A
Summer Internship Report
On
"Cloud Infrastructure and Security Domain"

(IT446 – Summer Internship - II)

Prepared by
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Under the Supervision of
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Submitted to
Charotar University of Science & Technology (CHARUSAT)
for the Partial Fulfillment of the Requirements for the
Degree of Bachelor of Technology (B.Tech.)
for Semester 7

Submitted at

CHARUSAT
CHAROTAR UNIVERSITY OF SCIENCE AND TECHNOLOGY
Accredited with Grade A+ by NAAC.
Accredited with Grade A by KCG

cspit
Chandubhai S Patel
Institute of Technology

SMT. KUNDANBEN DINSHA PATEL DEPARTMENT OF INFORMATION TECHNOLOGY

Chandubhai S. Patel Institute of Technology (CSPIT)
Faculty of Technology & Engineering (FTE), CHARUSAT
At: Changa, Dist: Anand, Pin: 388421.
August,2023

CERTIFICATE

This is to certify that the report entitled "**Cloud infrastructure and security In Microsoft Azure**" is a bonafied work carried out by **Jainam Patel (20IT096)** under the guidance and supervision of **Mr. Jalpesh Vasa** & **Mr. Prateek Kashyap and Mr. Sanskar pareek** for the subject **Summer Internship – II (IT446)** of 7th Semester of Bachelor of Technology in **Department of Information Technology** at Chandubhai S. Patel Institute of Technology (CSPIT), Faculty of Technology & Engineering (FTE) – CHARUSAT, Gujarat.

To the best of my knowledge and belief, this work embodies the work of candidate himself, has duly been completed, and fulfills the requirement of the ordinance relating to the B.Tech. Degree of the University and is up to the standard in respect of content, presentation, and language for being referred by the examiner.

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COMPANY CERTIFICATE

Celebal Summer Internship'23 | Offer Letter | Celebal Technologies
2 messages

Priyanka Maharshi <priyanka.maharshi@celebaltech.com>   Thu, May 11, 2023 at 6:25 PM
To: 20it096@charusat.edu.in <20it096@charusat.edu.in>

Celebal Summer Internship'23 Offer Letter

Date- 11th May 2023
To Jainam Patel
Chandubhai s patel Institute of Technology (CHARUSAT)

Subject- Summer Internship Offer Letter

TO WHOMSOEVER IT MAY CONCERN

Dear Jainam Patel,

On behalf of **Celebal Technologies**, we are excited to confirm your selection as a Summer Intern under the Cloud Infrastructure and security Department of our organization. We were impressed with your technical skills and knowledge during the assessment process, and we believe that you will be a valuable addition to our team.

Celebal Technologies takes pride in providing this exceptional opportunity to young tech enthusiasts like you to make them Industry-ready. Your internship will give emphasis on learning new skills with deeper understanding of concepts through hands-on application of the Industrial knowledge which you will gain as a Summer Intern.

Please note that as a temporary employee, you will not be eligible for any of the employee benefits, and you will not receive any stipend during your internship.

This offer letter represents the full extent of the Internship Offer. Please review this letter in full and give acknowledgement.

Rewards & Benefits:

1. Certificate of Internship
2. Webinar with Industry Experts
3. Industry Visits
4. Goodies for PPO's
5. Get a chance to qualify for Pre-Placement Offer

Perks:

1. Flexible working hours from Monday to Saturday
2. Expand your network.
3. Boost your resume.
4. Avail college degree credits

We look forward to a worthwhile and fruitful association which will make you equipped for future projects, wishing you the most enjoyable and truly meaningful Summer Internship Program experience.

Sharthak Acharjee
(HR Consultant)

ACKNOWLEDGEMENT

To become a professional in Information Technology industry, industrial training is the foundation for each undergraduate student.

I, the developer of the Project in the domain of "**Cloud Infrastructure and Security**", with immense pleasure and commitment would like to present the internship project assignment. The development of this project has given me wide opportunity to think, implement and interact with various aspects of management skills as well as the new emerging technologies.

