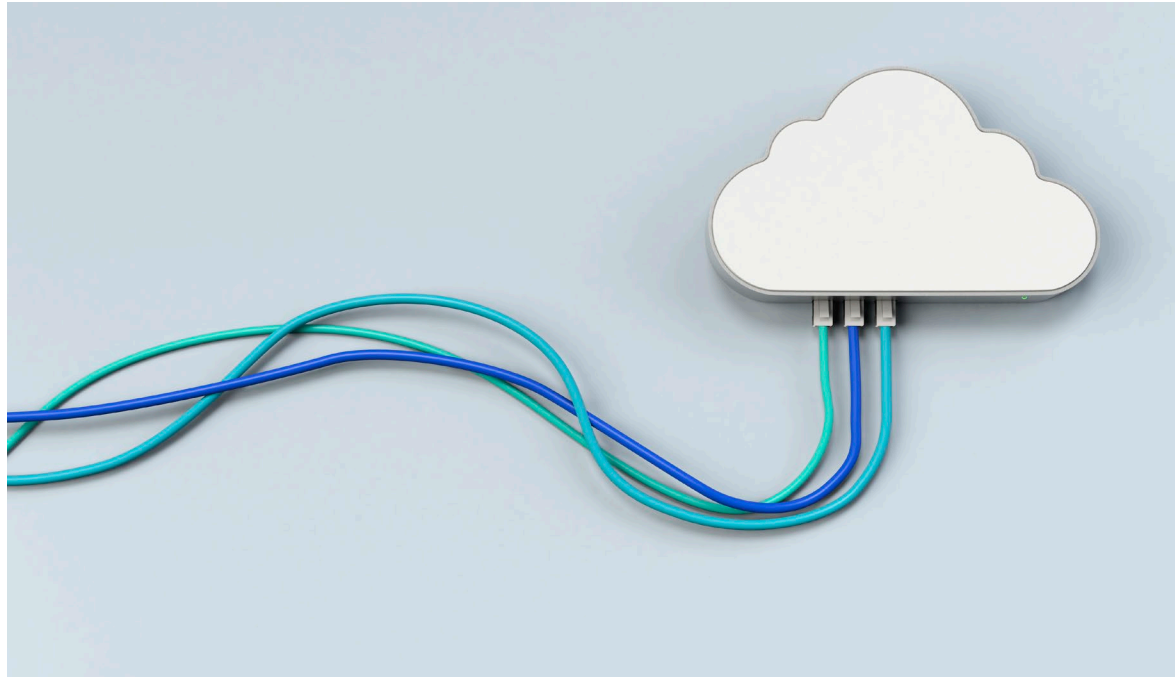


Final Course Project

- NETW211 Introduction to Cloud Computing
- Instructor Professor Risley
- John O'Leary
- February 2023





This is a project which includes five modules of stages in developing a cloud compute environment in Microsoft Azure.

Introduction

Virtual Machine (VM) Instances



This module includes steps of configuring virtual hardware such as Virtual Machines (VM's), CPU and RAM, and virtualization in the Microsoft Azure cloud environment. It also covers deploying a VM as well as deallocating and deleting the VM. And cloud infrastructure.

Deploying a VM in Azure

Connect Start Restart Stop Capture Delete Refresh Open in mobile CLI / PS

^ Essentials

Resource group ([move](#))
[NETW211-JO](#)

Status
Running

Location
East US

Subscription ([move](#))
[Azure for Students](#)

Subscription ID
536285ed-dc84-425c-9f7a-98eec4b0f5aa

Tags ([edit](#))
[Click here to add tags](#)

Operating system
Windows (Windows Server 2019 Datacenter)

Size
Standard B1s (1 vcpu, 1 GiB memory)

Public IP address
[20.163.203.62](#)

Virtual network/subnet
[NETW211-JO-vnet/default](#)

DNS name
[Not configured](#)

Screenshot of the *NETW211VM* page with information such as the resource group name, subscription, public IP address, etc.

