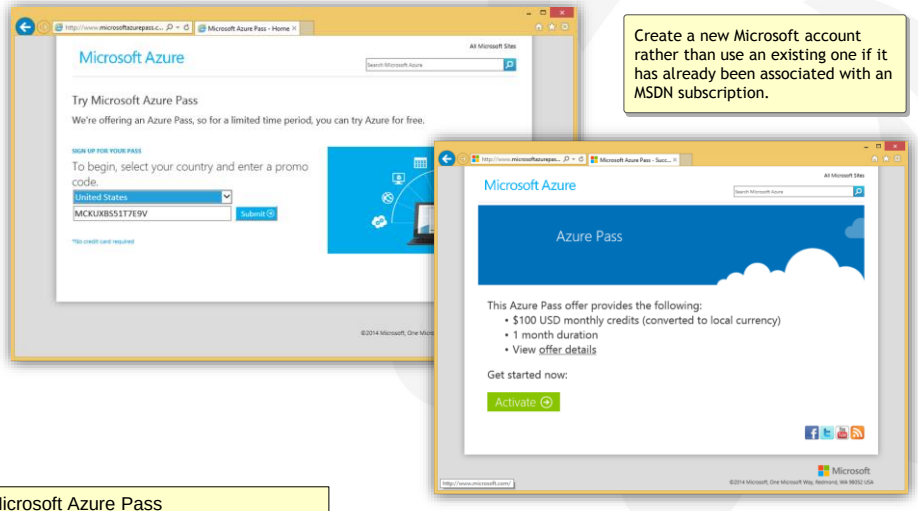
Developing Microsoft Azure Solutions
Labs

Warning! The labs have been written for Azure SDK 2.6. You can download this version manually.

- In the hands-on labs for 20532B you will take an existing ASP.NET web application and extend the application using various Azure services.
  - You will get most out of it if you have experience with ASP.NET MVC and Entity Framework and WCF and so on, for example, by completing Firebrand's MCSD Web Applications course.
- To perform the labs you can work in a virtual machine environment hosted entirely in Azure.
  - Your host machine only requires a compatible browser and an application that supports the Remote Desktop Protocol.
- Alternatively, you can install Visual Studio 2015 Community Edition to work locally which can be quicker for labs that don't need deployment to Azure.

Developing Microsoft Azure Solutions

Microsoft Azure Learning Pass



Create a new Microsoft account rather than use an existing one if it has already been associated with an MSDN subscription.

Microsoft Azure Pass
https://www.microsoftazurepass.com/howto

Microsoft Azure Pass
http://www.microsoftazurepass.com/

Further Study

Microsoft Azure

- Microsoft Azure is changing so fast that printed books are not the best choice
- Read the official online documentation

Microsoft Azure
http://msdn.microsoft.com/en-us/library/windowsazure/dd163896.aspx

- Keep up-to-date with ScottGu's blog

ScottGu's Blog – Azure Tags
http://weblogs.asp.net/scottgu/archive/tags/Azure/default.aspx

- You can download a 211 page PDF about "Building Real-World Cloud Apps with Windows Azure"

Building Real-World Cloud Apps with Windows Azure
http://www.asp.net/aspnet/overview/developing-apps-with-windows-azure/building-real-world-cloud-apps-with-windows-azure/introduction

- Introduction To Windows Azure Training

http://www.microsoftvirtualacademy.com/training-courses/introduction-to-windows-azure

0.31

Further Study
Free Microsoft Azure-Related eBooks

Free eBooks from Microsoft Press
http://www.microsoftvirtualacademy.com/ebooks

0.32

Further Study
Microsoft Connect 2015 Videos

What's New for Azure Developers (Azure SDK 2.8)
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/602

Building your first Service Fabric application
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/912

What's new in Azure Redis Cache
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/910

What's new in Azure SQL Database for Developers
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/901

Introduction to Azure IoT Suite and IoT Hub for developers
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/900

Scott Hanselman's best demo! IoT, Azure, Machine Learning & more
https://channel9.msdn.com/Events/Visual-Studio/Connect-event-2015/061

Module 1
Overview of the Microsoft Azure Platform

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Overview of the Microsoft Azure Platform
Features

- Compute (load-balanced)
  - **Virtual Machines**: any O.S.
  - **Cloud Services**: Web or Worker Roles (pre-created VMs for Windows Server platforms)
  - **Web Apps***: shared (no RDP)
- Caching for scalability
  - **Content Delivery Network** (CDN)
  - **Redis**
- Service Bus for messaging
  - **Relay**: safe message exchange
  - **Queue**: smooth workload
  - **Topic**: publish/subscribe
  - **Notifications**: for mobile apps
- Data
  - **Storage**
    - **Table**: non-relational entities
    - **Queue**: smooth workload
    - **Blob**: images, videos, files
    - **Files**: persistent file system
  - **SQL Database**: relational
  - **DocumentDb**: non-relational
  - **Data Lake**: hybrid
- Authentication
  - **Active Directory** (AD)

Microsoft Azure
http://azure.microsoft.com/

* Previous known as Azure Web*sites*

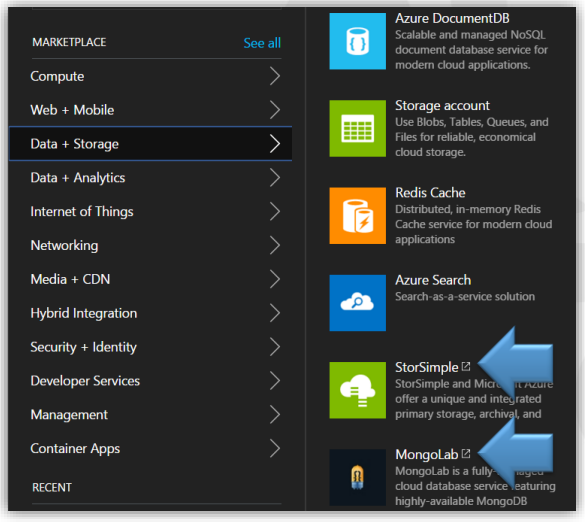
Overview of the Microsoft Azure Platform
Two GUI Portals

1.3

Overview of the Microsoft Azure Platform
Some Features Require the Old Portal

1.4

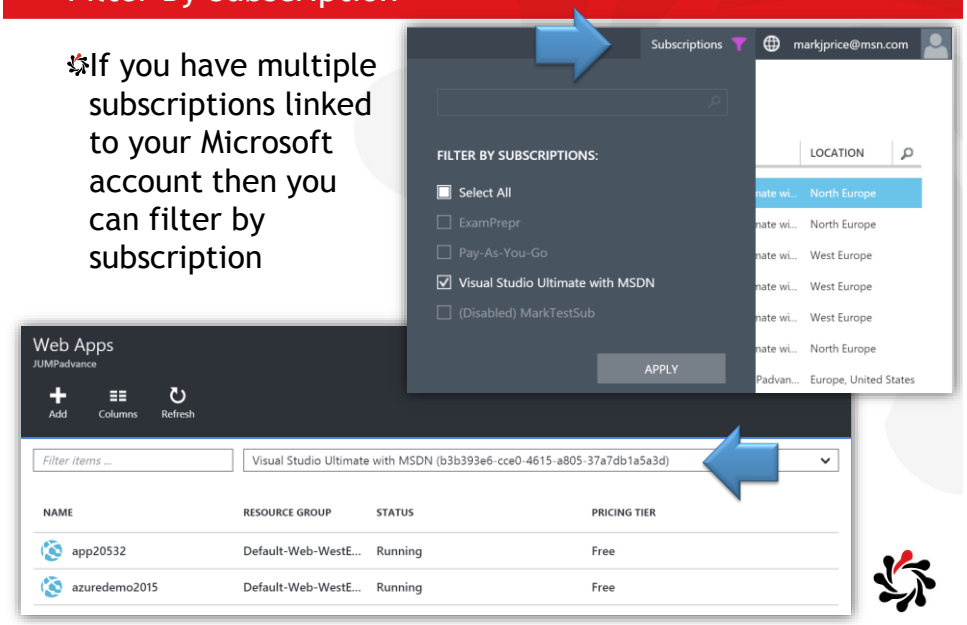
Indicates a link to the old portal or external site



Overview of the Microsoft Azure Platform
Filter By Subscription

1.5

- If you have multiple subscriptions linked to your Microsoft account then you can filter by subscription



Overview of the Microsoft Azure Platform
Limits, Quotas, and Constraints

1.6

Storage Limits

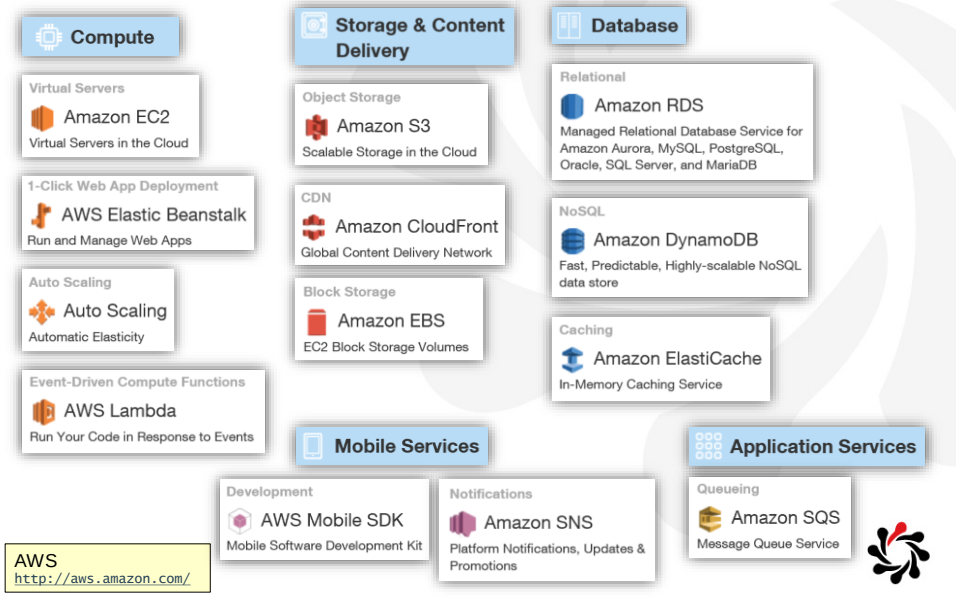
Standard Storage Limits

RESOURCE	DEFAULT LIMIT
Max number of storage accounts per subscription	100[1]
TB per storage account	500 TB
Max number of blob containers, blobs, file shares, tables, queues, entities, or messages per storage account	Only limit is the 500 TB storage account capacity
Max size of a single blob container, table, or queue	500 TB
Max number of blocks in a block blob or append blob	50,000
Max size of a block in a block blob or append blob	4 MB
Max size of a block blob or append blob	50,000 X 4 MB (approx. 195 GB)
Max size of a page blob	1 TB
Max size of a table entity	1 MB
Max number of properties in a table entity	252
Max size of a message in a queue	64 KB

Azure Subscription and Service Limits, Quotas, and Constraints
https://azure.microsoft.com/en-gb/documentation/articles/azure-subscription-service-limits/

Overview of the Microsoft Azure Platform

Amazon Web Services for Developers



Module 2
Establishing a Development Environment using Azure Virtual Machines

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Microsoft Server Products on Azure VMs

- Which version of Microsoft server products are officially supported on Azure VMs?
  - BizTalk Server 2013 and later
  - Dynamics AX 2012 R3 and later
  - Dynamics CRM/GP/NAV 2013 and later
  - Exchange 2013 and later
  - HPC Pack 2012 and later
  - Project Server 2013 and later
  - SharePoint 2010 and later
  - SQL Server 2008 and later
  - Team Foundation Server 2012 and later
  - Windows Server 2008 R2 and later (most roles)

Microsoft server software support for Microsoft Azure virtual machines
https://support.microsoft.com/en-us/kb/2721672

VM Disks

- All Azure virtual machines have at least two disks – an **operating system disk** and a **temporary disk**.
  - The operating system disk is created from an image, and both the operating system disk and the image are actually virtual hard disks (VHDs) stored as page blobs in a standard or premium storage account.
  - Three copies of the OS disk are created for high durability.
- Virtual machines also can have one or more **data disks**, that are also stored as VHDs.

About disks and VHDs for Azure virtual machines
https://azure.microsoft.com/en-gb/documentation/articles/virtual-machines-disks-vhds/

VM Sizes

- Basic: no load balancing or auto scale

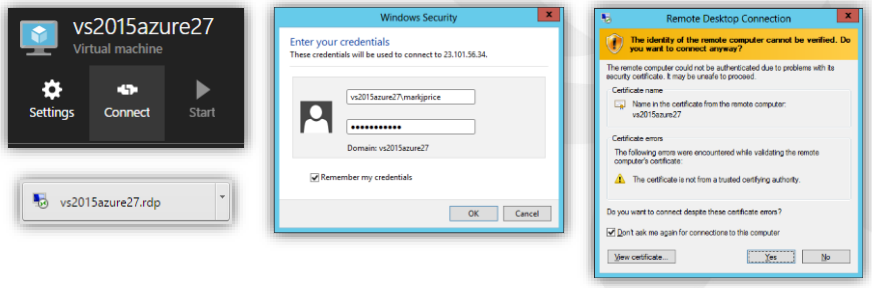
- D series: SSD, DS series: super-fast small SSD

Note: If you choose a **D2 Standard** instead of an **A3 Standard** for Lab 2 (because Visual Studio works best with an SSD local drive) then the storage account used for the VHDs must be Premium.

Establishing a Development Environment using Virtual Machines
Starting and Connecting to a VM

2.5

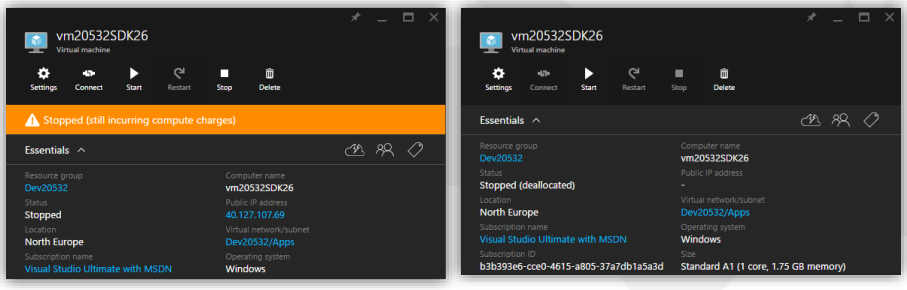
- Once you receive a notification that a VM has been successfully deployed you can view it's properties
  - At the top you can choose Connect which will download a .rdp file that when opened will establish a remote desktop protocol connection and window



Establishing a Development Environment using Virtual Machines
Stopping a VM

2.6

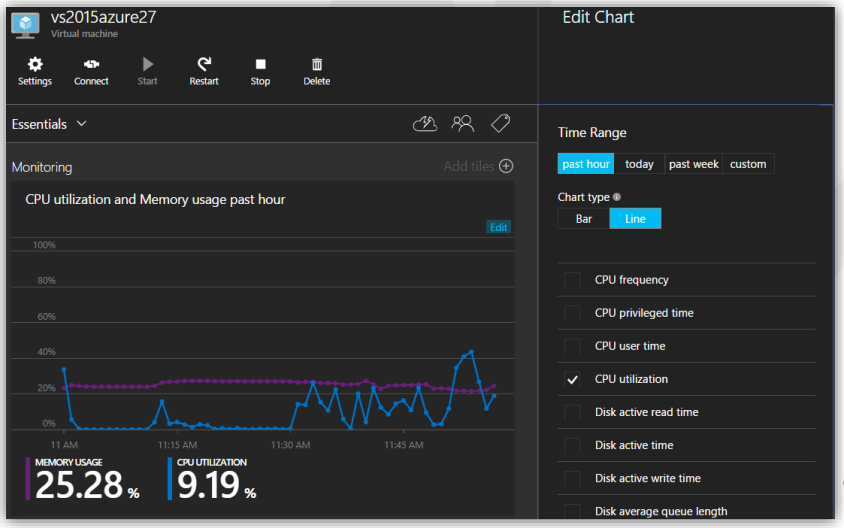
- Shutting down a virtual machine from inside the VM sets its status to **Stopped** but you are still being charged for resources!
  - Use the portal to **Stop** the VM and wait for its status to be **Stopped (deallocated)**