I am thankful to Celebal Technology with whom we had an experience to learn and develop professional skills. So, we would definitely feel lucky to be a part of them.

It is helpful for us to improve our practical skills related to interpersonal, problems solving, as well as soft skills. And it also helps us to get exposure to the industry, apply the gained knowledge throughout the academic program and learn new updated technologies. Besides, this internship program makes me realized that the value of working together as a team and as a new experience in working environment. So, it was a great experience and throughout I have learned many things.

Besides this, as a student of CSPIT (IT), we are so grateful to Dr. Parth Shah (HOD, IT) and fellow interns of CSPIT and DEPSTAR who helps me during internship and gave us such a great opportunity to work as intern at Celebal Technology.

Thanks,
Jainam Patel (20IT096)
Chandubhai.S.Patel Institute of Technology

ABSTRACT

Industrial training is an important learning phase of a student life. After the completion of my internship, I learn how development process work in corporate sector.

In this internship my role is to gain knowledge of various aspects of cloud computing with Microsoft Azure though out this internship I work upon creating virtual network peering and site to site peering to connect our on-premises device to Microsoft Azure in different region and come to know about distinct kind of networking models and services of Microsoft Azure

Apart from technical skill I also learn soft skill with working and managing team as team leader.

we have explored things like **Creating Virtual Network in cloud, connection of virtual machine and various concept of cloud computing** and other relevant technologies for our project.

Overall, this internship report serves as a comprehensive account of the purpose, scope, and outcomes of the internship. It encapsulates the practical work undertaken, the conclusions derived, and the valuable lessons learned throughout the internship experience.

DESCRIPTION OF COMPANY

Celebal Technologies is a premier software services company in the field of Data Science, Big Data, and Enterprise Cloud. We help you achieve a competitive advantage with intelligent data solutions, built using cutting-edge technology. Our core offerings are around Cloud Innovation, Supply Chain Analytics, Chat Bots, Power Platforms, and Data Analytics. Our solutions can help you accelerate decision-making and take giants leaps in your digital transformation journeys. Our team of experts with their expertise can guarantee to form your business delineate on-line in a skilled manner. Our individual attention towards clients is the key to attain & achieve the business goals. Celebal Technologies has mobilized the right individuals, skills, technology, security, and processes to help client's strength in their competitive advantage. With the futuristic/artistic approach, we are committed to providing solutions powered by modern cloud and artificial intelligence that integrate with traditional enterprise software.

Website	**https://celebaltech.com/**
Company size	2200 employees
Headquarters	Jaipur, Rajasthan
Specialties	Artificial Intelligence, Big Data, Cloud innovation, Azure
Location	7th floor Corporate Tower JLN Marg, near Jawahar Circle, Malviya Nagar, Jaipur, Rajasthan 302017
Other Branch	Noida, Singapore, Houston United States