[Properties](#) [Monitoring](#) [Capabilities \(8\)](#) [Recommendations](#) [Tutorials](#)

Virtual machine

Computer name NETW211VM

Networking

Public IP address 20.163.203.62

The screenshot shows the Windows Server Manager interface. The left-hand navigation pane includes 'Dashboard', 'Local Server' (selected), 'All Servers', and 'File and Storage Services'. The main area displays the 'PROPERTIES For NETW211VM' page. The properties are organized into several sections:

Property Name	Value
Computer name	NETW211VM
Workgroup	WORKGROUP
Last installed updates	Yesterday at 6:46 PM
Windows Update	Install updates automatically using Windows Update
Last checked for updates	Yesterday at 4:05 AM
Windows Defender Firewall	Private: On
Windows Defender Antivirus	Real-Time Protection: On
Remote management	Enabled
Feedback & Diagnostics	Settings
Remote Desktop	Enabled
IE Enhanced Security Configuration	On
NIC Teaming	Disabled
Time zone	(UTC) Coordinated Universal Time
Ethernet	IPv4 address assigned by DHCP, IPv6 enabled
Product ID	00430-00000-00000-AA650 (activated)
Operating system version	Microsoft Windows Server 2019 Datacenter
Processors	Intel(R) Xeon(R) Platinum 8272CL CPU @ 2.60GHz
Hardware information	Microsoft Corporation Virtual Machine
Installed memory (RAM)	1 GB
Total disk space	130.45 GB

Connecting
to the VM

Screenshot of the *PROPERTIES for NETW211VM* page, with the computer name, operating system version, hardware information, etc.

Microsoft Azure Search resources, services, and docs (G+)

joleary@my.devry.edu
DEVRY UNIVERSITY (MYDEVRYE...)

Home >

Resource groups

DeVry University (mydevryedu.onmicrosoft.com)

+ Create Manage view Refresh Export to CSV Open query Assign tags

Filter for any field... Subscription equals all Location equals all Add filter

0 Unsecure resources 0 Recommendations

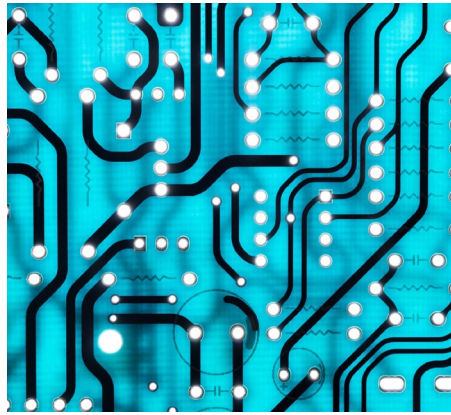
No grouping List view

<input type="checkbox"/> Name ↑↓	Subscription ↑↓	Location ↑↓
<input type="checkbox"/> NetworkWatcherRG	Azure for Students	East US

Deleting the VM

Screenshot of the *Resource groups* page, with the *Azure for Students* subscription selection and the “*No resource groups to display*” message.

Azure VNet and Subnets



This module focuses on Virtual Networks in the Cloud environment. It includes lessons on cloud connectivity and identity and access management (IAM). There are also steps of analyzing the effect of cloud infrastructure on network services, such as DHCP, DNS and routing. And creating Virtual Networks and Sub-nets and testing the connectivity.

Creating a VNet with Two Subnets

- 1. With a /24 network prefix, how many **usable** IPv4 host addresses are there? [hint: you learned this in NETW191]
- Answer here: 254
-
- 2. Given the answer above, why is the number of available IP addresses for Subnet0 (10.0.0.0/24) or Subnet1 (10.0.1.0/24) shown as 251? [hint: where did the missing addresses go?]
- Answer here: First 3 address are reserved in Azure VNet, 3 addresses are used for internal purposes.
- For example:
- VNET: 192.0.0.0/24
- Network Address: 192.168.0.0
- Reserved Address: 192.168.0.1-192.168.0.3
- Broadcast Address: 192.168.0.255

- 1. Microsoft Q&A <https://social.msdn.microsoft.com/Forums/en-US/network?forum=WAVirtualMachinesVirtualNetwork> (vijisankar Thursday, April 27, 2017)

Deploying VMs into Subnets

Properties section of the **Subnet0-VM** page, showing the networking and size information of the VM.

The screenshot displays the Azure portal interface for a virtual machine named "Subnet0-VM". The left-hand navigation pane includes sections for Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings (Networking, Connect, Windows Admin Center, Disks, Size), Microsoft Defender for Cloud, Advisor recommendations, Extensions + applications, and Continuous delivery. The main content area is divided into two primary sections: "Essentials" and "Properties".