Establishing a Development Environment using Virtual Machines
Monitoring a VM

2.7

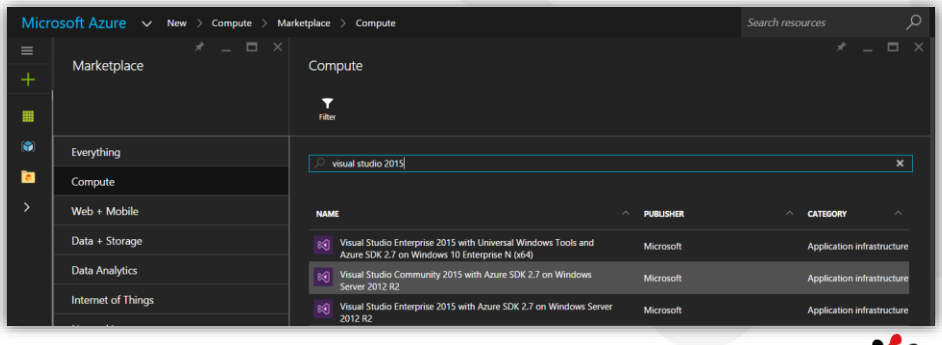
- Click **Edit** on the **Monitoring** chart to add metrics



Establishing a Development Environment using Virtual Machines
Lab Changes

2.8

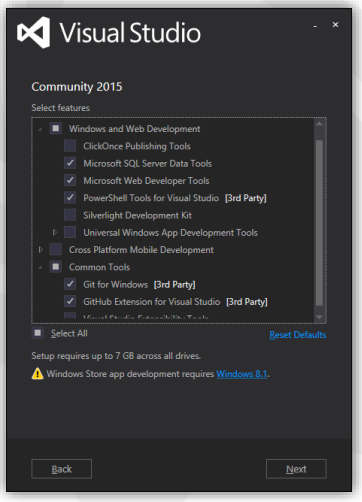
- Azure Learning Pass includes a licence to use pre-configured VMs with Visual Studio 2015 but choose one that does NOT include the latest Azure SDK
  - Manually install Azure SDK 2.6



Establishing a Development Environment using Virtual Machines

Visual Studio Installation

- Download and install Visual Studio 2015 Community
  - Microsoft SQL Server Data Tools
  - Microsoft Web Developer Tools
  - PowerShell Tools for Visual Studio
  - Git for Windows
  - GitHub Extension for Visual Studio



Establishing a Development Environment using Virtual Machines

SQL Server LocalDB Installation

- Install SQL Server 2012 LocalDb
  - …because although Visual Studio 2015 installs SQL LocalDb 2014, the labs expect SQL LocalDb 2012
- Microsoft SQL Server has many editions
  - Microsoft SQL Server Express is free but installs as a Windows Service
  - Microsoft SQL Server LocalDB runs as an application so is a better choice for a simple local data store and is installed with Microsoft Visual Studio 2012 and later automatically
- LocalDB server names
  - Visual Studio 2012/2013 uses SQL Server 2012: **(localdb)\v11.0**
  - Visual Studio 2015 uses SQL Server 2014: **(localdb)\MSSQLLocalDB**

Clone the Lab Files

- In the Team Explorer
  - Clone from: https://github.com/MicrosoftLearning/20532-DevelopingMicrosoftAzureSolutions
  - Clone to: C:\Allfiles\

Warning! If you clone to desktop then the paths will be too long for NuGet packages to be deployed.

- Use the *.md files at that URL to view updated lab instructions and lab answers

Note: Although Microsoft have re-branded Azure to remove Windows in the name many of the .NET assemblies and namespaces follow this naming convention: Microsoft.WindowsAzure.*

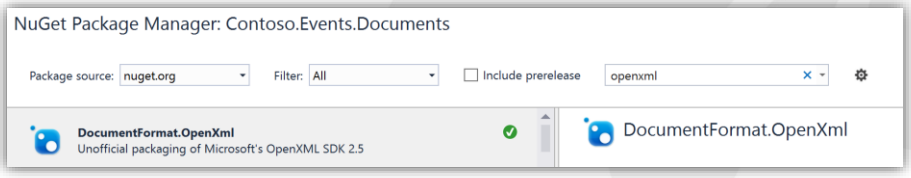
Module 3
Hosting Web Applications on the Azure Platform

Developing
Microsoft Azure Solutions

Updated 29th November 2015

How to Fix the Demo (1 of 3)

- Note
  - Students do not need to do the demo to compete Lab 3.
- In the project Contoso.Events.Documents
  - Expand **References**, right-click and remove the broken assembly reference to DocumentFormat.OpenXml.
  - Right-click the project and choose Manage NuGet Packages, search for “openxml” and then re-install the package.



- Rebuild the solution to restore all other packages.

How to Fix the Demo (2 of 3)

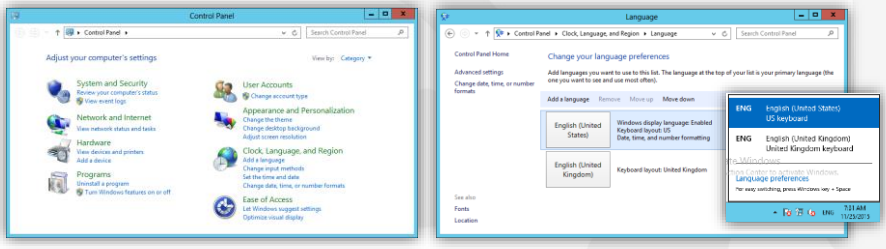
- Ensure SQL Server 2012 Express LocalDb (64-bit) is installed.
- In the Contoso.Events.Data.Generation project, modify App.config connection string to use **Initial Catalog = EventsContextModule3Demo**
- Start the Microsoft Azure Storage Emulator.
- In the project Contoso.Events.Web
  - In the file RegisterController.cs, modify to use dev. account:

```
var storageAccount = CloudStorageAccount.DevelopmentStorageAccount;
```

- Do the same in the project Contoso.Events.ViewModels
  - In the file RegisterViewModel.cs

How to Fix the Demo (3 of 3)

- The sample data uses MM/DD/YYYY format so change your language preferences to **English (United States)**.
  - Note: If you have created a new Azure VM then you will already be using English (US) by default.



- Set **Location** to **null** in the sample data code if you get number format errors e.g. in regions like Germany where dots and commas are swapped.

How to Complete the Lab

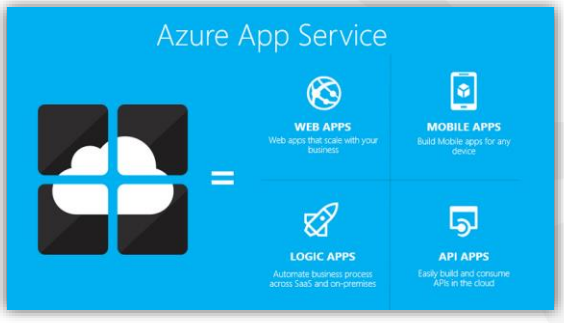
- You can choose to use either the new or old portals
  - Both will create the same type of **Web App + SQL** option but the old portal has easier options to understand.

> **Note:** **Websites** are now named **Web Apps** and **Web Hosting Plans** are now named **App Service plans**.

- To Debug the solution, right-click the **Contoso.Events.Management** project and choose **Set as StartUp Project**, then press **F5** or click **Start** button.
  - Make sure that you remove the broken reference to DocumentFormat.OpenXml assembly, install the latest version of it using NuGet, and rebuild the solution.

Microsoft Azure App Service

- What is the Azure App Service?
  - **App Service** = **Web Apps** + **Mobile Services** + **Logic Apps** + **API Apps** + connectors for common SaaS like Salesforce
  - App Service pricing is the same as the old Websites offering

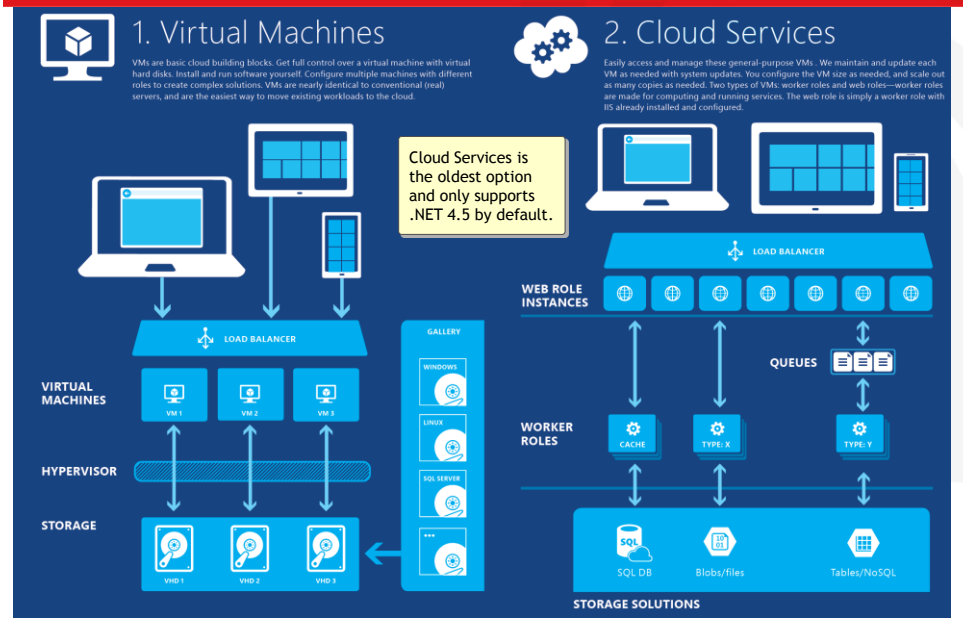


Announcing the new Azure App Service
http://weblogs.asp.net/scottgu/announcing-the-new-azure-app-service

3.7

Hosting Web Applications on the Azure Platform

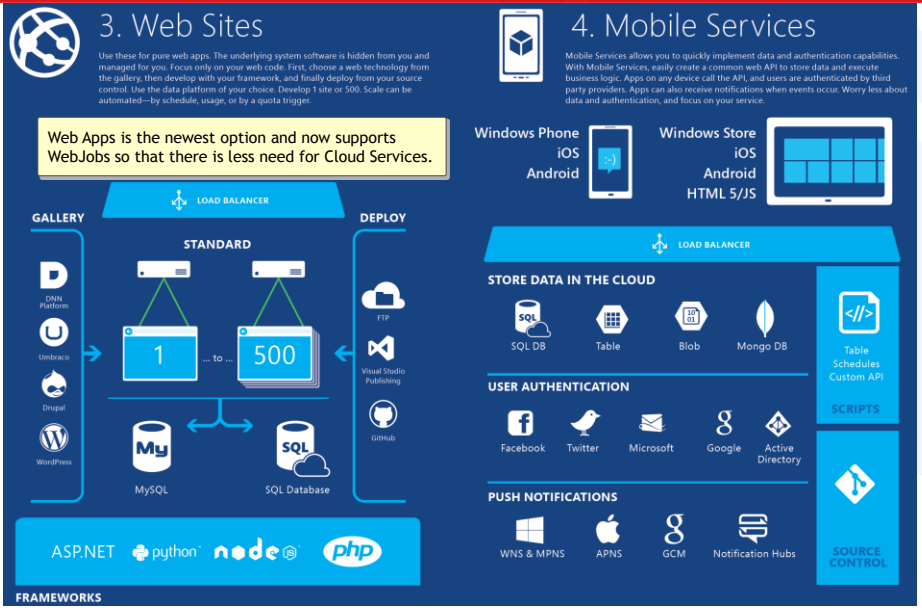
Four Models for Building and Running Apps (1 of 2)



3.8

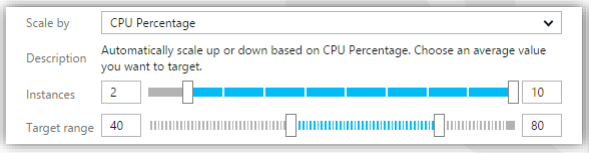
Hosting Web Applications on the Azure Platform

Four Models for Building and Running Apps (2 of 2)

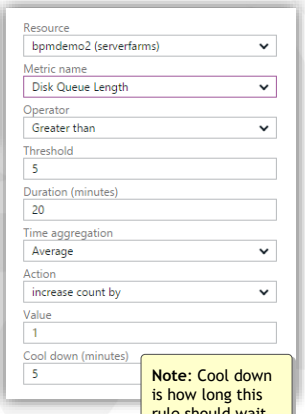


Autoscaling App Service Plans

- Autoscale will never take your service below or above the boundaries that you set, no matter your load.



- The average value is calculated across all instances over the specified Duration (e.g. 20 mins)
  - A scale out will happen when the average CPU exceeds the maximum you define, likewise, a scale in will happen whenever the average CPU drops below the minimum.

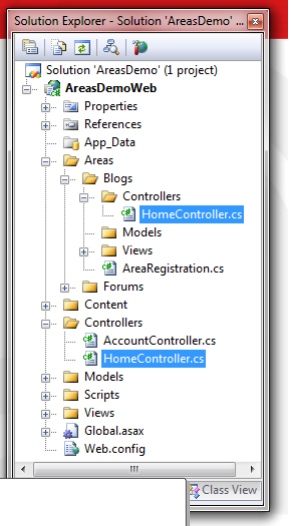


Note: Cool down is how long this rule should wait after the previous scale action to scale again.

Scale instance count manually or automatically
https://azure.microsoft.com/en-us/documentation/articles/insights-how-to-scale/

Controllers with Same Name

- By default, controllers must have unique names within an MVC project, even with multiple areas
  - To reuse a controller name in an area you must specify the root namespace when registering the default route by passing an array of string



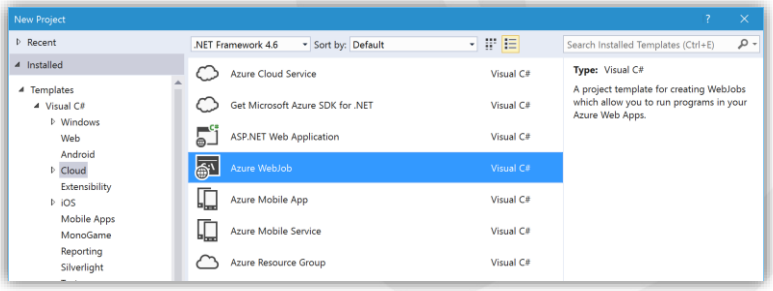
Warning! The Web API project template creates an area that works fine locally but throws exceptions when deployed to Azure Web Apps so you must use this technique to fix the issue.

```
routes.MapRoute("Default", // Route name
  "{controller}/{action}/{id}", // URL
  new { controller = "Home", action = "Index", id = "" }, // Defaults
  new[] { "AreasDemoWeb.Controllers" } // Namespace
);
```

Hosting Web Applications on the Azure Platform
WebJobs

3.11

- Run a Console application (or script) inside a Web App for background processing.