DETAILS OF CHAPTERS

LIST OF FIGURES

CHAPTER 1 – PROJECT DEFINTION & INTERNSHIP PLAN

1.1 PROJECT DEFINITION

Aim: configuration of on-premises to hub and spoke connectivity using s2s tunneling from on-premises and hub and transit vnet peering from hub to spoke. Configure rras on on-premises vm and establish s2s connectivity to the hub. The on-premises vm should be able to ping both hub vm and spoke vm successfully. The connectivity should be bi-directional. There is no direct connectivity established between spoke and on-premises vnet.
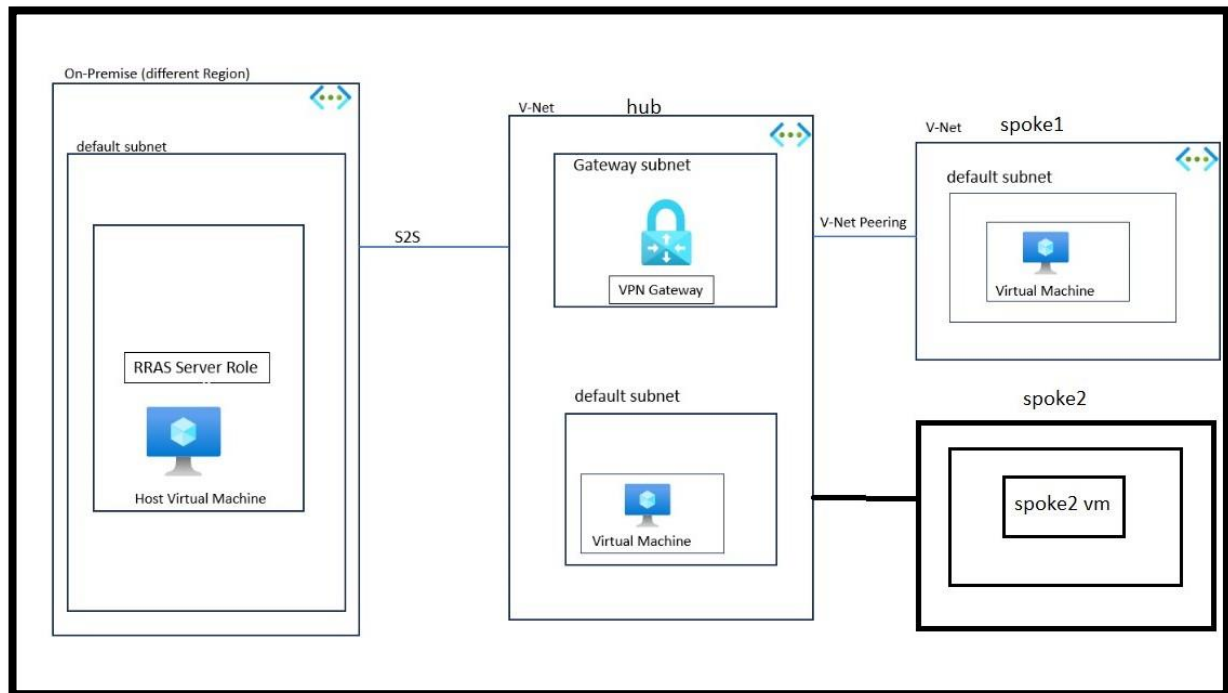

Figure 1.1: Architecture

1.2 INTERNSHIP OBJECTIVES

The purpose behind internship is to understand and experience the phenomena of the it industry through involvement in real life software development. By joining internship, we got to know about various industry regulation along with different cloud concept and did hands-on of microsoft azure services and documentation.involvement with industry software development has brought us enlightenment knowledge of industry prerequisites and requirement.

Generally, we had only one Technical/Doubt-solving session on every Friday each week throughout the internship program

1.3 OVERVIEW OF INTERNSHIP ACTIVITIES

TABLE 1.3.1 INTERNSHIP PLAN

	Date	Day	Name of Module
Week 1	22/05/23 to 27/05/23	Monday-Saturday	HR orientation session about company on 27th May 2023 and share detail about internship
Week 2	29/05/23 to 02/06/23	Monday-Friday	company mentors have provided basics of Microsoft Azure and we have created Microsoft account.
Week 3	05/06/23 to 09/06/23	Monday-Friday	Task related to create virtual machine in the virtual network and foundation of a robust cloud infrastructure.

Week 4	12/06/23 to 16/06/23	Monday-Friday	Learn about Vnet peering and Create Vnet peering between two VM
Week 5,6	19/06/23 to 30/06/23	Monday-Friday	Learn about site-to-site peering and create connection between On-premises to Azure VM and setup virtual network gateway
Week 7	03/07/23 to 07/07/23	Monday-Friday	Learn about hub-spoke architecture and create connection Between hub VM and spoke VM.
Week 8,9	10/07/23 to 21/07/23	Monday-Friday	Create mini project and create architecture by combining all above concept and evolution of project and HR activity.