Essentials

Resource group (move)	: NETW211-RG	Operating system	: Windows (Windows Server 2019 Datacenter)
Status	: Running	Size	: Standard B1s (1 vcpu, 1 GiB memory)
Location	: West US 3 (Zone 1)	Public IP address	: 20.171.30.11
Subscription (move)	: Azure for Students	Virtual network/subnet	: NETW211-RG-vnet/default
Subscription ID	: 536285ed-dc84-425c-9f7a-98eec4b0f5aa	DNS name	: Not configured
Availability zone	: 1		
Tags (edit)	: Click here to add tags		

Properties

Virtual machine	Networking		
Computer name	Subnet0-VM	Public IP address	20.171.30.11
Health state	-	Public IP address (IPv6)	-
Operating system	Windows (Windows Server 2019 Datacenter)	Private IP address	10.1.0.4
Publisher	Microsoft/WindowsServer	Private IP address (IPv6)	-
Offer	WindowsServer	Virtual network/subnet	NETW211-RG-vnet/default

Deploying VMs into Subnets cont'd

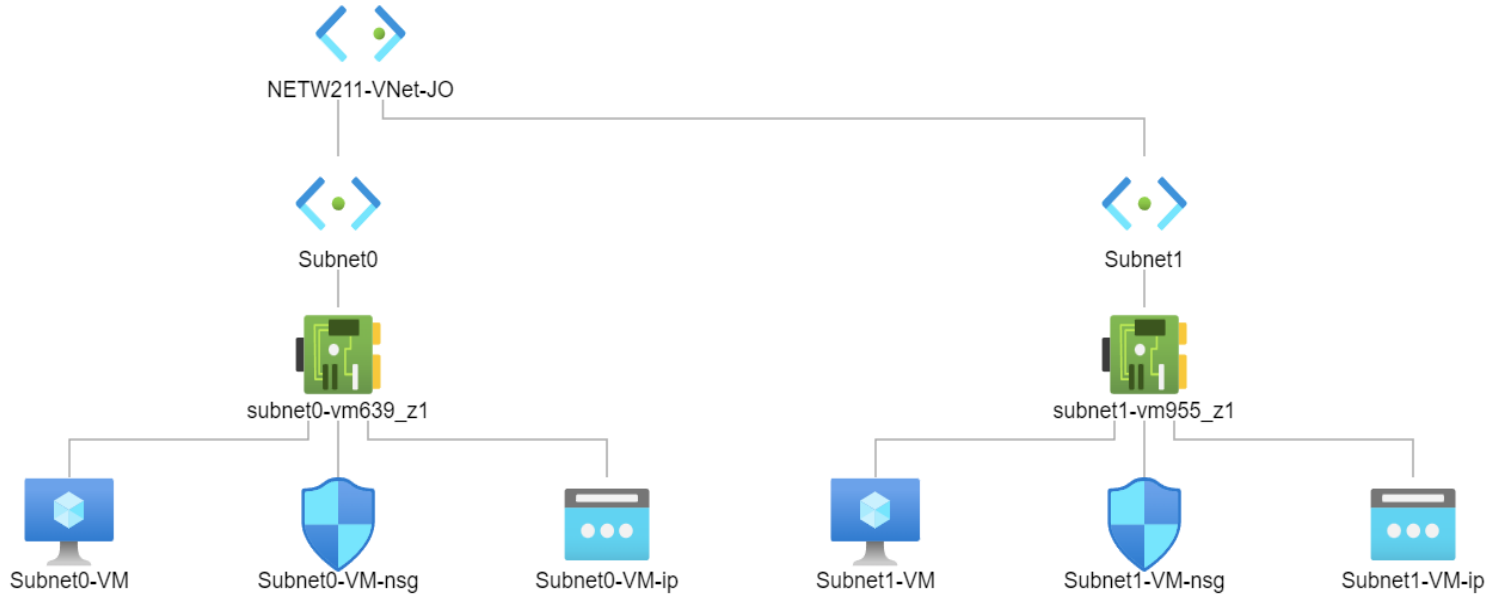
Properties section of the **Subnet1-VM** page, showing the networking and size information of the VM.

The screenshot displays the Azure portal interface for a virtual machine named "Subnet1-VM". The left-hand navigation pane includes sections for Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, and Settings. The Settings section is expanded to show Networking, Connect, Windows Admin Center, Disks, Size, Microsoft Defender for Cloud, Advisor recommendations, Extensions + applications, and Continuous delivery. The main content area is titled "Essentials" and provides key information about the VM, including its resource group (NETW211-RG), status (Running), location (West US 3 (Zone 1)), subscription (Azure for Students), and availability zone (1). Below this, there are tabs for Properties, Monitoring, Capabilities (8), Recommendations, and Tutorials. The Properties tab is active, showing two columns of information: "Virtual machine" and "Networking".