Introducing Windows Azure WebJobs
http://www.hanselman.com/blog/IntroducingWindowsAzureWebJobs.aspx

Run Background tasks with WebJobs
https://azure.microsoft.com/en-gb/documentation/articles/web-sites-create-web-jobs/

Hosting Web Applications on the Azure Platform
WebJob Entry Point and Configuration

3.12

- The entry point and Storage account configuration for logging to dashboard and application data storage

```
using Microsoft.Azure.WebJobs;
namespace WatermarkImageWebJob
{
    public class Program
    {
        static void Main()
        {
            var host = new JobHost();
            host.RunAndBlock();
        }
    }
}
```

```
<connectionStrings>
    <add name="AzureWebJobsDashboard" connectionString="" />
    <add name="AzureWebJobsStorage" connectionString="" />
```

DefaultEndpointsProtocol=https;
AccountName=*[accountname]*;
AccountKey=*[accesskey]*;

Create a .NET WebJob in Azure App Service
https://azure.microsoft.com/en-gb/documentation/articles/websites-dotnet-webjobs-sdk-get-started/

WebJob Functions

- Use attributes to specify triggers to run static methods

```
using System.IO;
using Microsoft.Azure.WebJobs;
namespace WatermarkImageWebJob
{
    public class Functions
    {
        public static void ProcessQueueMessage(
            [QueueTrigger("queue")] string message,
            TextWriter log)
        {
            log.WriteLine(message);
        }
        public static void ApplyWatermark(
            [BlobTrigger("input/{blobname}.png")] Stream input,
            [Blob("output/{blobname}-watermark.png")] Stream output)
        {
            input.CopyTo(output);
        }
    }
}
```

Module 4
Storing SQL Data in Azure

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Storing SQL Data in Azure

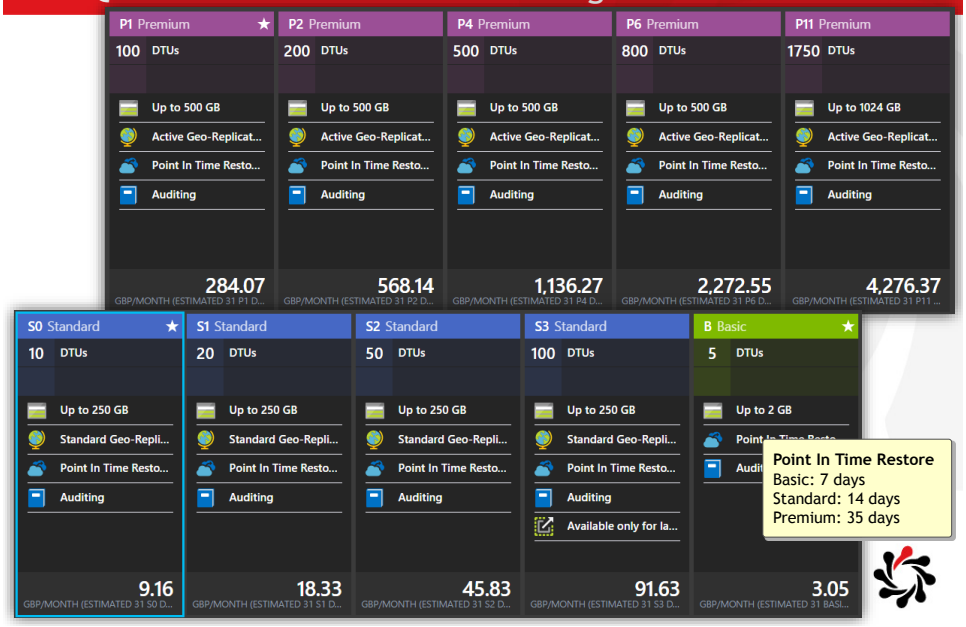
How to Fix the Lab

- If the lab does not compile
  - Remove and re-install the DocumentFormat.OpenXml assembly package.
  - Rebuild the solution.
- If you are not using the VM (that will already be set up to use US English) then you will need to configure Control Panel to add a language for English (US) and move it to the top and then restart Visual Studio.
- You will need to manually create a deployment package instead of using the UI, and then manually import the package into the portal.

4.3

Storing SQL Data in Azure

SQL Database Features and Pricing



4.4

Code First Run-Time Model

Define the Entities for the Model

- Create the entities for the model by defining POCO ("plain old CLR object") classes

Use HashSet<T> for storing collections because it is faster than List<T>

```
public class Category {
    public Category() { Products = new HashSet<Product>(); }
    public int CategoryID { get; set; }
    public string CategoryName { get; set; }
    public virtual ICollection<Product> Products { get; set; }
}
```

```
public class Product {
    public int ProductID { get; set; }
    public string ProductName { get; set; }
    public string CategoryID { get; set; }
    public virtual Category Category { get; set; }
}
```

Relationships MUST be virtual to support lazy-loading

Tutorial: Code First with EF
http://codefirst.codeplex.com/

Define: What is a HashSet?
http://stackoverflow.com/questions/4558754/define-what-is-a-hashset

Code First Run-Time Model

Define a Context for the Model

4.5

- Define a context that derives from DbContext and has a typed DbSet<TEntity> for each class in my model

```
using System.Data.Entity;
```

```
public class Northwind : DbContext
{
    public DbSet<Category> Categories { get; set; }
    public DbSet<Product> Products { get; set; }
```

```
<connectionStrings>
  <add name="Northwind"
       providerName="System.Data.SqlClient"
       connectionString="Data Source=(localdb)\v11.0;
                         Initial Catalog=Northwind;
                         Integrated Security=true;" />
```

  - If you do not specify a connection string then DbContext creates a database for you on .\SQLEXPRESS which will be named after the fully qualified name of your derived context

Code First Run-Time Model

Database Initializers

4.6

- System.Data.Entity has several initializers
  - **CreateDatabaseIfNotExists<TContext>**: will recreate and optionally re-seed the database only if the database doesn't exist
  - **DropCreateDatabaseAlways<TContext>**: will always recreate and optionally re-seed the database the first time that a context is used in the app domain
  - **DropCreateDatabaseIfModelChanges<TContext>**: will delete, recreate, and optionally re-seed the database only if the model has changed since the database was created
  - **MigrateDatabaseToLatestVersion<TContext**, **TMigrationsConfiguration>**: will use Code First Migrations to update the database to the latest version
  - For all, create a derived class and override the Seed method

Database.SetInitializer<TContext> Method
http://msdn.microsoft.com/en-us/library/gg679461(v=vs.113).aspx

Code First Run-Time Model
Modifying Entities and Saving Changes

4.7

```
using (var db = new Northwind())
{
    // context can automatically open and close connection
    // multiple times unless you explicitly manage it yourself
    db.Database.Connection.Open();

    var categories = await db.Categories.ToListAsync();

    var toInsert = new Category { CategoryName = "Foods" };
    db.Categories.Add(toInsert);

    var toModify = db.Categories.Find(5);
    toModify.CategoryName = "Changed";

    var toDelete = db.Categories.Find(9);
    db.Categories.Remove(toDelete);

    int recordsAffected = await db.SaveChangesAsync(); // => 3

    db.Database.Connection.Close();
}
```

XxxAsync methods are available in EF 6 and later

DbContext.SaveChangesAsync Method
https://msdn.microsoft.com/en-us/library/dn220070(v=vs.113).aspx

Code First Run-Time Model
Annotations

4.8

- You can apply annotations to your model

```
[Table("t_categories")]
public class Category
{
  [Key] [Column("col_ref")]
  public int Reference { get; set; }
  [MaxLength(20, ErrorMessage="20 chars max!")]
  public string CategoryName { get; set; }
```

```
using System.ComponentModel.DataAnnotations;
```

- Table, Column: to rename tables and columns
- Required, StringLength, MaxLength: to validate input
- InverseProperty, ForeignKey: to define relationships
- Key, ConcurrencyCheck, DatabaseGenerated, Timestamp, NotMapped, ComplexType

System.ComponentModel.DataAnnotations Namespace
http://msdn.microsoft.com/en-us/library/system.componentmodel.dataannotations(v=vs.110).aspx

Code First Run-Time Model
Fluent API

4.9

- Fluent API is an alternative to using Data Annotations that avoids cluttering your POCOs

```
public class Northwind : DbContext
{
  protected override void OnModelCreating(DbModelBuilder modelBuilder)
  {
    modelBuilder.Entity<Supplier>().Property(s => s.Name).IsRequired();
```

- How to use fluent API for complex relationships

```
modelBuilder.Entity<Book>()
    .HasOptional(b => b.FirstAuthor)
    .WithMany(a => a.BooksAsFirstAuthor);
modelBuilder.Entity<Book>()
    .HasOptional(b => b.SecondAuthor)
    .WithMany(a => a.BooksAsSecondAuthor);
```

Configuring/Mapping Properties and Types with the Fluent API
http://msdn.microsoft.com/en-us/data/jj591617#2.4

Code First Run-Time Model
Conventions

4.10

- Primary key convention
  - Code First infers that a property is a primary key if a property is named “ID” (case-insensitive) or “*classname*ID”…
  - … and if the type of the property is numeric or GUID it will be configured as an identity column
- Custom primary key convention
  - With the following any property in our model named Key will be configured as the primary key of whatever entity its part of

```
protected override void OnModelCreating(DbModelBuilder modelBuilder)
{
    modelBuilder.Properties()
        .Where(p => p.Name == "Key").Configure(p => p.IsKey());
```

Code First Conventions
http://msdn.microsoft.com/en-gb/data/jj679962.aspx

Custom Code First Conventions (EF6 onwards)
http://msdn.microsoft.com/en-gb/data/jj819164

Code First Run-Time Model
Migration Support

- For example, if you wanted to add a new column to a Blogs table called Url

```
public partial class AddBlogUrl : DbMigration
{
  public override void Up()
  {
    AddColumn("Blogs", "Url", c => c.String());
  }
  public override void Down()
  {
    DropColumn("Blogs", "Url");
  }
}
```

EF 4.3 Released
http://blogs.msdn.com/b/adonet/archive/2012/02/09/ef-4-3-released.aspx

Module 5
Designing Cloud Applications for Resiliency

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Transient Fault Handling
What Is It?

- When you're designing a real world cloud app, one of the things you have to think about is how to handle temporary service interruptions.
  - You can frequently get little glitches that are typically self-healing, and if you aren't prepared to handle them intelligently, they'll result in a bad experience for your customers.
- Use smart retry/back-off logic to mitigate the effect of transient failures.
  - Instead of throwing an exception and displaying a not available or error page to your customer, you can recognize errors that are typically transient, and automatically retry the operation that resulted in the error, in hopes that before long you'll be successful.

Transient Fault Handling
http://www.asp.net/aspnet/overview/developing-apps-with-windows-azure/building-real-world-cloud-apps-with-windows-azure/transient-fault-handling

Implementing Smart Retry Logic

- Several ways you can implement smart retry logic.
  - Microsoft Patterns & Practices group has a **Transient Fault Handling Application Block** that does everything for you if you're using ADO.NET for SQL Database access (not through Entity Framework).

```
var policy = RetryPolicy.Create<SqlAzureTransientErrorDetectionStrategy>(
    retryCount: 3, retryInterval: TimeSpan.FromSeconds(5));
using (var conn = new ReliableSqlConnection(connStr, policy))
```

  - EF6 builds in this kind of retry logic.

```
public class EFConfiguration : DbConfiguration
{
    public EFConfiguration()
    {
        AddExecutionStrategy(() => new SqlAzureExecutionStrategy());
```

Transient Fault Handling Application Block
http://msdn.microsoft.com/en-us/library/dn440719(v=pandp.60).aspx

Module 6
Managing Cloud Services in Azure

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Managing Cloud Services in Azure
Configuring Azure Virtual Machines

File	Description
ServiceDefinition.csdef (changes require a new deployment)	Defines: - Endpoints for communicating between VMs - Size of VM and upgrade domain count - Modules for diagnostics, RDP, and so on - Certificates (location) - Startup tasks and environment variables - Configuration settings to load from .cscfg
ServiceConfiguration.cscfg (changes can be applied "live" BUT beware that some will cause a restart e.g. certificates)	Configures: - Number of instances of each type of VM - Certificates (thumbprint) - Values of configuration settings
WebRole.cs, WorkerRole.cs	Custom code executed when the VM: - OnStart, Runs, OnStop - Changes to configuration
Global.asax	Application_Start and _End events
Web.config	Normal ASP.NET and IIS configuration

Azure Service Definition Schema (.csdef File)
https://msdn.microsoft.com/en-us/library/azure/ee758711.aspx

Azure Service Configuration Schema (.cscfg File)
https://msdn.microsoft.com/en-us/library/azure/ee758710.aspx

Managing Cloud Services in Azure

Endpoints in Service Definition Files

ServiceDefinition.csdef

- Contains the definitions for the roles available to a service, specifies the service endpoints, and establishes configuration

```
<ServiceDefinition ...>
  <WebRole name="web-role-name" ...
    <Endpoints>
      <InputEndpoint name="endpoint-name" protocol="HTTP" port="80" ...
      <InternalEndpoint ...
      <InstanceInputEndpoint ...
```

- **InputEndpoint**: an endpoint to a role from the external world
- **InternalEndpoint**: available only to other role instances running within the service
- **InstanceInputEndpoint**: associated with a specific role instance by using port forwarding in the load balancer

WebRole Schema
http://msdn.microsoft.com/en-us/library/windowsazure/gg557553.aspx

Managing Cloud Services in Azure

Startup Tasks (ServiceDefinition.csdef)

Perform operations before a role starts

- e.g. installing a component, registering COM components, setting registry keys, or starting a long running process
- executionContext: limited (same as role), elevated (admin)
- taskType: simple (synchronous, wait for completion one at a time), foreground or background (asynchronous)

Warning! You cannot directly call a PowerShell script so you must have a batch file that calls PowerShell to run the .ps1 script instead.

```
<Startup>
  <Task commandLine="Startup.cmd"
        executionContext="limited" taskType="simple" >
    <Environment>
      <Variable name="MyVersionNumber" value="1.0.0.0" />
    </Environment>
  </Task>
</Startup>
```

Run Startup Tasks in Windows Azure
http://msdn.microsoft.com/en-us/library/windowsazure/hh180155.aspx

Managing Cloud Services in Azure

RoleEntryPoint and RoleEnvironment Events

6.5

- When you create Cloud Service projects each role will have a WebRole.cs or WorkerRole.cs
  - Derives from **RoleEntryPoint** which has three methods you can override: **OnStart**, **OnStop**, **Run**
  - Can handle events on **RoleEnvironment** class
    - **Changed**, **Changing**: if the configuration is changed
    - **StatusCheck**, **Stopping**

```
public class WebRole : RoleEntryPoint
{
  public override bool OnStart()
  {
    RoleEnvironment.Changing
      += RoleEnvironment_Changing;
    return base.OnStart(); // true
```

```
void RoleEnvironment_Changing(
  object sender,
  RoleEnvironmentChangingEventArgs e)
{
  Log(e.Changes);
  e.Cancel = true; // causes a restart
```

Leveraging the RoleEntryPoint
http://brentdacodemonkey.wordpress.com/2011/09/24/leveraging-the-roleentrypoint-year-of-azure-week-12/

Managing Cloud Services in Azure

Run Method

6.6

- The Run is considered the Main method for your application
  - Overriding the Run method is not required; the default implementation never returns
  - If you do override the Run method, your code should block indefinitely
  - If your Run method returns, the role is automatically recycled by raising the Stopping event and calling the OnStop method so that your shutdown sequences may be executed before the role is taken offline

```
public override void Run()
{
   try
   {
      Trace.WriteLine("Run");
      while (true)
      {
         Thread.Sleep(10000);
         Trace.WriteLine("Working");
      }
```

RoleEntryPoint.Run Method
https://msdn.microsoft.com/en-us/library/microsoft.windowsazure.serviceruntime.roleentrypoint.run.aspx

Managing Cloud Services in Azure

OnStop and Waiting for a Process to Exit

- If you override the OnStop method, you must call the base class' OnStop after completing your actions

```
public override void OnStop()
{
  try
  {
    // make the current thread wait until
    // the associated process terminates
    Process.Start("myapp.exe").WaitForExit();
    base.OnStop();
```

  - Code has 5 minutes to finish when it is called for reasons other than a user-initiated shutdown after which the process is terminated, so you must make sure that code in the OnStop method can run quickly or tolerates not running to completion