CHAPTER 2- PROJECT DESCRIPTION

2.1 PROJECT DESCRIPTION

Project aims to establish a secure and reliable network connectivity between an on-premisesvirtual machine (VM) and a Hub VM in the cloud, using Site-to-Site (S2S) tunneling.

Additionally, we will enable communication between the Hub VM and multiple Spoke VMsthrough Transit VNet peering. Objective is to ensure bidirectional connectivity, allowing theOn-premises VM to successfully ping both the Hub VM and the Spoke VMs.

To achieve this, we will configure the Routing and Remote Access Service (RRAS) on the On-premises VM. This will serve as our on-premises router, enabling traffic to be securely tunneled to the Hub VM using S2S VPN. The Hub VM will act as the central hub, connectingthe On-premises VM to two Spoke VMs through Transit VNet peering.

The project ensures that no direct connectivity is established between the Spoke VMs and the On-premises VNet, maintaining network security. Through careful setup communication between the On-premises, Hub, and Spoke VMs.

CHAPTER 3 - SYSTEM REQUIREMET

3.1 REQUREMENTS

These are the necessary required Microsoft Azure Subscription and Internet Connectivity.

3.1.1 SOFTWARE REQUIREMENTS

The software requirements for the Azure project are as follows:

- On-Premises VM: Windows Server with Routing and Remote Access Service (RRAS) configured to act as the on-premises router for S2S tunneling.
- Azure Hub VM: Virtual machine instance in Azure, capable of hosting the central hub for the network.
- Azure Spoke VMs: Multiple virtual machine instances in Azure, connected to the hub via Transit VNet peering.
- Virtual Networks (VNet): Separate VNets for On-premises, Hub, and Spoke VMs in the same Azure region.
- S2S VPN Tunnel: Establish a secure VPN tunnel between On-premises VM and Hub VM.
- Transit VNet Peering: Configure peering between Hub and Spoke VNets to enable communication.
- Routing Configuration: Set up routing rules to allow communication between Spoke VMs through the Hub VM.
- Subnet Definitions: Define appropriate subnets in each VNet to host the VMs.
- Firewall Rules: Configure firewalls to allow necessary traffic for the S2S and Transit VNet connections.
- Network Security Groups: Define NSGs to control inbound and outbound traffic to VMs and subnets.

3.1.2 HARDWARE REQUIREMENTS

The hardware requirements for the Azure project are as follows:

- On-premises VM: A capable virtual machine with adequate CPU, RAM, and storage resources to run the Routing and Remote Access Service (RRAS) and handle network traffic efficiently.
- Hub VM: A robust virtual machine in the cloud with sufficient CPU, RAM, and storage to support VPN tunneling and handle the traffic from the On-premises VM and Spoke VMs.
- Spoke VMs (spoke1 and spoke2): Adequate virtual machines in the cloud with appropriate CPU, RAM, and storage to accommodate the required workloads and facilitate communication through Transit VNet peering.
- Network Equipment: Standard networking equipment (routers, switches, firewalls)

with VPN capabilities to facilitate the secure communication between the on-premises environment and the cloud-based VMs.

- Internet Connectivity: Reliable and stable internet connections both at the on-premises location and in the cloud environment to ensure uninterrupted VPN tunneling and data transfer.

3.2 TOOLS AND TECHNOLOGIES

- Microsoft Azure Subscription
- Azure Portal/CLI
- Virtual Networks
- Virtual Machines
- Virtual Network Gateway
- Local Network Gateway
- Networking Security Groups
- Routing and Remote Access Service (RRAS)
- Site-to-Site (S2S) VPN
- Transit VNet Peering
- Route Configuration
- Subnet
- Hub
- Spoke
- Routers