Virtual machine		Networking	
Computer name	Subnet1-VM	Public IP address	20.38.40.130
Health state	-	Public IP address (IPv6)	-
Operating system	Windows (Windows Server 2019 Datacenter)	Private IP address	10.1.0.5
Publisher	MicrosoftWindowsServer	Private IP address (IPv6)	-
Offer	WindowsServer	Virtual network/subnet	NETW211-RG-vnet/default

Deploying VMs into Subnets cont'd

Topology diagram of the VNet (*NETW211-VNet-Your Initials*) with two subnets (*Subnet0* and *Subnet1*) and one VM in each subnet (*Subnet0-VM* and *Subnet1-VM*).



Verifying Connectivity between VMs

ipconfig and ping x.x.x.x results in the command prompt window, including the **Subnet0-VM – x.x.x.x – Remote Desktop Connection** window title.

```
Microsoft Windows [Version 10.0.17763.3887]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\myaccount>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : zohgt2mydngebgnacher3b0kh.rx.internal.cloudapp.net
    Link-local IPv6 Address . . . . . : fe80::ecc8:bfeb:f5a0:710%4
    IPv4 Address. . . . . : 10.0.1.4
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.1.1

C:\Users\myaccount>ping 10.0.0.4

Pinging 10.0.0.4 with 32 bytes of data:
Reply from 10.0.0.4: bytes=32 time=1ms TTL=128
Reply from 10.0.0.4: bytes=32 time=1ms TTL=128
Reply from 10.0.0.4: bytes=32 time=2ms TTL=128
Reply from 10.0.0.4: bytes=32 time=1ms TTL=128

Ping statistics for 10.0.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 2ms, Average = 1ms

C:\Users\myaccount>
```

Verifying Connectivity between VMs cont'd

ipconfig and *ping x.x.x.x* results in the command prompt window, including the **Subnet1-VM – x.x.x.x – Remote Desktop Connection** window title.

```
Microsoft Windows [Version 10.0.17763.3887]
(c) 2018 Microsoft Corporation. All rights reserved.

C:\Users\myaccount>ipconfig

Windows IP Configuration

Ethernet adapter Ethernet:

    Connection-specific DNS Suffix  . : zohgt2mydngebgnacher3b0kh.rx.internal.cloudapp.net
    Link-local IPv6 Address . . . . . : fe80::bc13:912e:1ad9:6bd5%6
    IPv4 Address. . . . . : 10.0.0.4
    Subnet Mask . . . . . : 255.255.255.0
    Default Gateway . . . . . : 10.0.0.1

C:\Users\myaccount>ping 10.0.1.4

Pinging 10.0.1.4 with 32 bytes of data:
Reply from 10.0.1.4: bytes=32 time=1ms TTL=128
Reply from 10.0.1.4: bytes=32 time=1ms TTL=128
Reply from 10.0.1.4: bytes=32 time=1ms TTL=128
Reply from 10.0.1.4: bytes=32 time=1ms TTL=128

Ping statistics for 10.0.1.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 1ms, Maximum = 1ms, Average = 1ms

C:\Users\myaccount>_
```

Azure Virtual Machine Security

This module covers cloud security methods and security configurations for resources in the cloud including Virtual Networks and other hardware resources security.



Launching a Virtual Machine

Details of VM instance set up.

The screenshot displays the Azure portal interface for a virtual machine instance named "NETW211-VM-JO". The page is divided into a left-hand navigation pane and a main content area. The navigation pane includes sections for "Overview", "Activity log", "Access control (IAM)", "Tags", and "Diagnose and solve problems". Below these are "Settings" options such as "Networking", "Connect", "Disks", "Size", "Microsoft Defender for Cloud", "Advisor recommendations", "Extensions + applications", "Continuous delivery", "Availability + scaling", "Configuration", "Identity", "Properties", and "Locks". The main content area features a search bar, a toolbar with actions like "Connect", "Start", "Restart", "Stop", "Capture", and "Delete", and a warning message: "NETW211-VM-JO virtual machine agent status is not ready. Troubleshoot the issue". Below the warning is an "Essentials" section with a "JSON View" link, listing various properties of the VM. At the bottom, there are tabs for "Properties", "Monitoring", and "Capabilities (7)".