RoleEntryPoint.OnStop Method
http://msdn.microsoft.com/en-us/library/azure/microsoft.windowsazure.serviceruntime.roleentrypoint.onstop.aspx

Process.WaitForExit Method
http://msdn.microsoft.com/en-us/library/fb4aw7b8.aspx

Managing Cloud Services in Azure

Remote Desktop (RDP) (ServiceDefinition.csdef)

- By using the Azure SDK and Remote Desktop Services, you can access Azure **web**, **worker**, and **VM** roles
- Step 1: Set up a certificate
  - The certificates for a remote desktop connection are different from the certificates that you use for other Azure operations
  - The remote access certificate must have a private key which should be exported as a PFX file
- Step 2: Import modules

```
<Imports>
  <Import moduleName="RemoteAccess" /><!-- allow RDP connection to this role -->
  <Import moduleName="RemoteForwarder" /><!-- only one role can be forwarder -->
```

Using Remote Desktop with Windows Azure Roles
http://msdn.microsoft.com/en-us/library/windowsazure/gg443832.aspx

How does Remote Desktop works in Windows Azure?
http://blogs.msdn.com/b/avkashchauhan/archive/2011/12/06/how-does-remote-desktop-works-in-windows-azure.aspx

Managing Cloud Services in Azure
Diagnostics Logs (ServiceDefinition.csdef)

6.9

- Windows Azure Diagnostics configuration defines values that are used to initialize the Diagnostics Monitor
  - Sections: DiagnosticInfrastructureLogs, Logs, Directories, PerformanceCounters, WindowsEventLog
- The Logs element defines the buffer configuration for basic Windows Azure logs

```
<Logs bufferQuotaInMB="2"
      scheduledTransferLogLevelFilter="Warning"
      scheduledTransferPeriod="PT1M" />
```

ISO 8601:
Period Time 1 Minute

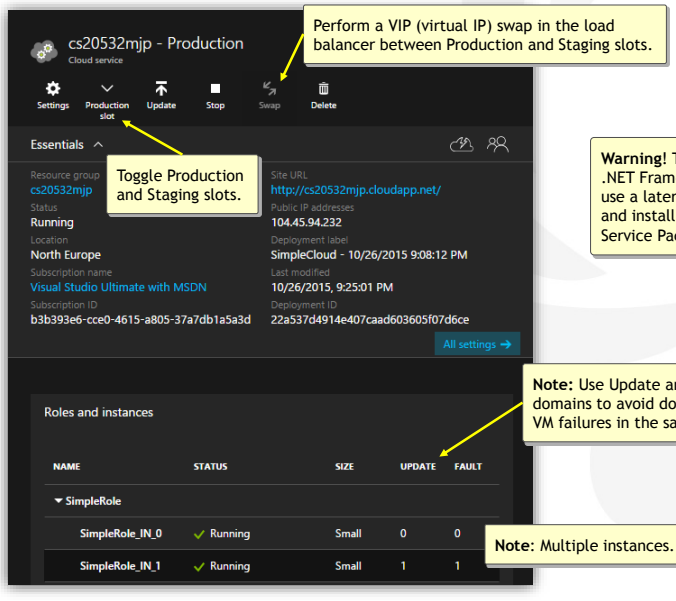
  - scheduledTransferLogLevelFilter: Specifies the minimum severity level for log entries that are transferred
  - scheduledTransferPeriod: Specifies the interval between scheduled transfers of data, rounded up to the nearest minute

Windows Azure Diagnostics Configuration Schema
http://msdn.microsoft.com/en-us/library/gg593185.aspx

ISO 8601 - Durations
http://en.wikipedia.org/wiki/ISO_8601#Durations

Managing Cloud Services in Azure
Deploying Cloud Services

6.10



Module 7
Storing Tabular Data in Azure

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Azure Storage Overview
Choices

- Azure storage (500TB per account, 100 accounts)
  - **Table**: schema-less entities (<1MB each), table (unlimited)
  - **Blob**: block for media (<200GB each) or page for VHDs (<1TB)
  - **Queue**: message exchange (<64KB each)
  - **Files**: permanent file system using SMB protocol
  - **Local**: temporary file system in a role VM (lost at any time)
- Why use Microsoft Azure storage?
  - Cloud-native functionality at very low cost.
- …but you have other choices too
  - Instead of **Table** you could use **DocumentDB**, **Redis**, **SQL Database**, **MongoDB**, **Data Lake**, and others.
  - Instead of **Queue** you could use **Service Bus Queues**.

Azure Storage Overview

Replication Choices for Storage Account

7.3

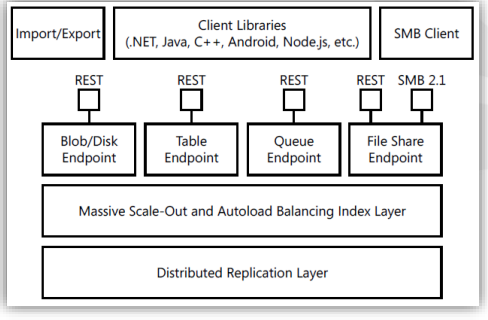
- **Locally Redundant** replicates in the same data center.
- **Zone Redundant** replicates in a secondary data center.
- **Geo-Redundant** replicates in a secondary region.
- **Read-Access Geo-Redundant** replicates in a secondary region + the replica can be read from for extra scale.
  - The secondary Read-Access endpoint is similar to the primary endpoint, but appends the suffix **-secondary** to the account name.

Azure Storage Overview

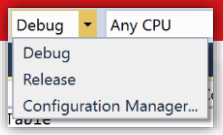
Demos and Labs

7.4

- If you use Azure SDK 2.6
  - Install WindowsAzure.Storage Client Library 4.3 NuGet Package
  - Warning! The Server Explorer only shows “Classic” storage accounts so make sure you use a “Classic” storage account.



Common API Pattern (1 of 2)



- Get a reference to the storage account
  - Local development account for testing

```
#if DEBUG
    var account = CloudStorageAccount.DevelopmentStorageAccount;
#endif
```

  - Parse storage connection string from configuration file

```
<add key="StorageConnectionString"
     value="DefaultEndpointsProtocol=https;AccountName=storagesample;
            AccountKey=nYV0gln9fT7bvY+rxu2iWAEyzPNITGkhM88J8HUoyofpK7C
                       8fHcZc2kIZp6cKgYRUM74lHI84L50Iau1+9hPjB==" />
```

```
#if !DEBUG
    var account = CloudStorageAccount.Parse(
        CloudConfigurationManager.GetSetting("StorageConnectionString"));
#endif
```

How to use Queue storage from .NET
https://azure.microsoft.com/en-gb/documentation/articles/storage-dotnet-how-to-use-queues/

Common API Pattern (2 of 2)

- Create a client for the type of storage you want

```
var tclient = account.CreateCloudTableClient();
var bclient = account.CreateCloudBlobClient();
var qclient = account.CreateCloudQueueClient();
```

- Get a reference to a resource, create if it does not exist

```
var table = tclient.GetTableReference("muppets");
table.CreateIfNotExists();
```

```
var queue = qclient.GetQueueReference("muppets");
queue.CreateIfNotExists();
```

- Create entity/queue/blob and perform operation

```
var msg1 = new CloudQueueMessage("kermit");
queue.AddMessage(msg1);
Console.WriteLine(queue.ApproximateMessageCount);
var msg2 = queue.GetMessage();
Console.WriteLine(msg2.AsString);
```

Azure Storage Tables
Storage Table Entity Design

7.7

- Entities must have three properties
  - **PartitionKey**, **RowKey**: both are strings of up to 1024 bytes (therefore about 500 characters).
  - Calculate the square root of total number of entities as guide
  - **TimeStamp**: DateTime (can be auto-created but then you won't be able to get or set the value assigned).
  - **ETag**: string used to detect other processes changes in optimistic concurrency scenarios. If the ETag in your entity doesn't match the current value in the Table then it fails. To ignore failures, set to an asterisk: *
- Inherit from **TableEntity** or implement **ITableEntity**

Designing a Scalable Partitioning Strategy for Windows Azure Table Storage
http://msdn.microsoft.com/en-us/library/windowsazure/hh508997.aspx

Azure Storage Tables
Storage Table Entity Design

7.8

- Entities can only use the following types
  - char, string, int, long, DateTime, byte[], bool, double, Guid
- Warning!
  - You cannot use your own subtypes
- Warning!
  - Storage emulator has limitations (see link below)

Use the Azure Storage Emulator for Development and Testing
https://azure.microsoft.com/en-us/documentation/articles/storage-use-emulator/

Azure Storage Tables

Storage Table Operations (1 of 2)

7.9

- To insert a single entity

```
Employee first = new Employee
    { PartitionKey = "IT", RowKey = "ibahena", YearsAtCompany = 7 };
TableOperation insertOperation = TableOperation.InsertOrReplace(first);
table.Execute(insertOperation);
```

- To insert a batch of entities in a transaction

```
Employee second = new Employee
    { PartitionKey = "HR", RowKey = "rreeves", YearsAtCompany = 12 };
Employee third = new Employee
    { PartitionKey = "HR", RowKey = "rromani", YearsAtCompany = 3 };
TableBatchOperation batchOperation = new TableBatchOperation();
batchOperation.InsertOrReplace(second);
batchOperation.InsertOrReplace(third);
table.ExecuteBatch(batchOperation);
```

  - Batches must be on the same partition and are limited to a maximum of 4 MB

Azure Storage Tables

Storage Table Operations (2 of 2)

7.10

- To retrieve a single entity

```
TableOperation retrieveOperation =
    TableOperation.Retrieve<Employee>("IT", "ibahena");
TableResult result = table.Execute(retrieveOperation);
Employee itEmployee = (Employee)result.Result;
```

- To retrieve multiple entities

```
string queryFilter = TableQuery.GenerateFilterCondition(
    "PartitionKey", QueryComparisons.Equal, "HR"); // => "PartitionKey eq 'HR'"
TableQuery<Employee> query = new TableQuery<Employee>().Where(queryFilter);
Console.WriteLine("HR Employees\n");
foreach (Employee hrEmployee in table.ExecuteQuery<Employee>(query))
{
    Console.WriteLine(hrEmployee);
}
```

- Querying on non-key columns performs a table scan!

Azure Storage Tables

Storage REST APIs and OData

7.11

- All storage services are accessible via REST APIs
  - Supports both HTTP and HTTPS
  - Using HTTPS-only is default and highly recommended
- Storage Tables have a REST API that implements the OData protocol
- Every request made against a storage service must be authenticated…
  - …unless the request is for a blob or container resource that has been made available for public or given a SAS token
  - Requires two headers: Date/x-ms-date and Authorization

Table Service REST API
https://msdn.microsoft.com/en-us/library/azure/dd179423.aspx

Authentication for the Azure Storage Services
https://msdn.microsoft.com/en-gb/library/azure/dd179428.aspx

Azure Storage Tables

When NOT to use Table Storage

7.12

- Azure Table Storage is good but severely limited because it does not support secondary indexes.
  - Its write capabilities scale very, very well.
  - Its querying and indexing capabilities are astonishingly limited.

How can we improve Azure Storage? Support secondary Indexes, November 24, 2009
http://feedback.azure.com/forums/217298-storage/suggestions/396314-support-secondary-indexes

Azure Storage Tables
Redis

- Redis (for data storage and caching)
  - Very popular open-source, networked, in-memory, key-value data store known for high performance, flexibility, a rich set of data structures, and a simple straightforward API.
  - MS Open Tech has been working with the Redis community to build a production-ready Windows port of Redis, including 64-bit support, an installer for Microsoft Azure, NuGet support, and much more.
- To use Redis with a .NET application
  - Install the StackExchange.Redis NuGet package.
  - Use the ConnectionMultiplexer class to connect.
  - Use StringSet(*key*, *value*) and StringGet(*key*) to write and read.
  - Use StringIncrement(*key*) to increment an integer value.

Redis
http://msopentech.com/opentech-projects/redis/

Azure Storage Tables
DocumentDB

- DocumentDB is a fully-managed, highly-scalable, NoSQL document database service
  - Rich query over a schema-free JSON data model
  - Transcational execution of JavaScript logic
  - Scalable storage and throughput
  - Blazingly fast and write optimized database service
- Warning!
  - Microsoft will not be putting any more effort into DocumentDB

DocumentDB
http://azure.microsoft.com/en-us/services/documentdb/

Azure Storage Tables
Data Lake

- Azure Data Lake includes all the capabilities required to make it easy for developers, data scientists and analysts to store data of any size, shape and speed, and do all types of processing and analytics across platforms and languages.
- A Data Lake is a large storage repository that “holds data until it is needed”.
  - Allows an organization to hold their data sets in their original native format rather than forcing integration of large volumes of data up front.
  - “One of the more controversial ways to manage big data.”

Gartner Says Beware of the Data Lake Fallacy
http://www.gartner.com/newsroom/id/2809117

Data Lake
https://azure.microsoft.com/en-gb/solutions/data-lake/

8.1

Module 8
Storing and Consuming Files from Azure Storage

Developing
Microsoft Azure Solutions

Updated 29th November 2015

8.2

Storing and Consuming Files from Azure Storage
Labs

- When using Azure SDK 2.6
  - The Server Explorer only shows “Classic” storage accounts so make sure you use a “Classic” storage account for Lab 8
- Warning!
  - The Lab 8 instructions for specifying the filename does not include the file extension. The lab answer key correctly tells you to include .docx for the file extension.

Blob Storage Overview

- Blob storage is used to keep the images from a website, streaming audio and video, storing data for access on-premises or from Azure, and so on.
- Blobs are stored in Containers.
- Block blobs are most common and can store up to 200 GB of data and are optimized for streaming.
- Page blobs can store up to 1 TB and are optimized for random read/write operations. VHDs for VMs use them.
- Containers and blobs have system properties such as ETag and LastModified.
- Blobs can have user-defined metadata up to 8 KB.

Copying Storage

- AzCopy is a command-line utility designed for high-performance uploading, downloading, and copying data to and from Microsoft Azure Blob, File, and Table storage.

```
AzCopy /Source:C:\myfolder
    /Dest:https://myaccount.blob.core.windows.net/mycontainer
    /DestKey:key
    /Pattern:abc.txt
```

  - When you copy blobs or files with AzCopy, keep in mind that another application may be modifying the data while you are copying it. If possible, ensure that the data you are copying is not being modified during the copy operation.

Getting Started with the AzCopy Command-Line Utility
https://azure.microsoft.com/en-gb/documentation/articles/storage-use-azcopy/

File Storage Overview

- File storage uses the standard Server Message Block (SMB) 2.1 protocol.
  - Azure VMs and cloud services can access the File storage account using the SMB protocol, and on-premises devices can access the File storage account using the File Storage API from the Azure .Net Storage Client Library or REST HTTP calls.
- There is no limit to the number of Azure resources that can connect to the File storage and access the file share.
- Applications that access a File storage will not have to be rewritten to use a new storage type, such as Blob storage.