CHAPTER 4 – CONFIGURATION

4.1 AZURE SUBSCRIPTION
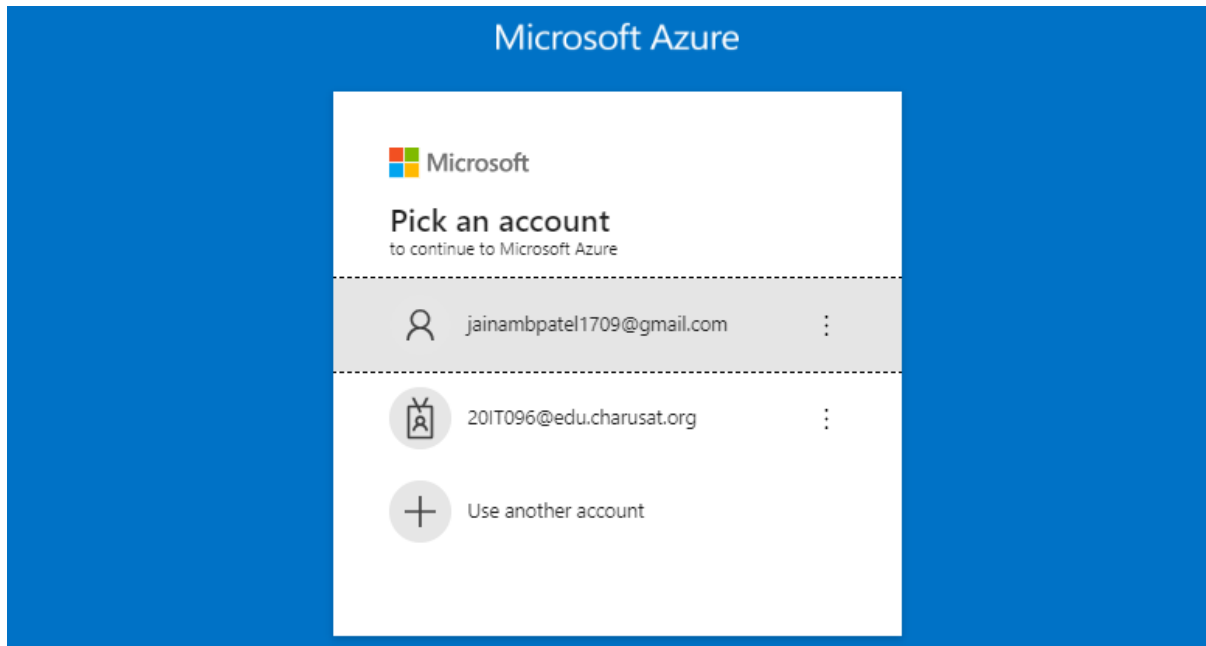
Figure 4.1: Azure Subscription

4.2 ON-PREMISES TO HUB CONNECTIVITY (S2S TUNNELING):

ON-PREMISES SIDE

1. Create Resource Group
   - Name: OnPrem-RG
   - Region: East US

2. Create Virtual Network
   - Resource Group: OnPrem-RG
   - Name: OnPrem-VNet
   - Region: East US
   - Address Space: 10.3.0.0/16
   - Subnet: 10.3.0.0/24 (default)

3. Create Virtual Machine
   - Resource Group: OnPrem-RG
   - Region: East US
   - Name: Jainam-OnPrem_VM
   - Username: jainamonpremvm

HUB SIDE

4. Create Resource Group
   - Name: hub_RG
   - Region: Central India

5. Create Virtual Network
   - Resource Group: hub_RG
   - Name: Jainam_hub_Vnet
   - Region: Central India
   - Address Space: 10.0.0.0/16
   - Subnet: 10.0.0.0/24 (default)
   - GatewaySubnet: 10.0.1.0/24

6. Create Virtual Machine
   - Resource Group: hub_RG
   - Region: Central India
   - Name: Jainam_hub_vm
   - Username: jainaamhubvm

7. Virtual Network Gateways
   - Resource group: hub_RG
   - Region: Central India
   - Name: VNG
   - SKU: VpnGw2
   - Virtual Network: Jainam_hub_Vnet
   - Gateway type: VPN
   - VPN type: Route-based
   - Public IP address: 20.244.1.148