NETW211-VM-JO Virtual machine

Search << >> Connect Start Restart Stop Capture Delete ...

Overview

- Activity log
- Access control (IAM)
- Tags
- Diagnose and solve problems

Settings

- Networking
- Connect
- Disks
- Size
- Microsoft Defender for Cloud
- Advisor recommendations
- Extensions + applications
- Continuous delivery
- Availability + scaling
- Configuration
- Identity
- Properties
- Locks

NETW211-VM-JO virtual machine agent status is not ready. Troubleshoot the issue →

Essentials [JSON View](#)

Resource group (move)	: NETW211-RG-JO
Status	: Running
Location	: East US (Zone 1)
Subscription (move)	: Azure for Students
Subscription ID	: 536285ed-dc84-425c-9f7a-98e...
Availability zone	: 1
Operating system	: Linux
Size	: Standard B1s (1 vcpu, 1 GiB me...
Public IP address	: 172.174.161.96
Virtual network/subnet	: NETW211-RG-JO-vnet/default
DNS name	: Not configured
Tags (edit)	: Click here to add tags

Properties Monitoring Capabilities (7) ...

Virtual machine

- Computer name: NETW211-VM-JO
- Health state

Connecting to the VM via SSH

IPv4 address of the VM in the Azure cloud.

```
C:\Users\jfo84\Downloads>ssh -i NETW211-VM-J0_key.pem azureuser@172.173.166.145
Welcome to Ubuntu 20.04.5 LTS (GNU/Linux 5.15.0-1031-azure x86_64)

 * Documentation:  https://help.ubuntu.com
 * Management:    https://landscape.canonical.com
 * Support:       https://ubuntu.com/advantage

System information as of Tue Jan 24 02:24:28 UTC 2023

System load:  0.0                Processes:            101
Usage of /:   5.7% of 28.89GB     Users logged in:     0
Memory usage: 28%                IPv4 address for eth0: 10.0.0.4
Swap usage:   0%

6 updates can be applied immediately.
4 of these updates are standard security updates.
To see these additional updates run: apt list --upgradable

New release '22.04.1 LTS' available.
Run 'do-release-upgrade' to upgrade to it.
```

Configuring an NSG

Inbound port rules section with the newly added *Allow_Ping* rule.

 **Network Interface: netw211-vm-jo128** [Effective security rules](#)
[Troubleshoot VM connection issues](#) [Topology](#)

Virtual network/subnet: [NETW211-RG-JO-vnet/default](#)


NIC Public IP: [172.173.166.145](#) NIC Private IP: **10.0.0.4**

Accelerated networking: **Disabled**


Inbound port rules

Outbound port rules

...

 Network security group [NETW211-VM-JO-nsg](#) (attached to network interface: [netw211-vm-jo128](#))
Impacts 0 subnets, 1 network interfaces

[Add inbound port rule](#)

Priority	Name	Port	Protocol
300	 SSH	22	TCP
310	AllowAnyCustomAny...	Any	ICMP
65000	AllowVnetInBound	Any	Any
65001	AllowAzureLoadBala...	Any	Any
65500	DenyAllInBound	Any	Any



```
azureuser@NETW211-VM-J0:~$  
azureuser@NETW211-VM-J0:~$ ping 172.173.166.145  
PING 172.173.166.145 (172.173.166.145) 56(84) bytes of data.  
64 bytes from 172.173.166.145: icmp_seq=1 ttl=57 time=0.598 ms  
64 bytes from 172.173.166.145: icmp_seq=2 ttl=57 time=0.916 ms  
64 bytes from 172.173.166.145: icmp_seq=3 ttl=57 time=0.824 ms  
64 bytes from 172.173.166.145: icmp_seq=4 ttl=57 time=0.796 ms  
^C  
--- 172.173.166.145 ping statistics ---  
4 packets transmitted, 4 received, 0% packet loss, time 3044ms  
rtt min/avg/max/mdev = 0.598/0.783/0.916/0.115 ms  
azureuser@NETW211-VM-J0:~$ █
```

Successful ping result from a local computer to the VM in the Azure cloud.

Configuring an NSG cont'd

Cloud Storage



This module includes information about cloud data storage and backup methods including on-premises and cloud storage.