Module 9
Designing a Communication Strategy by Using Queues and Service Bus

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Azure Storage Queues
Setting Up a Queue

- Reliable, low latency, high-throughput messaging
  - With queues you can decouple your components or roles. A Web Role can put data in a Queue for a Worker Role to perform. This makes it possible for the roles to scale independently.

```
var qclient = account.CreateCloudQueueClient();
var queue = qclient.GetQueueReference("muppets");
queue.CreateIfNotExists();
var msg1 = new CloudQueueMessage("kermit");
queue.AddMessage(msg1);
Console.WriteLine(queue.ApproximateMessageCount);
var msg2 = queue.GetMessage();
Console.WriteLine(msg2.AsString);
```

How to use Queue storage from .NET
https://azure.microsoft.com/en-gb/documentation/articles/storage-dotnet-how-to-use-queues/

Azure Storage Queues
Processing Messages

9.3

- When you dequeue a message using GetMessage() the message is made invisible for 30 seconds

```
using Microsoft.WindowsAzure.Storage.Queue;
using Microsoft.WindowsAzure.Storage.RetryPolicies;
```

```
var message = new CloudQueueMessage("kermit");
queue.AddMessage(message,
    timeToLive: TimeSpan.FromDays(7), // from 1 second up to 7 days
    initialVisibilityDelay: TimeSpan.FromSeconds(0),
    options: new QueueRequestOptions
        { LocationMode = LocationMode.PrimaryThenSecondary });
```

  - Messages in queues expire after seven days

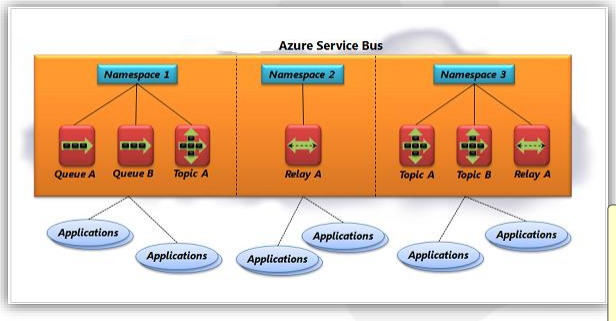
```
var message = queue.GetMessage(visibilityTimeout: TimeSpan.FromSeconds(30));
// process message
queue.DeleteMessage(message);
```

```
IEnumerable<CloudQueueMessage> messages = queue.GetMessages(3); // <=32
```

Azure Service Bus
Service Bus Namespaces

9.4

- SB namespace is used to group related features



When you create a queue, topic, relay, or hub, you give it a name. Combined with whatever you called your namespace, this name creates a unique identifier for the object.

  - **Relay**: live message exchange
  - **Queue/Topic**: messages pushed and pulled *manually*
  - **Notification Hub**: messages pushed to clients *automatically*

Azure Service Bus
https://azure.microsoft.com/en-gb/documentation/articles/service-bus-fundamentals-hybrid-solutions/

Azure Service Bus

Configuring Service Bus Relay Endpoints

- Replace *** with your registered namespace

```
<services>
  <service name="Service.ProblemSolver">
    <endpoint contract="Service.IProblemSolver"
              binding="netTcpRelayBinding"
              address="sb://***.servicebus.windows.net/solver"
              behaviorConfiguration="sbTokenProvider"/>
```

Must use a binding with *Relay* in the name

- Use your key provider for the issuer name

```
<behaviors>
  <endpointBehaviors>
    <behavior name="sbTokenProvider">
      <transportClientEndpointBehavior>
        <tokenProvider>
          <sharedSecret issuerName="owner"
                        issuerSecret="**key**" />
```

issuerName must be “owner”

issuerSecret is the secret key

How to Use the Service Bus Relay Service
http://www.windowsazure.com/en-us/develop/net/how-to-guides/service-bus-relay/

Securing and authenticating azure service bus relay messages using a shared secret
http://acaseyblog.wordpress.com/2013/03/22/securing-and-authenticating-azure-service-bus-relay-messages-using-a-shared-secret/

Module 10
Managing Infrastructure in Azure

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Managing Infrastructure in Azure
Lab 10

- Create a “classic” network and virtual machine to complete the lab

Managing Infrastructure in Azure

System Center 2012 R2 and Hybrid Cloud

- System Center 2012 R2 includes
  - App Controller: VM and application self-service.
  - Service Manager: portal for custom service desk offerings.
  - Virtual Machine Manager (VMM): configure and manage virtualisation host, networking, and storage resources to create and deploy virtual machines and services to private clouds.
  - Orchestrator: workflow management solution.
  - Operations Manager: monitor services, devices, and operations for many computers in a single console.
  - Data Protection Manager (DPM): enterprise backup system.
  - Configuration Manager: secure and scalable deployment.
- Full implementation would need 40+ VMs!

System Center 2012 R2
http://www.microsoft.com/en-gb/server-cloud/products/system-center-2012-r2/

Managing Infrastructure in Azure

Endpoints

- All virtual machines that you create in Azure can automatically communicate using a private network channel with other virtual machines in the same cloud service or virtual network.
- However, computers on the Internet or other virtual networks require endpoints to direct the inbound network traffic to a virtual machine.

How to set up endpoints to a virtual machine
https://azure.microsoft.com/en-gb/documentation/articles/virtual-machines-set-up-endpoints/

Managing Infrastructure in Azure

CIDR Notation

- Classless Inter-Domain Routing (CIDR) notation is a shorthand representation of a subnet mask.
- It uses the number of bits to represent a subnet mask.
  - For example, a subnet mask of 255.0.0.0 uses 8 bits, hence it's written as /8. And a subnet mask of 255.255.0.0 uses 16 bits, which is written as /16 in CIDR notation.
  - With CIDR, 10.0.0.0/8 represents a network ID of 10.0.0.0 and a subnet mask of 255.0.0.0, which corresponds to the address range 10.0.0.0 to 10.255.255.255

Managing Infrastructure in Azure

IP Addresses

- Each VM has at least two associated IP addresses: a public-facing virtual IP (VIP) address, and an internal dynamic IP (DIP) address.
- You can reserve VIPs so that you can assign static public IPs to your VMs. Each Azure subscription is allowed to reserve 20 VIPs.

Desired State Configuration (DSC)

- DSC is a declarative platform used for configuration, deployment, and management of systems.
- DSC is a means to *maintain* existing configurations.
  - Not just for initial deployment, it can run on a schedule and attempt to reset changes to conform to a desired state.
- Configurations are declarative PowerShell scripts which define and configure instances of resources.
  - Upon running the configuration, DSC (and the resources being called by the configuration) will simply “make it so”).

Windows PowerShell Desired State Configuration Overview
https://msdn.microsoft.com/en-us/PowerShell/DSC/overview

DSC Configuration

- DSC configurations are PowerShell scripts that define a special type of function. To define a configuration, you use the PowerShell keyword Configuration.
- Before you can enact a configuration, you have to compile it into a MOF document. You do this by calling the configuration like you would a PowerShell function.

```
Configuration MyDscConfiguration {

    param(
        [string[]]$computerName="localhost"
    )
    Node $computerName {
        WindowsFeature MyFeatureInstance {
            Ensure = “Present”
            Name =    “RSAT”
        }
        WindowsFeature My2ndFeatureInstance {
            Ensure = “Present”
            Name = “Bitlocker”
        }
    }
}
```

DSC Configurations
https://msdn.microsoft.com/en-us/PowerShell/DSC/configurations

Module 11
Automating Integration with Azure Resources

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Automating Integration with Azure Resources
Lab 11

- Cmdlets used by lab have been deprecated!
  - "We deprecated Get-AzureResourceGroupGalleryTemplate and removed the API that supported it too early. Please accept our apologies about this. We are working on a replacement for these cmdlets. It will enable all the current capabilities add ability to save "non default" templates (like variations on SQL images), will not require to authenticate to save public items, among other improvements."
  - Read details at link below…

get-azureresourcegroupgallerytemplate returning "missing api version in the query string"
https://github.com/Azure/azure-powershell/issues/1064

Automating Integration with Azure Resources

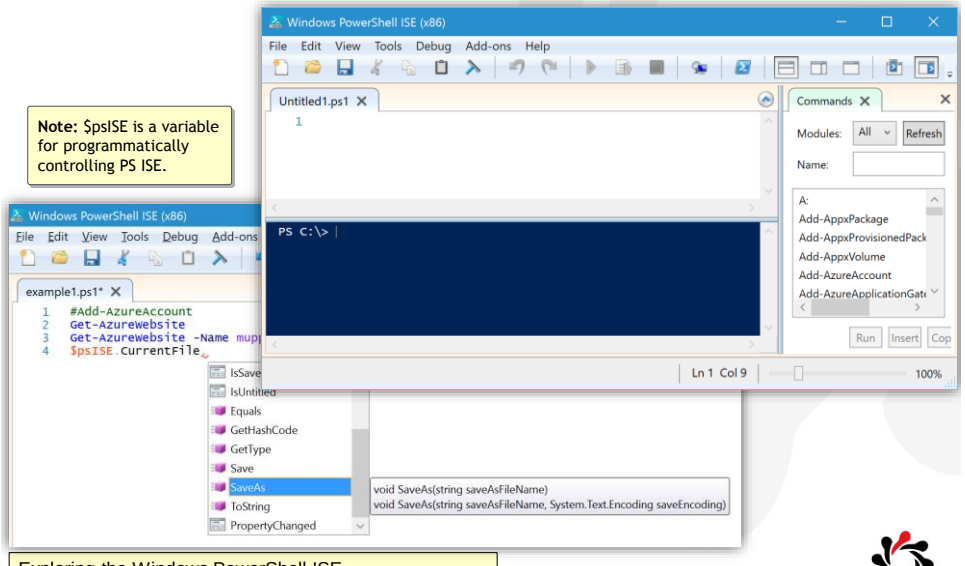
PowerShell ISE

- Windows PowerShell Integrated Scripting Environment (ISE) is a host application for Windows PowerShell.
  - In Windows PowerShell ISE, you can run commands and write, test, and debug scripts in a single Windows-based graphic user interface with multiline editing, tab completion, syntax coloring, selective execution, context-sensitive help, and support for right-to-left languages.
- To run it, start the Microsoft Azure PowerShell and enter powershell_ise.exe at the prompt.
  - PS C:\> powershell_ise
- File extensions: Scripts (.ps1), data (.psd1), modules (.psm1), configuration (.ps1xml)

Windows PowerShell Integrated Scripting Environment (ISE)
https://technet.microsoft.com/en-gb/library/dd819514.aspx

Automating Integration with Azure Resources

PowerShell ISE User Interface



Exploring the Windows PowerShell ISE
https://technet.microsoft.com/en-us/library/dd819513.aspx

Automating Integration with Azure Resources

PowerShell Cmdlets (“Command Lets”)

- You can use each cmdlet separately, but their power is realized when you use these simple tools in combination to perform complex tasks.
  - Windows PowerShell includes more than one hundred basic core cmdlets, and you can write your own cmdlets and share them with other users.
  - Azure extends with hundreds more.
- Unlike traditional command lines, PowerShell deals with objects not strings.
  - Although the output is one or more objects, the console displays the output formatted as text.
  - PowerShell is based on .NET Framework.

Automating Integration with Azure Resources

PowerShell Verb-Noun Convention

- All cmdlets follow the Verb-Noun convention
  - Get-Date, Get-Service, Stop-Service, Suspend-Service, …
- You can filter by verb or noun

```
PS> Get-Command -Verb Get
CommandType     Name                            Definition
-----------     ----                            ----------
Cmdlet          Get-Acl                         Get-Acl [[-Path] <String[]>]...
Cmdlet          Get-Alias                       Get-Alias [[-Name] <String[]...
Cmdlet          Get-AuthenticodeSignature       Get-AuthenticodeSignature [-...
...
```

```
PS C:\> Get-Command -Noun AzureWebsite

CommandType     Name                                               Version    Source
-----------     ----                                               -------    ------
Cmdlet          Get-AzureWebsite                                   0.9.7      Azure
Cmdlet          New-AzureWebsite                                   0.9.7      Azure
Cmdlet          Remove-AzureWebsite                                0.9.7      Azure
Cmdlet          Restart-AzureWebsite                               0.9.7      Azure
Cmdlet          Set-AzureWebsite                                   0.9.7      Azure
Cmdlet          Show-AzureWebsite                                  0.9.7      Azure
Cmdlet          Start-AzureWebsite                                 0.9.7      Azure
Cmdlet          Stop-AzureWebsite                                  0.9.7      Azure
```

PowerShell Help

- Get-Command *: lists all commands
- Get-Command *azure*: lists Azure-related commands
- Get-Help *command*: syntax, aliases, remarks
- Get-Help *command* –Online: more detailed help in the web browser
- Get-Service: list for all services info.
- Get-Service –Name aspnet_state: specific service info.
- Get-Service | Get-Member: list members of an instance of a service e.g. Status, Name, Display Name, etc.

PowerShell Basics

- $: dollar as a prefix indicates a variable.
  - Built-in variables : $true, $false, $PSVersionTable, $HOME
  - $_ : *this* token
- | (pipe) : Catch output of the command and pass it to another command. Pipes allow you to chain together cmdlets to create more complex actions.
- ` (back tick) : Continue command on next line.
- # : Single Line / End of line comment.
- <#..#>: Multi-line Comment.
- $() : Evaluate sub-expression inside double-quoted string eg: "Hello $($MyUser.First), how are you today?"

Automating Integration with Azure Resources

PowerShell Pipes

- Most commands accept objects as input and output
  - For example, Get-Service returns one or more service instances

```
PS C:\> Get-Service

Status   Name               DisplayName
------   ----               -----------
Running  AdobeARMservice    Adobe Acrobat Update Service
Stopped  AJRouter           AllJoyn Router Service
Stopped  ALG                Application Layer Gateway Service
```

- You can pipe outputs as inputs to another command
  - For example, pipe the list of all services into a filter to show those services that are currently running

```
Get-Service | Where-Object { $_.Status -eq "Running" }
```

```
(Get-Service -Name aspnet_state).StartType  # => Manual
```

Automating Integration with Azure Resources

How to Connect to Azure

- Best way is to use the **Add-AzureAccount** cmdlet
  - It will open a browser window for you to log in to your Azure account for the current PowerShell session.
- Another way is to download your profile and sign in using a certificate. This is not recommended if you are using a shared computer.
  - Get-AzurePublishSettingsFile
  - Import-AzurePublishSettingsFile -PublishSettingsFile "<SubscriptionName-SubDatecredentials.publishsettings"
  - The publishSettingsFile has certificate credentials embedded in it. After adding it to PowerShell, you should delete it from your computer.

Automating Integration with Azure Resources

Common Cmdlets

- Working with accounts
  - **Get-AzureAccount**: List all accounts.
  - **Remove-AzureAccount** <ID>: The account is not removed from Azure, the credentials are simply removed from PowerShell.
- Working with subscriptions
  - **Get-AzureSubscription**: List all subscriptions.
  - **Select-AzureSubscription** -SubscriptionName "*SubName*"
- Get-Command *azure*
  - Lists all the Cmdlets and Aliases with azure in the name
- Get-Help <Command> -example
  - Get an example of using a command

Note: There are new cmdlets suffixed with **RM** to differentiate from the classic model.

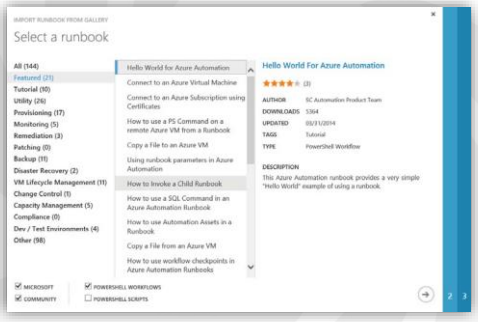
Switch-AzureMode
https://msdn.microsoft.com/en-us/library/dn722470.aspx

Azure Resource Manager Cmdlets
https://msdn.microsoft.com/en-us/library/mt125356.aspx

Automating Integration with Azure Resources

Automation with Runbooks

- Azure has automation built in via PowerShell workflows.
- Workflows are often referred to as runbooks in many automation platforms.



- Using runbooks, you can automate or orchestrate the creation, deployment, maintenance, and monitoring of services and resources in Azure.