8. Local network gateways
   - Resource group: hub_RG
   - Region: Central India
   - Name: LNG
   - IP address: 40.76.247.18 (onprem-vm)
   - Address space: 10.3.0.0/16 (Onprem-vnet)

9. Connections
   - Resource group: hub_RG
   - Region: Central India
   - Name: S2S-Connection
   - Connection type: Site-to-Site (IPsec)
   - Virtual network gateway: VNG
   - Local network gateway: LNG
   - IKE Protocol: IKEv2

10. Start OnPrem VM
    - Open Server Manager
    - Open add roles and features.

- Select Remote Access
- Select the role services.
  - DirectAccess and VPN (RAS)
  - Routing

11. Setup Routing and Remote Access (RRAS)
   - Create Interface: S2S
   - VPN type IKEv2
   - Destination IP Address: 20.244.1.148 (VNG public IP)
   - Add static route.
     - Destination: 10.1.0.0
     - Network mask: 255.255.255.0

   - Go to Network Interfaces/S2S/Properties/Security – Enter pre shared key.
   - Go to Network Interfaces/S2S/Properties/Options – Select Persistence connection.
   - Connect S2S Network Interface.

12. Check S2S Connectivity
   - Open onprem-vm and hub-vm
   - Enable ICMP protocol in both vm
   - Open cmd
   - ping 10.0.0.4 (onprem to hub)
   - ping 10.3.0.4 (hub to onprem)

4.3 HUB TO SPOKE CONNECTIVITY (TRANSIT VNET PEERING):

FOR SPOKE-1

13. Create Resource Group for Spoke-1
    - Name: spoke1_RG
    - Region: Central India

14. Create Virtual Network
    - Resource Group: spoke1_RG
    - Name: Jainam_Spoke1_Vnet
    - Region: Central India
    - Address Space: 10.1.0.0/16
    - Subnet: 10.1.0.0/24 (default)

15. Create Virtual Machine
    - Resource Group: spoke1_RG
    - Region: Central India
    - Name: Jainam_Spoke1_VM
    - Username: jainamspoke1vm

FOR SPOKE2

16. Create Resource Group for Spoke-2
    - Name: spoke2_RG
    - Region: Central India

17. Create Virtual Network
    - Resource Group: spoke2_RG
    - Name: Jainam_Spoke2_Vnet
    - Region: Central India
    - Address Space: 10.2.0.0/16
    - Subnet: 10.2.0.0/24 (default)

18. Create Virtual Machine
    - Resource Group: spoke2_RG
    - Region: Central India
    - Name: Jainam_Spoke2_VM
    - Username: jainamspoke2vm

FOR PEERING:

19. Open hub-vnet
    - Go to Peering and add hub to spoke1 peering.
        - Allow traffic forwarded.
        - Select use this virtual network's gateway or route server.
        - Peering link name: hub-spoke1
        - Virtual network: Jainam_Spoke1_Vnet
        - Select use this remote network's gateway or route server.

    - Go to Peering and add hub to spoke2 peering.
        - Allow traffic forwarded.
        - Select use this virtual network's gateway or route server.
        - Peering link name: hub-spoke2
        - Virtual network: Jainam_Spoke2_Vnet
        - Select use this remote network's gateway or route server.

20. Check Hub to Spoke Connectivity (Bi-Direction)
    - Open hub-vm and spoke-vm
    - Enable ICMP protocol in both vm
    - Open cmd
    - ping 10.1.0.4 (hub to spoke1)
    - ping 10.2.0.4 (hub to spoke2)
    - ping 10.0.0.4 (spoke1 to hub)
    - ping 10.0.0.4 (spoke2 to hub)

4.4 SPOKE-TO-SPOKE COMMUNICATION (ROUTE CONFIGURATION)

21. Open Route tables
    - Resource Group: spoke1-RG
    - Region: Central India
    - Name: spoke-2-spoke

22. Open Routes in spoke-2-spoke route table
    - Route Name: spoke1-to-spoke2
    - Destination Type: IP Addresses
    - Destination IP Addresses/CIDR Ranges: 10.2.0.4/24
    - Next Hope Type: Virtual network gateway (VNG)