There are sections on object storage, file system storage, and VM-attached storage services in the major Cloud Services Providers.

The module also covers backup methods and redundancy strategies.

Uploading and Accessing a File

Browser window with the image uploaded from your local computer and the URL on top of the window.

The screenshot shows a browser window with two tabs. The top tab is titled "MyImageFile.png (1559x790)" and displays the image file's URL: `netw211storage0979.blob.core.windows.net/netw211container0979/MyImageFile.png`. The bottom tab is titled "netw211container0979 - Micros..." and shows the Microsoft Azure portal interface. The portal header includes the "Microsoft Azure" logo, a search bar, and the user's email "joleary@my.devry.edu". The main content area shows the "netw211container0979" container overview, including a search bar, navigation options (Upload, Change access level, Refresh, Delete, Change tier, Acquire lease), and a table with columns for Name, Modified, Access tier, Archive status, and Blob. The table currently displays "No results".

Questions

What does the *access tier* setting do? What are the Azure blob storage access tiers?

Answer here:

Hot tier - An online tier optimized for storing data that is accessed or modified frequently. The hot tier has the highest storage costs, but the lowest access costs.

Cool tier - An online tier optimized for storing data that is infrequently accessed or modified. Data in the cool tier should be stored for a minimum of 30 days. The cool tier has lower storage costs and higher access costs compared to the hot tier.

Archive tier - An offline tier optimized for storing data that is rarely accessed, and that has flexible latency requirements, on the order of hours. Data in the archive tier should be stored for a minimum of 180 days.

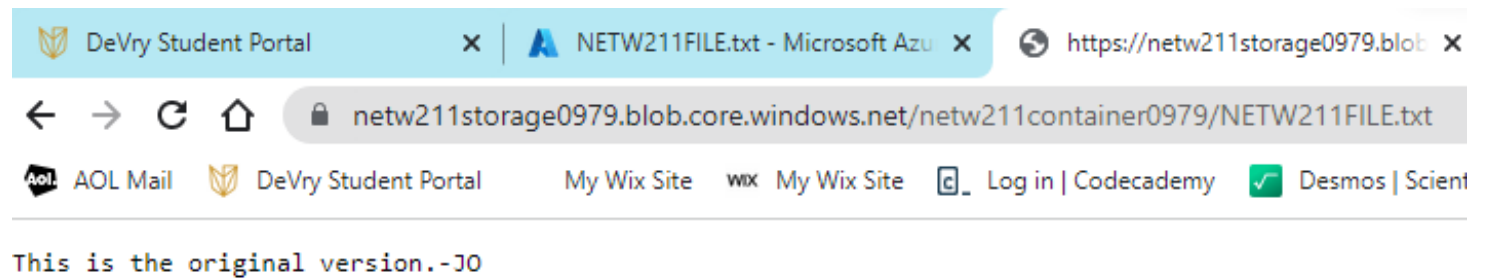
"Hot" tier is used for every day, frequently accessed data. "Cool" tier stores data that does not get access frequently but needs to be accessible for 30 days or more. The "Archive" tier is used for data that needs long term storage but will never or very rarely need to be accessed. So, data in the archive is stored off-line. But the metadata is kept available for reference and retrieval purposes.

Hot, Cool, and Archive access tiers for blob data, <https://docs.microsoft.com/en-us/azure/storage/blobs/access-tiers-overview>
Azure Blob Storage Access Tiers,
https://cdn2.percipio.com/secure/c/1675348819.223ff5bb614ce0099bfcee2eae6d0f6bcfc358ec/eot/transcripts/c5cdbf64-fb3e-462a-8401-80571701e530/it_cldsaz2020_06_enus.html#section_9