Module 12
Securing Azure Web Applications

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Securing Azure Web Applications
Lab 12

- Don't bother making a copy of the lab solution
- The final step throws an exception because there isn't a valid database connection string in the Web.config—but by then you've seen the authentication work ☺

Securing Azure Web Applications

Visual Studio Project Templates

- The ASP.NET project templates in Visual Studio 2013 have the ability to automatically create an entry for your application in Azure Active Directory

Use a Microsoft Account to Create Web Apps Protected by Azure AD
http://blogs.msdn.com/b/webdev/archive/2014/08/04/use-a-microsoft-account-to-create-web-apps-protected-by-azure-ad-with-vs2013-update-3.aspx

Module 13
Maintaining and Monitoring Web Solutions in Azure

Developing
Microsoft Azure Solutions

Updated 29th November 2015

Maintaining and Monitoring Web Solutions in Azure

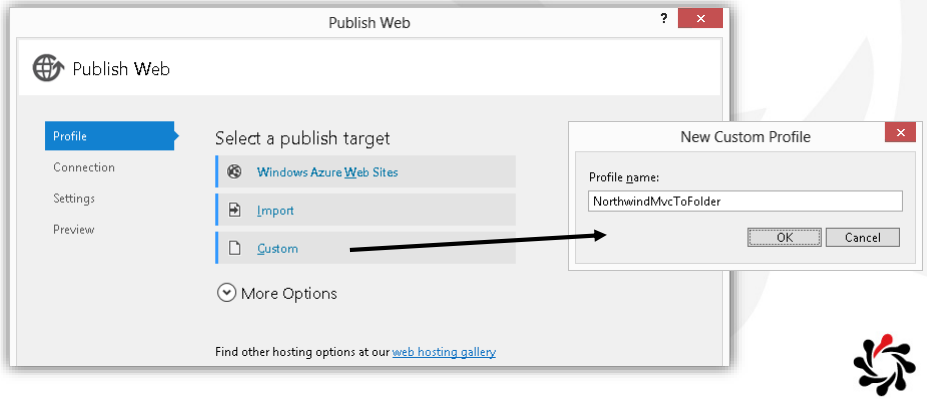
Configuring Diagnostics

- You can configure the diagnostics monitor programmatically or using **diagnostics.wadcfg** which has these advantages over writing code:
  - Diagnostics starts before the OnStart method is run so that errors in startup tasks can be caught and logged.
  - Any changes made to the configuration at run time will remain after a restart.
  - Diagnostics configuration changes do not require the code to be rebuilt.
  - You can automatically start the diagnostics monitor with a specific configuration without needing additional code (which might cause an exception that would prevent your role from starting).

Use the Azure Diagnostics Configuration File
https://msdn.microsoft.com/en-us/library/azure/hh411551.aspx

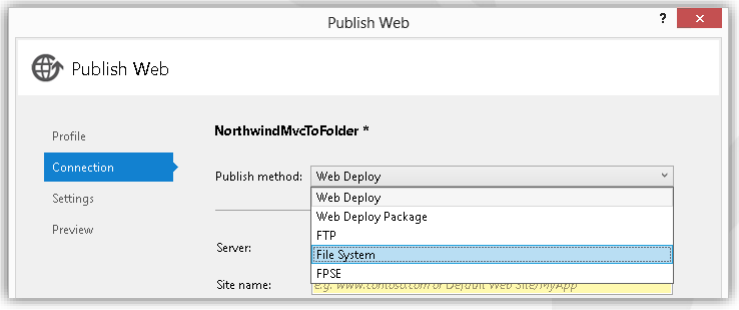
Publishing a Web Project

- On the Build menu, choose Publish *ProjectName*
  - To deploy to Azure, Import (a publisher profile) or click Windows Azure Web Sites or More Options
  - To deploy on premise, click Custom and enter a profile name



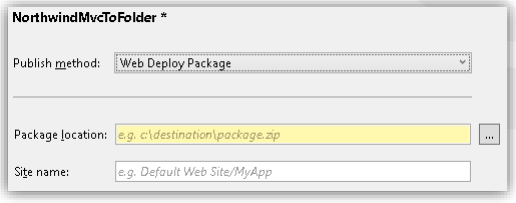
Connection Options

- You can deploy to
  - Web Deploy (either directly or to a ZIP package)
  - FTP, File System, or FrontPage Server Extensions



Web Deploy Packages

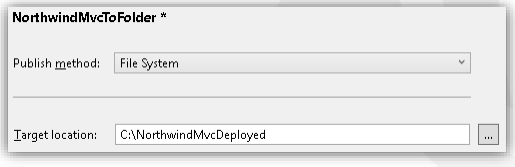
- For any question about deployment tools, the answer is almost always use Web Deploy because
  - It works securely
  - It is powerful and flexible by changing the web publish pipeline
  - You can install SSL certificates using a custom target



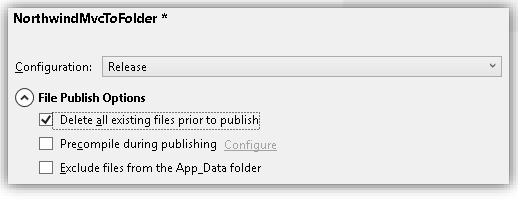
- Only choose to use FTP, XCopy, VPN, SSH, and so on if you have a very good reason

File System

- To deploy to the file system, enter the target path

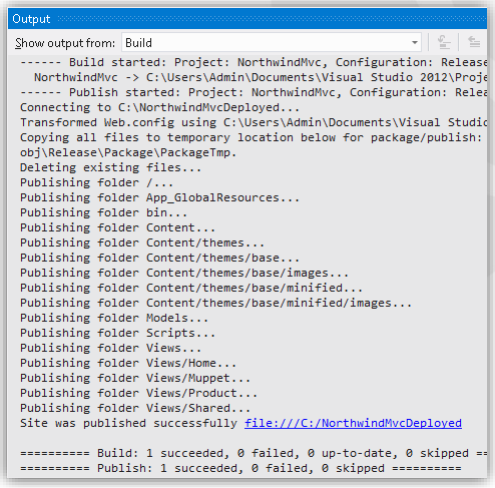


- Next, select Release or Debug configuration
  - This affects which transformation is applied to your Web.config



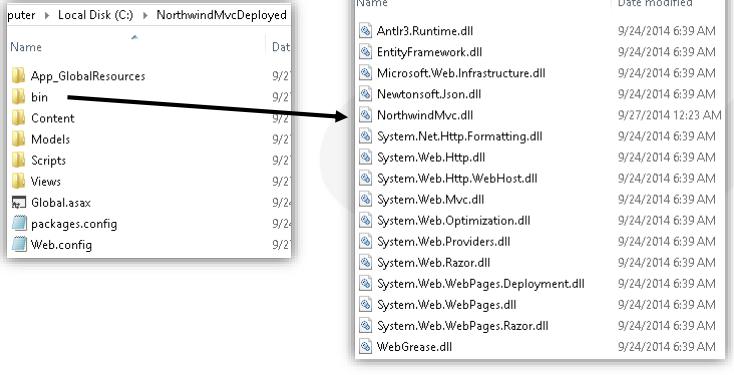
Publish Output

- When you click Publish button, your project will be re-built, Web.config transformed, and then published



Deployed Files

- All C# source code is compiled into a single assembly and deployed to the bin folder along with any other dependent assemblies



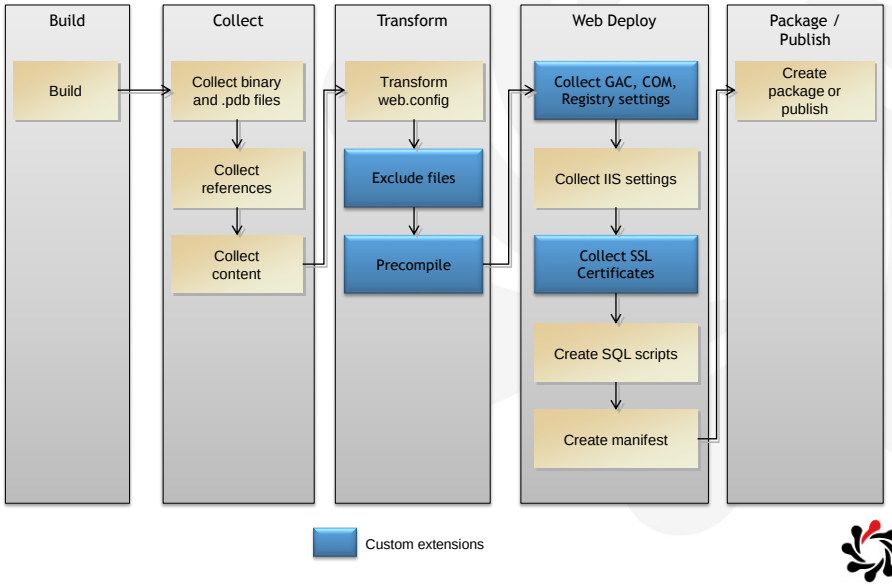
Maintaining and Monitoring Web Solutions in Azure
13.9

Packages

- IIS Settings
  - Application Pool
  - Authentication method
  - Error Handling
- Deploy Database Scripts
- Production Settings
  - Release / Debugging
  - Connection Strings
- Capable of Custom Extensions
  - Security Certificates
  - Windows Registry Settings
  - Assemblies in Global Assembly Cache (GAC)

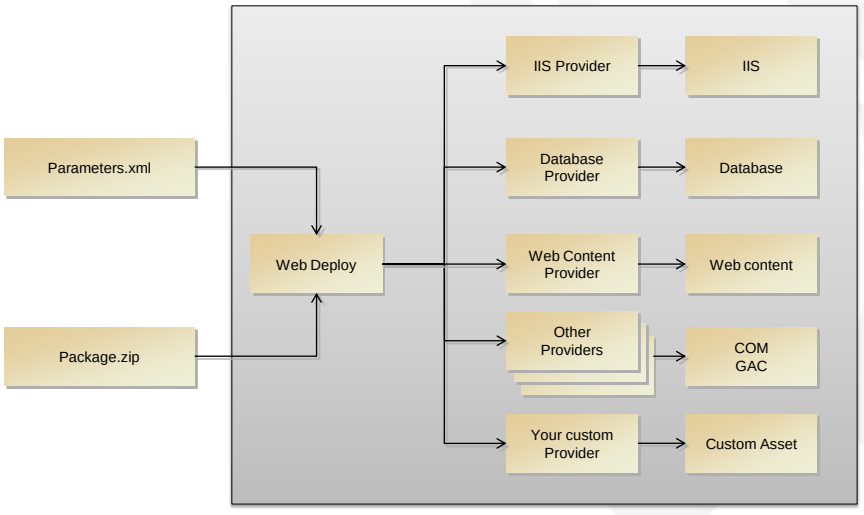
Maintaining and Monitoring Web Solutions in Azure
13.10

Publishing Pipeline



Maintaining and Monitoring Web Solutions in Azure

Importing Package into IIS



Maintaining and Monitoring Web Solutions in Azure

Swapping Staging and Production

- A packaged application can be deployed to the staging environment in Windows Azure to be tested before you move it to the production environment in which the application is accessible on the Internet
- The staging environment is exactly like the production environment, except that you can only access the staged application with an obfuscated (GUID-based) URL that is generated by Windows Azure
- After you have verified that your application is working correctly, it can be deployed to the production environment by performing a Virtual IP (VIP) swap

Appendix A
Architecting Microsoft Azure Solutions

Developing
Microsoft Azure Solutions

Updated 29th November 2015

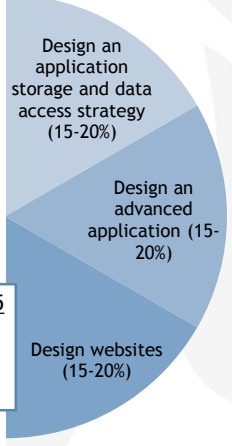
Architecting Microsoft Azure Solutions
Contents

Exam 70-534 has three sections for developers

Pass = 49% = 24/49 = 700/1000

Exam 70-534

Note
Half of the 70-534 "Architecting Microsoft Azure Solutions" exam is about developing topics. The other half is about infrastructure topics. Combined they form a "DevOps" exam.



Since November 2015
150 minutes total
49 questions in total
29 in main section
3 case studies (5, 7, 8)

MCSD: Azure Solutions Architect—Study Resources You Need To Know
https://borntolearn.mslearn.net/b/weblog/archive/2015/05/18/mcsd-azure-solutions-architect-study-resources-you-need-to-know

Exam 70-534 Architecting Microsoft Azure Solutions
https://www.microsoft.com/learning/en-gb/exam-70-534.aspx

Early Experts Study Guide for Microsoft Specialist Certification Exam 70-534, Architecting Microsoft Azure Solutions
http://blogs.technet.com/b/keithmayer/archive/2015/01/12/early-experts-study-guide-for-microsoft-specialist-certification-exam-70-534-architecting-microsoft-azure-solutions.aspx

Design an application storage and data access strategy

Design data storage

- *Design storage options for data, including Table Storage, SQL Database, DocumentDB, Blob Storage, MongoDB and MySQL*
  - Know the various storage types and their uses.
  - **Queue Storage**: for decoupling components of a system.
  - **Blob Storage**: for images, videos, text, XML, and so on.
  - **Table Storage**: for entities indexed only by partition and row.
  - **DocumentDB**: Microsoft JSON-based NoSQL, indexed every field
  - **MongoDB**: open-source JSON-based NoSQL, created in Azure Linux VMs (IaaS) or by creating an account on MongoLab servers.
  - **SQL Database**: Microsoft relational database
  - **MySQL**: open-source relational database (ClearDB)

Storage documentation
https://azure.microsoft.com/en-us/documentation/services/storage/

Design an application storage and data access strategy

Design data storage

- *Design security options for SQL Database or Azure Storage*
  - SQL Database can have a list of all of the IP addresses that are allowed to access the database (there is also a switch with which you can turn on access from your Azure Services)
  - SQL Database and Azure Storage require that you use Secure Sockets Layer (SSL) encryption at all times (Azure Storage can disable SSL but it is not recommended)
  - Azure Storage access requires the account name and key(s)
  - Azure Storage can issue Shared Access Signature (SAS) to allowed time limited permissions to a resource for a user
  - Azure Storage can have up to five Shared Access Policies
  - Azure Storage Blobs can have public containers

SQL Azure: Cloud Database Security
https://technet.microsoft.com/en-us/hh352139.aspx

Design an application storage and data access strategy

Design data storage

- *Identify the appropriate VM type and size for a solution*
  - **SQL Database** tiers:

	Basic	Standard				Premium				
		S0	S1	S2	S3	P1	P2	P4	P6/P3	P11
Maximum database size	2 GB	250 GB				500 GB				1 TB
DTUs	5	10	20	50	100	125	250	500	1,000	1,750
Point-in-time restore	Any point last 7 days	Any point last 14 days				Any point last 35 days				
Disaster recovery	Geo-Restore, restore to any Azure region	Standard Geo-Replication, offline secondary				Active Geo-Replication, up to 4 online (readable) secondary backups				
Max In-Memory OLTP storage	NA	NA	NA	NA	NA	1 GB	2 GB	3 GB*	8 GB	10 GB*
Max concurrent requests	30	60	90	120	200	200	400	800	1,600	2,400
Max concurrent logins	30	60	90	120	200	200	400	800	1,600	2,400
Max sessions	300	600	900	1,200	2,400	2,400	4,800	9,600	19,200	32,000

** In-Memory OLTP storage limits will soon adjust to 4 for P4 and 14 for P11.*

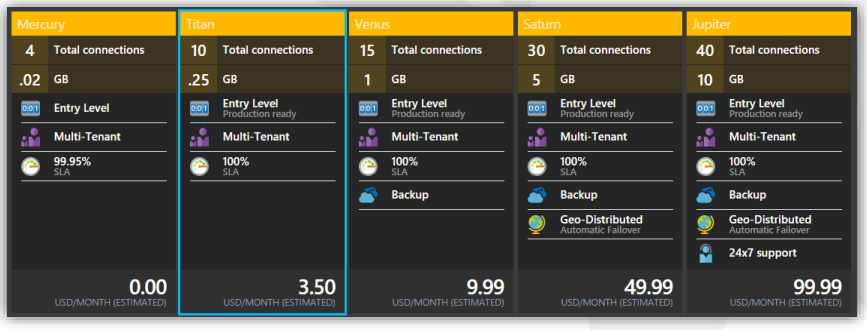
  - **MongoDB** also has various performance and size settings.

Azure SQL Database resource limits
https://azure.microsoft.com/en-gb/documentation/articles/sql-database-resource-limits/

Design an application storage and data access strategy

Design data storage

- *Identify the appropriate VM type and size for a solution*
  - **MySQL** tiers



How to Create a MySQL Database in Azure
https://azure.microsoft.com/en-gb/documentation/articles/store-php-create-mysql-database/

A.7

Design an application storage and data access strategy

Design applications that use Mobile Services

Create Azure Mobile Services

- Mobile Services can create a mobile proxy to any data source including on-prem
- Mobile Services can implement a “soft delete” option for marking a record as deleted without actually deleting it
- Mobile Services has built-in support for using common social networking providers for authentication
- Mobile Services back-end can be coded in Node.js or .NET
- Mobile Services has push notifications
- Mobile Services could be replaced by a custom Web App service but it is easier to use something ready-created

Azure Mobile Services
http://azure.microsoft.com/en-us/documentation/services/mobile-services/

A.8

Design an application storage and data access strategy

Design applications that use Mobile Services

Consume Mobile Services from cross-platform clients

- Support for iOS, Android, Windows, Xamarin, HTML5/JavaScript
- .NET support with Microsoft.WindowsAzure.MobileServices NuGet package

Integrate offline sync capabilities into an application

- Offline Sync uses a local SQLite database within the app itself, which makes it possible for data to be stored locally

How to Use iOS Client Library for Azure Mobile Services
https://azure.microsoft.com/en-us/documentation/articles/mobile-services-ios-how-to-use-client-library/

Get Started with Offline Data Sync in Mobile Services
https://azure.microsoft.com/en-us/documentation/articles/mobile-services-ios-get-started-offline-data/

A.9

Design an application storage and data access strategy

Design applications that use Mobile Services

Extend Mobile Services using custom code

- A custom API is an endpoint in your mobile service that is accessed by one or more of the standard HTTP methods: GET, POST, PUT, PATCH, and DELETE

Implement Mobile Services using .NET or Node.js

- A .NET mobile service project is built on top of a Web API project and access to the data that is stored in the SQL Database is achieved through the **/tables** route

Secure Mobile Services using Azure AD

- Synchronize the corporate Active Directory to the Azure AD
- Four modes: Application Key Required, Everyone, Authenticated Users, and Admins And Other Scripts

Authenticate your app with Active Directory Authentication Library Single Sign-On
https://azure.microsoft.com/en-us/documentation/articles/mobile-services-dotnet-backend-ios-adal-sso-authentication/

A.10

Design an application storage and data access strategy

Design applications that use notifications

Implement push notification services in Mobile Services

- Each mobile platform employs a different Platform Notification Service (PNS)
- Mobile Services implements push notification for Windows Store Apps, Apple Push Notification, and Google Cloud Messaging
- Notification hubs are optimized to broadcast millions of push notifications within minutes compared to Mobile Services push notification which is good for simple event-driven events

Send push notifications to all subscribers, specific subscribers or a segment of subscribers

Add push notifications to your Mobile Services app
https://azure.microsoft.com/en-us/documentation/articles/mobile-services-dotnet-backend-windows-universal-dotnet-get-started-push/

Design an application storage and data access strategy

Design applications that use a web API

Implement a custom web API

- See FB487_DataServicesAzure: Modules 3 and 4

Scale using Azure Websites

- Azure Web Apps can scale up (by choosing a larger VM size) and out (having multiple instances)
- Standard plans support autoscale; metrics that you can use to scale are CPU, Memory Percentage, Disk Queue, Length, HTTP Queue Length, Data In, and Data Out

Scale a web app in Azure App Service
https://azure.microsoft.com/en-us/documentation/articles/web-sites-scale/

Design an application storage and data access strategy

Design applications that use a web API

Offload long-running applications using WebJobs

- Azure WebJobs are executables or scripts that run in a website to handle long-running jobs
- Supports: .cmd, .bat, .exe (using Windows cmd), .ps1 (using Windows PowerShell), .sh (using Bash), .php (using PHP), .py (using Python), .js (using Node)
- Zip all of the supporting files such as DLLs that are needed to run the program and then upload the zip file
- Three modes: continuously, on a schedule, or on demand
- For continuous tasks, it is recommended that you turn on the Always On feature on the Configure page for the Web App
- WebJobs that are set to run continuously also will run on all instances of the Web App by default but you can configure a single instance using the portal

Azure WebJobs documentation resources
https://azure.microsoft.com/en-us/documentation/articles/websites-webjobs-resources/

Design an application storage and data access strategy

Design applications that use a web API

- *Secure a web API using Azure AD*
  - Azure has three solutions for authentication, but you could always use custom solutions that you develop
  - **Azure AD Service**: A stand-alone directory or synchronized with an on-premises Active Directory.
  - **Active Directory Federation Services (AD FS)**: Requests identity back to the on-prem Active Directory.
  - **Azure Access Control Service (ACS)**: Can use multiple identity services to authenticate, including Active Directory.

Use Active Directory for authentication in Azure App Service
https://azure.microsoft.com/en-us/documentation/articles/web-sites-authentication-authorization/

Design an application storage and data access strategy

Design a data access strategy for hybrid applications

- *Connect to on-premises data from Azure applications using Service Bus Relay, BizTalk Hybrid Connections or the VPN capability of Websites*
  - Use these when there are concerns with respect to keeping the data in Azure or if there is too much data to move
  - Service Bus Relay: no need to change incoming firewall rules or requiring big changes to a corporate network infrastructure
  - BizTalk API Apps Hybrid Connections: connections to on-premises resources that use static TCP ports, such as SQL Server, MySQL, Web APIs, and most web services
  - Set up group policies to determine what resources applications can access through the Hybrid Connections
  - Web Apps VPN: reference services in a Virtual Network that could be connected to on-prem resources

Access on-premises resources using hybrid connections in Azure App Service
https://azure.microsoft.com/en-us/documentation/articles/web-sites-hybrid-connection-get-started/

A. 15

Design an application storage and data access strategy

Design a data access strategy for hybrid applications

- *Identify constraints for connectivity with VPN*
  - Maximum number of networks to which you can connect is 10.
  - A Virtual Network (VNET) can connect to six on-premises sites as well as four other VNETs.
  - This makes it possible for a company to connect to multiple sites around the world, and they can all share the VNET.
- *Identify options for joining VMs to domains or cloud services*
  - Cloud Services: add to domain using PowerShell or code in RoleEntryPoint, but remove only with code.
  - Using code requires elevated mode which is not good practice.
  - For VMs automate adding to domain at creation time.

Integrate a web app with an Azure Virtual Network
https://azure.microsoft.com/en-us/documentation/articles/web-sites-integrate-with-vnet/

A. 16

Design an application storage and data access strategy

Design a media solution

- *Describe Media Services*
  - Media Services is an extensible PaaS offering that you can use to build scalable media management and delivery applications.
  - Supports on-demand and live streaming delivery.
- *Understand key components of Media Services, including streaming capabilities, video on-demand capabilities and monitoring services*
  - Read more at the link below

Media Services documentation
https://azure.microsoft.com/en-us/documentation/services/media-services/

A. 17

Design an advanced application

Create compute-intensive applications

Design high-performance computing (HPC) and other compute-intensive applications using Azure Services

- Azure's A8, A9, A10, and A11 virtual machine (VM) sizes are tailored specifically for HPC workloads.
- An HPC cluster comprises a head node and a number of compute nodes. You can use Microsoft HPC Pack to create, manage, and run an HPC cluster that can be dedicated on-premises servers, part-time servers, VMs in the cloud, and even workstations.
- Azure Batch: schedule and manage large-scale parallel workloads on Azure-managed compute resources without the need to manage any infrastructure details. Azure Batch Apps: manage, run, and monitor repetitive batch jobs.
- Competing Consumers: design pattern by which you can implement a simple parallel task execution engine.

Batch documentation
https://azure.microsoft.com/en-us/services/batch/

A. 18

Design an advanced application

Create long-running applications

Implement worker roles for scalable processing

- With Cloud Services, you don't create virtual machines. Instead, you provide a configuration file that tells Azure how many of each you'd like, such as three web role instances and two worker role instances, and the platform creates them for you. You still choose what size those backing VMs should be, but you don't explicitly create them yourself. If your application needs to handle a greater load, you can ask for more VMs, and Azure will create those instances.

Design stateless components to accommodate scale

- Use queues and avoid state e.g. no Session state in ASP.NET

Cloud Services documentation
https://azure.microsoft.com/en-us/documentation/services/cloud-services/

A.19

Design an advanced application

Select the appropriate storage option

- *Use a queue-centric pattern for development*
  - Storage Queues or Service Bus Queues
- *Select the appropriate storage for performance*
- *Identify storage options for cloud services and hybrid scenarios with compute on-premises and storage on Azure*
- *Differentiate between cloud services and VMs interacting with storage service and SQL Database*

Managing the Data Lake
http://www.oreilly.com/data/free/managing-the-data-lake.csp

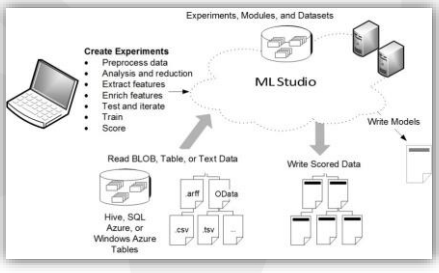
DocumentDB vs Azure SQL vs Azure Table
http://geekswithblogs.net/hroggero/archive/2014/09/11/documentdb-vs-azure-sql-vs-azure-table.aspx

A.20

Design an advanced application

Integrate Azure services in a solution

- *Identify the appropriate use of machine learning, big data, Media Services and search services*
  - Use **Machine Learning** to run predictive analysis models that learn from existing data in order to forecast future behaviours, outcomes, and trends.
  - Use **ML Studio** online to create experiments by processing datasets that you have uploaded to ML Studio.
  - Once your predictive analytics model is ready, you can deploy it as a REST web service.



Introduction to machine learning on Microsoft Azure
https://azure.microsoft.com/en-us/documentation/articles/machine-learning-what-is-machine-learning/

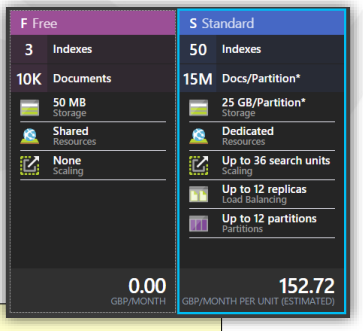
What is Azure Machine Learning Studio?
https://azure.microsoft.com/en-us/documentation/articles/machine-learning-what-is-ml-studio/

Design an advanced application

Integrate Azure services in a solution

Identify the appropriate use of machine learning, big data, Media Services and search services

- **Search Services**: Full-text search scoped over your content, plus advanced search behaviors similar to those found in commercial web search engines, such as type-ahead query suggestions based on a partial term input, hit-highlighting, and faceted navigation.
- Natural language support is built-in, using the linguistic rules that are appropriate to the specified language.



What is Azure Search?
https://azure.microsoft.com/en-us/documentation/articles/search-what-is-azure-search/

Design websites

Design websites for scalability and performance

Globally scale websites

- Use a **Content Delivery Network** (CDN). You can add a custom domain name to the website, and you can enable HTTPS and query string forwarding.
- Use Azure **Traffic Manager** you can deploy web applications around the world and then, via Traffic Manager, you use a single URL to reference all of them.
- Traffic Manager needs more manual effort than the CDN solution if new traffic patterns come up, but it provides better control on where the other web applications are being deployed around the world.

Web Apps overview
https://azure.microsoft.com/en-us/documentation/articles/app-service-web-overview/

Design websites

Design websites for scalability and performance

Create websites using Visual Studio

- Project template allows programmer to choose Web App at creation time, manage the Web App thought Server Explorer, and publish by integrating with the Web Deploy feature.

Debug websites

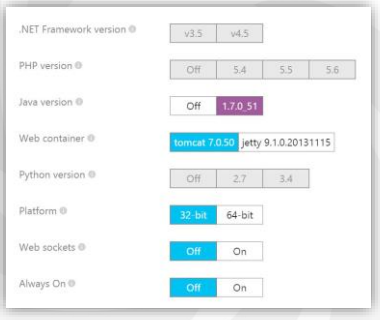
- Use the Monitor blade in the portal to record HTTP requests, and so on.
- Use Application Insights.
- Remotely debug the Web App by right-clicking it in Server Explorer and choosing Attach Debugger.
- Use Site Control Manager (SCM aka Project Kudo) by going to: `https://<webapp>.scm.azurewebsites.net/`

Design websites

Design websites for scalability and performance

Understand supported languages

- Supported languages are: .NET, Java, Node.js, PHP, Python



Differentiate between websites to VMs and cloud services

- VMs can scale larger than Cloud Services or Web Apps. Virtual Machines have options for running with up to 32 cores with 448 GB RAM. There are also options that are optimized for network traffic with a 40 GB network card.
- Cloud Services and Web Apps get automatic OS updates.
- Web Apps do not support RDP or startup tasks.

Design websites

Deploy websites

- *Implement Azure Site Extensions*
  - Create, deploy, and share custom administrator functionality.
- *Create packages, hosting plans, deployment slots, resource groups, publishing options, Web Deploy and FTP locations and settings*
  - A deployment slot is a feature of App Service Web Apps with which you can publish your code to Azure and have it running in the actual environment in which it will be used in production. The benefit of using a deployment slot is that you are not uploading to the live site; instead, you're uploading to a separate deployment slot. (Like Staging for Cloud Services.)

Azure Site Extensions
https://github.com/projectkudu/kudu/wiki/Azure-Site-Extensions

Azure App Service deployment documentation
https://azure.microsoft.com/en-us/documentation/articles/web-sites-deploy/

Design websites

Design websites for business continuity

- *Scale up and scale out using Azure Websites and SQL Database*
  - Scale up: Basic, Standard increasing numbers of cores
  - Scale out: Basic: manual instances, Standard: auto scale, Premium: more instances
  - SQL Database has elastic scale to shard the data.

Scale a web app in Azure App Service
https://azure.microsoft.com/en-us/documentation/articles/web-sites-scale/

A.27

Design websites

Design websites for business continuity

- *Configure data replication patterns*
  - Use CDN, SQL Sync, SQL geo-replication
- *Update websites with minimal downtime*
  - Use deployment slots
- *Back up and restore data*
  - Web App Standard tier has backup and restore
  - Free and Shared you could manually backup
  - Premium supports 50 backups per day

A.28

Design websites

Design websites for business continuity

- *Design for disaster recovery*
  - Maintain current backups of the web applications and databases used by the website.
  - Use Storage account with a pricing tier of Geo-Redundant or Read-Access Geo-Redundant for backups.
  - Use Azure Site Recovery to back up on-premises VMs to Azure Storage and then restore them into Azure.
- *Deploy websites to multiple regions for high availability*
  - Use Traffic Manager
- *Design the data tier*
  - SQL or NoSQL? Read more about data at the link below.