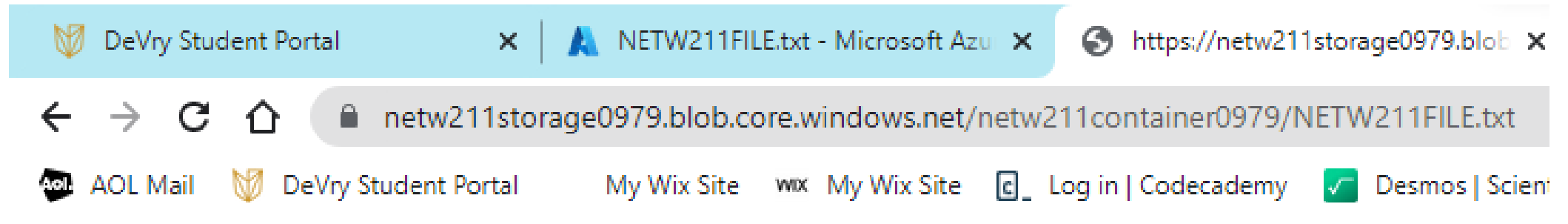


Creating Blob Snapshots

Example snapshot using blob storage in Azure



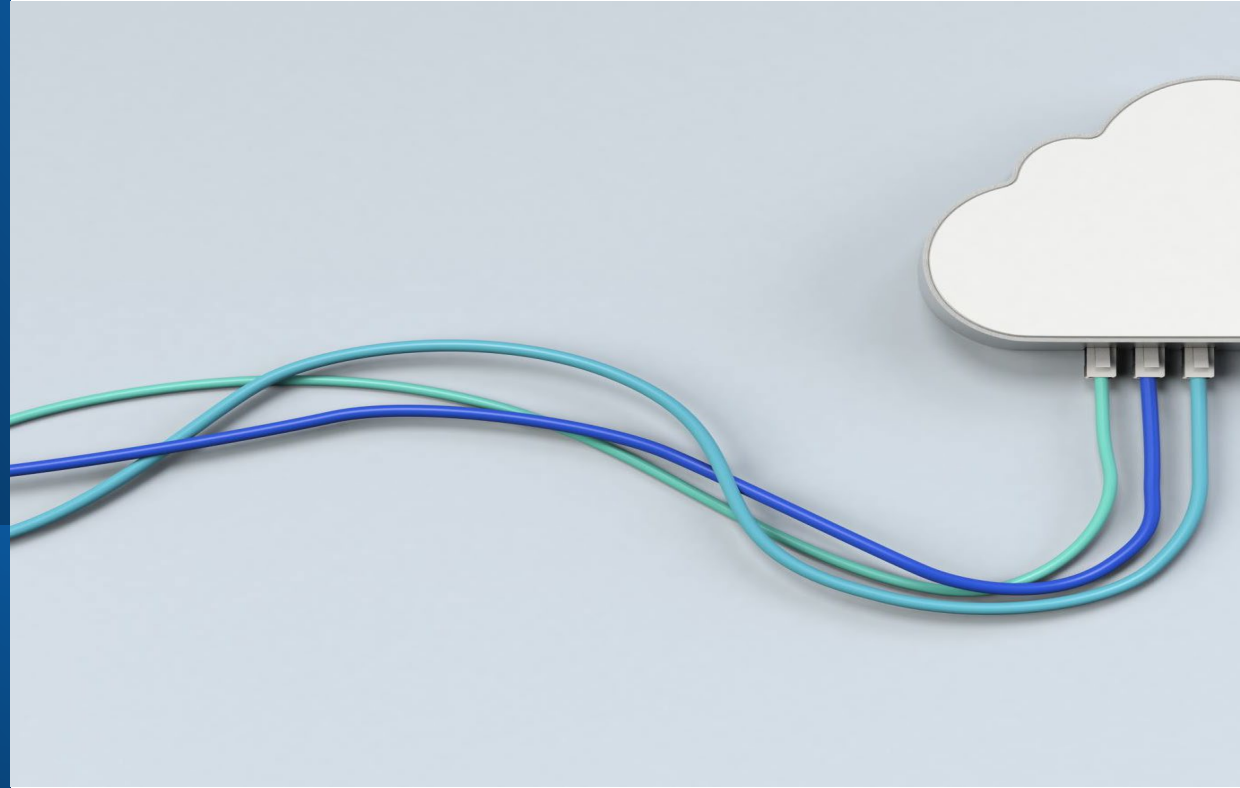
Example of Azure blob versioning.



`This is the first revised version.-JO`

Enabling Blob Versioning

Cloud Monitoring



This module includes examples of cloud monitoring and automation business continuity planning in the event of a disaster.

Home > NETW211-RG-JO0979 | Alerts >

Action groups ...

 Create  Columns  Refresh  Open query |  Delete  Enable  Disable  Test action group (preview)

Subscription : all




Resource group : NETW211-RG-JO0979

Location : all

Status : Enabled

Showing 1 to 1 of 1 Action groups.