Free Data Reports: what's happening in data science and big data.
http://www.oreilly.com/data/free/

B.1

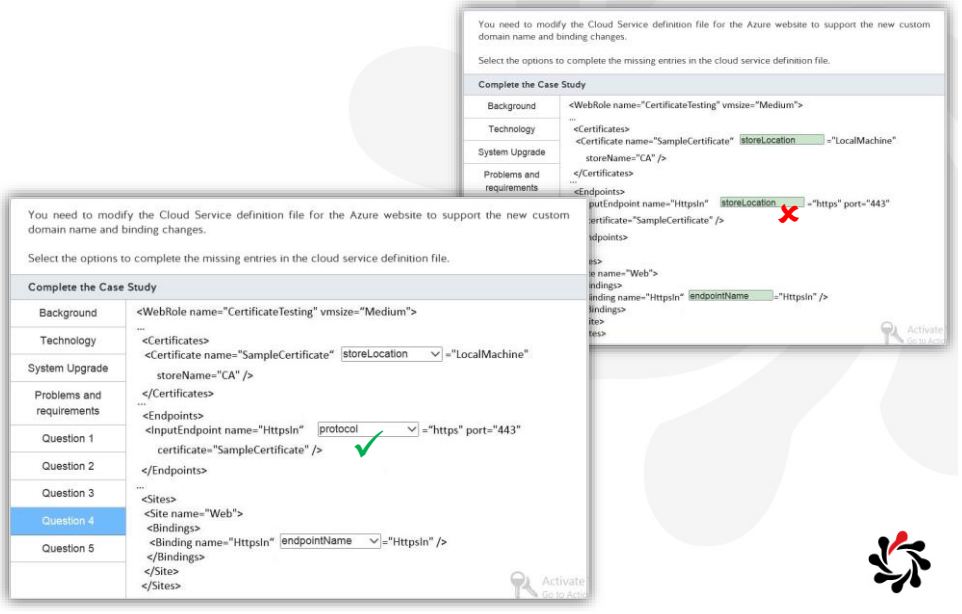
Appendix B
MeasureUp Errata

Developing
Microsoft Azure Solutions

Updated 29th November 2015

B.2

Question about Cloud Service Definition



B.3

Question about VM Endpoints

You plan to create several endpoints for a virtual machine (VM) hosted in an Azure subscription.

You need to identify the settings that you must collect to create the endpoints.

What information is required to create the endpoints? Select the required information.

Create a list in the correct order

Possible information	Required information
URL	Public port
IP address	Private port
Authentication method	Protocol

The order is not important!

Possible information	Required information
URL	Protocol
IP address	Private port
Authentication method	Public port

B.4

Question about Deploying a VM with PowerShell

Drag the code fragments to the appropriate location in the PowerShell script to deploy a new VM to the virtual network. A code fragment may be used once, more than once, or not at all.

Complete the Case Study

Background
Existing Environment
Interviews
Business Requirements
Technical Requirements
Question 1
Question 2
Question 3
Question 4

```
$vnet = "VNET-01"
$subnet = "Services"
$vmSvc = [Guid]::NewGuid()
$loc = "South Central US"
$vmHost = "VM001"
$image = "MyCustom_Windows-Server-2012-Datacenter-Image.vhd"

$cred = Get-Credential

$vm = New-AzureVMConfig -Name $vmHost `
  -InstanceSize Medium `
  -ImageName $image

$vm = $vm | Add-AzureProvisioningConfig `
  -Windows `
  -AdminUsername `
  $cred.GetNetworkCredential().UserName `
  -Password `
  $cred.GetNetworkCredential().Password

New-AzureService -ServiceName $vmSvc `
  -Location $loc

New-AzureVM -ServiceName $vmSvc `
  -VMs $vm -VNetName $vnet
```

You can't reference $vm before it has been assigned.

Explanation

You need to first create a VM configuration object using the New-AzureVMConfig cmdlet. This VM configuration includes the host name of the VM, the instance size, and the name of the image to use to create the VM OS disk. The Set-AzureSubnet cmdlet is used to specify a subnet by name that the VM will be deployed to.

Next, the VM configuration is modified to include provisioning information such as the type of VM (Windows or Linux) and the administrator credentials to use when connecting to the VM using Remote Desktop Protocol (RDP). This is achieved by calling the Add-AzureProvisioningConfig cmdlet.

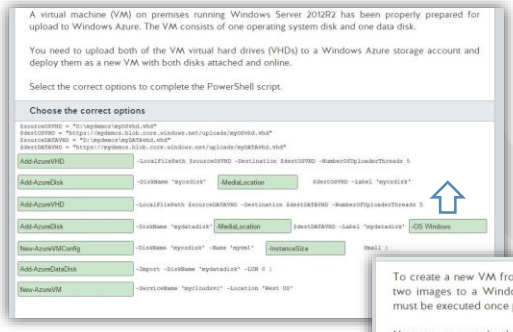
The cloud service the VM will be contained in must be created before the VM can be created. To create the cloud service, you must call the New-AzureService cmdlet and specify the cloud service name and location (or region) for the service.

You need to create the VM using the New-AzureVM command and pass the cloud service name for the VM, the VM configuration object, and the name of the virtual network to deploy the VM to.

Using Set-AzureSubnet to specify the subnet name for the VM is not required to deploy the VM to the virtual network. If the subnet is not specified, the New-AzureVM cmdlet will deploy the VM to the first available IP address in the virtual network. However, since the task requires you to deploy to the Services subnet, you must call the Set-AzureSubnet cmdlet to ensure that the VM is deployed to this subnet.

B.5

Question about Uploading Disks with PowerShell


A virtual machine (VM) on premises running Windows Server 2012R2 has been properly prepared for upload to Windows Azure. The VM consists of one operating system disk and one data disk.

You need to upload both of the VM virtual hard drives (VHDs) to a Windows Azure storage account and deploy them as a new VM with both disks attached and online.

Select the correct options to complete the PowerShell script.

Choose the correct options

Add-AzureVHD -LocalFilePath $sourceOSVHD -Destination $destOSVHD -NumberOfUploaderThreads 5

Add-AzureDisk -DiskName "myosdisk" -MediaLocation $destOSVHD -Label "myosdisk"

Add-AzureVHD -LocalFilePath $sourceDATAVHD -Destination $destDATAVHD -NumberOfUploaderThreads 5

Add-AzureDisk -DiskName "mydatadisk" -MediaLocation $destDATAVHD -Label "mydatadisk" -OS Windows

New-AzureVMConfig -DiskName "myosdisk" -Name "myvm1" -InstanceSize Small |

Add-AzureDataDisk -Import -DiskName "mydatadisk" -LUN 0 |

New-AzureVM -ServiceName "mycloudsvc" -Location "West US"

The **-OS Windows** flag should be used on the **myosdisk** not the **mydatadisk**!

To create a new VM from two properly prepared VHD files located on premises, you must first upload the two images to a Windows Azure storage account. This is done using the Add-AzureVHD cmdlet, which must be executed once per VHD file. This action is executed in actions 1 and 4.

Next you must make the VHD files usable in Azure. To do this, you use the Add-AzureDisk cmdlet twice, once per VHD at actions 2 and 5. The parameter to use for each of these commands at choices 3 and 6 is -MediaLocation. In this case, the cmdlet would be slightly different for each VHD. For the operating system disk, you should use the -OS switch at choice 7 to denote that the disk is bootable and also specify the operating system as Windows or Linux.

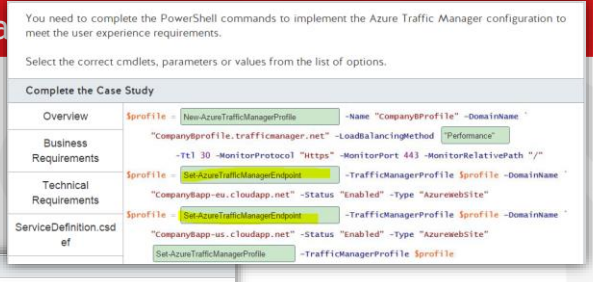
Next at Step 8, to begin assembling the configuration of the new VM in Azure, you should use the New-AzureVMConfig cmdlet. This cmdlet allows you to specify the first disk image to use as the boot image and the size of the VM to create. This cmdlet also allows you to specify the size of the VM to create using the -InstanceSize switch at step 9.

Next you must add the data disk using the New-AzureDataDisk cmdlet at step 10, specifying the Image name and the -import switch. The -import switch denotes that an existing image file is to be used for the datadisk. Alternatively, you can use the -CreateNew switch to attach a new blank disk, but not in this scenario.

Finally, you must execute the New-AzureVM cmdlet at step 11 to create the actual VM using the configuration specified.

B.6

Question about Tra


You need to complete the PowerShell commands to implement the Azure Traffic Manager configuration to meet the user experience requirements.

Select the correct cmdlets, parameters or values from the list of options.

Complete the Case Study

Overview

Business Requirements

Technical Requirements

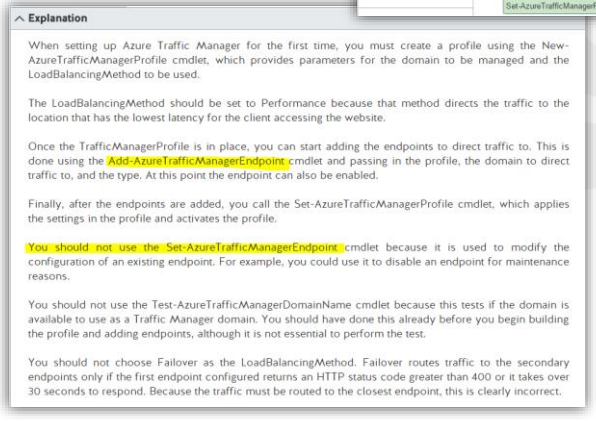
ServiceDefinition.csdef

$profile = New-AzureTrafficManagerProfile -Name "CompanyBProfile" -DomainName "CompanyBprofile.trafficmanager.net" -LoadBalancingMethod "Performance" -Ttl 30 -MonitorProtocol "Https" -MonitorPort 443 -MonitorRelativePath "/"

$profile = Set-AzureTrafficManagerEndpoint -TrafficManagerProfile $profile -DomainName "CompanyBapp-eu.cloudapp.net" -Status "Enabled" -Type "AzureWebSite"

$profile = Set-AzureTrafficManagerEndpoint -TrafficManagerProfile $profile -DomainName "CompanyBapp-us.cloudapp.net" -Status "Enabled" -Type "AzureWebSite"

Set-AzureTrafficManagerProfile -TrafficManagerProfile $profile


Explanation

When setting up Azure Traffic Manager for the first time, you must create a profile using the New-AzureTrafficManagerProfile cmdlet, which provides parameters for the domain to be managed and the LoadBalancingMethod to be used.

The LoadBalancingMethod should be set to Performance because that method directs the traffic to the location that has the lowest latency for the client accessing the website.

Once the TrafficManagerProfile is in place, you can start adding the endpoints to direct traffic to. This is done using the Add-AzureTrafficManagerEndpoint cmdlet and passing in the profile, the domain to direct traffic to, and the type. At this point the endpoint can also be enabled.

Finally, after the endpoints are added, you call the Set-AzureTrafficManagerProfile cmdlet, which applies the settings in the profile and activates the profile.

You should not use the Set-AzureTrafficManagerEndpoint cmdlet because it is used to modify the configuration of an existing endpoint. For example, you could use it to disable an endpoint for maintenance reasons.

You should not use the Test-AzureTrafficManagerDomainName cmdlet because this tests if the domain is available to use as a Traffic Manager domain. You should have done this already before you begin building the profile and adding endpoints, although it is not essential to perform the test.

You should not choose Failover as the LoadBalancingMethod. Failover routes traffic to the secondary endpoints only if the first endpoint configured returns an HTTP status code greater than 400 or it takes over 30 seconds to respond. Because the traffic must be routed to the closest endpoint, this is clearly incorrect.

Question abou

You create an Azure file share named aspnetresources that contains resources used by ASP.NET developers.

You are creating an image that will be used to create ASP.NET virtual machines (VMs). You assign the password "123Dev$*XYZ" to the Administrator account.

You need to ensure that the file share is automatically mounted each time a VM is created. The file share should be accessible even after the VM is rebooted.

You need to write a script to meet the requirements. Complete the script by selecting the appropriate script segments from the lists.

Complete the Case Study

Background	$pwd = 9ValRru/FwbHndqR7EA1vrEnAy3inRfAppsYHPcs5bmn1yZsXJNULwRDpthlL17IsYjEt2zGJ
Business requirements	$acct = companyo
Technical requirements	cmdkey /add:companyo.file.core.windows.net /user:$acct /pass:$pwd net use e: \\companyo.file.core.windows.net\aspnetresources /user:$acct /pass:$pwd

You should use the following script:

```
$pwd =
9ValRru/FwbHndqR7EA1vrEnAy3inRfAppsYHPcs5bmn1yZsXJNULwRDpthlL17IsYjEt2zGJZfNRLzNE5ofcA==
$acct = companyo
cmdkey /add:companyo.file.core.windows.net /user:$acct /pass:$pwd
net use e: \\companyo.file.core.windows.net\aspnetresources
```

When creating a persistent mounted file share on a Windows VM, you need to first store the credentials. You do so by using the cmdkey command with the /add option. You need to pass the name of the storage account to the /user option and the storage account key as the /pass option.

Next, you need to call net use to create the mounted share and associate it with a drive letter.

You should not set the variable used to store the password to the Administrator account password. The stored credentials need to be those of the storage account, not the Administrator account.

You should not set the variable used to store the account to Administrator. The stored credentials need to be those of the storage account, not the Administrator account.

You should not use the following command:

```
$ctx=New-AzureStorageContext $acct $pwd
```

B.8

Question about CIDR

The development organization is standardizing on a virtual network configuration to be used for multiple Azure subscriptions. You need to provide a virtual network configuration file that other teams can use. You export the network configuration from your subscription and need to make changes to your virtual network named VNET-Test to support the new network requirements that will be used for other teams.

Drag the code fragments to the appropriate location in the network configuration file to modify the file to support these requirements. A code fragment may be used once, more than once, or not at all.

Complete the Case Study

Background
Existing Environment
Interviews
Business Requirements
Technical Requirements
Question 1
Question 2
Question 3
Question 4

```
<NetworkConfiguration
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns="http://schemas.microsoft.com/ServiceHosting/2011/07/Net
workConfiguration">
  <VirtualNetworkConfiguration>
    <Dns />
    <VirtualNetworkSites>
      <VirtualNetworkSite name="VNET-Test" Location="West US">
        <AddressSpace>
          <AddressPrefix>10.0.0.0/22</AddressPrefix>
        </AddressSpace>
        <Subnets>
          <Subnet name="DCs">
            <AddressPrefix>10.0.0.0/29</AddressPrefix>
          </Subnet>
          <Subnet name="LOB-Apps">
            <AddressPrefix>10.0.0.8/28</AddressPrefix>
          </Subnet>
          <Subnet name="Staging">
            <AddressPrefix>10.0.1.0/27</AddressPrefix>
          </Subnet>
        </Subnets>
      </VirtualNetworkSite>
    </VirtualNetworkSites>
  </VirtualNetworkConfiguration>
</NetworkConfiguration>
```

Not given enough information to answer the question!

B.9

Question about VM Workloads

As part of your company migration from on-premises workloads to Azure Virtual Machines (VMs), you need to identify which Window Server core workloads are supported in Azure VMs.

For each type of workload, select a check box to indicate whether the workload is supported or unsupported.

Choose the correct options

Server Workload	Supported	Unsupported
Active Directory Domain Services	☑	☐
Active Directory Federation Services	☑	☐
DNS server	☐	☑
Active Directory Rights Management Services	☐	☑
DHCP server	☑	☐

Microsoft server software support for Microsoft Azure virtual machines
https://support.microsoft.com/en-us/kb/2721672

DNS
https://azure.microsoft.com/en-gb/services/dns/

Set up DHCP server in IaaS Azure VM
https://social.msdn.microsoft.com/Forums/en-US/9ce70dc2-89d4-4947-a614-7eeb4fca2162/set-up-dhcp-server-in-iaas-azure-vm-no-static-ip

B.10

Question about Connecting Two VNETs

Your company has created a virtual network named VN-Central in the Central US region. Virtual machines (VMs) in that network host a web service named CustomerServiceInfo. An application deployed on a virtual network named VN-NE in the North Europe region needs to be able to access the CustomerServiceInfo web service.

You need to configure Azure to meet the requirements.

Select the five objects you should create.

Create a list in the correct order

Possible options

- A static VPN gateway for VN-NE
- A virtual network that spans both regions
- A static VPN gateway for VN-Central
- A point-to-site connection
- An ExpressRoute connection

Options to use

- A local network for VN-Central
- A site-to-site connection
- A local network for VN-NE
- A dynamic VPN gateway for VN-Central
- A dynamic VPN gateway for VN-NE