No grouping

Name ↑↓	Short name ↑↓	Resource group ↑↓	Subscription ↑↓	Actions	Status ↑↓
<input type="checkbox"/> VM-Status-Change	VM-Status	 netw211-rg-jo0979	 Azure for Students	1 Email	 Enabled

- “VM-Status-Change” action group in Azure

Setting up an Action Group and Notifications

Alert rules ...

[+](#) Create [☰](#) Columns [↻](#) Refresh [↓](#) Export to CSV [🔗](#) Open query | [🗑️](#) Delete [▶](#) Enable Disable

Target resource type : all

Target scope : NETW211-VM-JO

Subscription : all

[▼](#) More (3)



Showing 1 to 2 of 2 Alert rules.







Name ↑↓	Condition	Severity ↑↓	Target scope	Target resource type	Signal type ↑↓	Status ↑↓
<input type="checkbox"/> VM-Deallocate	Category=Administrati...	4 - Verbose	NETW211-VM-JO	Virtual machine	Activity log	<input checked="" type="checkbox"/> Enabled
<input type="checkbox"/> VM-Restart	Category=Administrati...	4 - Verbose	NETW211-VM-JO	Virtual machine	Activity log	<input checked="" type="checkbox"/> Enabled


- *Alert rules window of the VM-Deallocate and VM-Restart rules.*

Setting up Alert Rules

'VM-Restart'
was activated
email message
with the date
and time of
the alert.

Important notice: Azure Monitor alert VM-Restart was activated  

 Microsoft Azure <azure-noreply@microsoft.com>     
To: O'Leary, John Thu 2/9/2023 5:48 AM

 Microsoft Azure



Azure Monitor alert 'VM-Restart' was activated for 'NETW211-VM-JO' at February 9, 2023 10:42 UTC







You're receiving this notification as a member of the VM-Status action group because an Azure Monitor alert was activated.

Activity log alert	VM-Restart
Time	February 9, 2023 10:42 UTC
Category	Administrative
Operation name	Microsoft.Compute/virtualMachines/restart/action
Correlation ID	01ed62fa-f4d4-4b7b-b0e1-45092105f8b3
Level	Informational


Testing Alerts

- *'VM-Deallocate'* was *activated* email message with the date and time of the alert.

Important notice: Azure Monitor alert VM-Deallocate was activated  

 Microsoft Azure
To: O'Leary, John     

Thu 2/9/2023 6:57 AM

 Microsoft Azure

Azure Monitor alert 'VM-Deallocate' was activated for 'NETW211-VM-JO' at February 9, 2023 11:50 UTC


You're receiving this notification as a member of the VM-Status action group because an Azure Monitor alert was activated.

Activity log alert	VM-Deallocate
Time	February 9, 2023 11:50 UTC
Category	Administrative
Operation name	Microsoft.Compute/virtualMachines/deallocate/action
Correlation ID	24506e6c-de41-41b6-83ca-2f1865a82508

Testing Alerts cont'd

Challenges

Some of the challenges I came up against in completing this project include an occasional problem with my laptop or peripherals.



I sometimes had initial difficulty when approaching a new concept until it became more familiar to me.



One other challenge I sometimes encountered is trouble navigating the Azure Cloud Environment.

Career Skills Aquired

- I gained great improvement in my critical thinking skills. Especially because I tend to want to figure things out on my own.
- My knowledge of technology and specifically cloud network technology has increased tremendously.
- I learned the value of joining organizations and developing a professional network of peers to stay relevant in the tech industry.

Conclusion

- In closing I want to say that this class is one of the most valuable and applicable to achieving a successful career in IT and Networking.
- The course was constructive from the Preview Week all the way to the Final Course Project.
- I'd like to thank all of the Professors for contributing their vast knowledge and experience, and I want to specifically thank Professor Risley for instructing the class in a way that very comprehensive, low stress and enjoyable.

References

- Microsoft Q&A <https://social.msdn.microsoft.com/Forums/en-US/network?forum=WAVirtualMachinesVirtualNetwork> (vijisankar Thursday, April 27, 2017)
- Hot, Cool, and Archive access tiers for blob data, <https://docs.microsoft.com/en-us/azure/storage/blobs/access-tiers-overview>
- Azure Blob Storage Access Tiers, https://cdn2.percipio.com/secure/c/1675348819.223ff5bb614ce0099bfcee2eae6d0f6bcfc358ec/eot/transcripts/c5cdbf64-fb3e-462a-8401-80571701e530/it_cldsaz2020_06_enus.html#section_9