23. Open Routes in spoke-2-spoke route table
    - Route Name: spoke2-to-spoke1
    - Destination Type: IP Addresses
    - Destination IP Addresses/CIDR Ranges: 10.1.0.4/24
    - Next Hope Type: Virtual network gateway (VNG)

24. Open Subnets in spoke-2-spoke route table
    - Associate Subnet for spoke1
        - Virtual network: Jainam_Spoke1_Vnet
        - Subnet: default
    - Associate Subnet for spoke2
        - Virtual network: Jainam_Spoke2_Vnet
        - Subnet: default
    - Open default subnet of spoke1
        - Subnet Address Range: (10.1.0.0/24)
        - Route Table: spoke-2-spoke.
    - Open default subnet of spoke2
        - Subnet Address Range: (10.2.0.0/24)
        - Route Table: spoke-2-spoke.

25. Enable IP Forwarding
    - Open hub-vm option/Networking/Network Interface/IP Confugrations – Enable IPForwarding
    - Execute one command in PowerShell of hub-vm
    - Command: Set-ItemProperty -Path HKLM:\SYSTEM\CurrentControlSet\Services\Tcpip\Parameters -NameIpEnableRouter -Value 1

26. Check Spoke to Spoke Connectivity (Bi-Direction)
    - Open spoke1-vm and spoke2-vm
    - Enable ICMP protocol in both vm
    - Open cmd
    - ping 10.2.0.4 (spoke1 to spoke2)
    - ping 10.1.0.4 (spoke2 to spoke1)

4.5 ON-PREMISES TO SPOKE CONNECTIVITY (RRAS SETUP):

27. Start OnPrem VM
    - Open Server Manager
    - Open Routing and Remote Access (RRAS)
    - Go to IPV4/Static Route
    - VPN type IKEv2
    - Destination IP Address: 20.244.1.148 (VNet-Public-IP)
    - Add static route to established connectivity between the onprem to spoke1 (Bi-Direction)
        - o Interface: S2S
        - o Destination: 10.1.0.0
        - o Network mask: 255.255.255.0

    - Add static route to established connectivity between the onprem to spoke2 (Bi-Direction)
        - o Interface: S2S
        - o Destination: 10.2.0.0
        - o Network mask: 255.255.255.0

28. Check onprem to spoke Connectivity (Bi-Direction)
    - Open onprem-vm and spoke-vm
    - Open cmd
    - ping 10.1.0.4 (onprem to spoke1)
    - ping 10.2.0.4 (onprem to spoke2)
    - ping 10.3.0.4 (spoke1 to onprem)
    - ping 10.3.0.4 (spoke2 to onprem)

CHAPTER 5 – MAJOR FUNCTIONALITY

5.1 MAJOR FUNCTIONALITY

On-Premises to Hub Connectivity (S2S Tunneling): Configure RRAS on the On-premises VM and establish a secure Site-to-Site (S2S) VPN tunnel to the Hub VM in the cloud. Thisenables bidirectional communication between the On-premises VM and the Hub VM.

Hub to Spoke Connectivity (Transit VNet Peering): Set up Transit VNet peering between the Hub VM and multiple Spoke VMs. This allows communication between the Hub and multipleSpoke VMs without establishing direct connectivity between the Spoke VMs.

Spoke-to-Spoke Communication (Route Configuration): Configure routes to enablecommunication between the two Spoke VMs through the Hub VM, completing the connectivity loop.

On-Premises to Spoke Connectivity (RRAS Setup): Configure RRAS on the On-premises VM to establish a connection to the Spoke VMs through the Hub VM, ensuring secure and efficient data exchange.

CHAPTER 6 – IMPLEMENTATION & OUTCOM

6.1 CONNECTIVITY BETWEEN ON-PREMISES TO HUB (BI-DIRECTIONAL)

Figure 6.1: Connectivity Between On-Premises to Hub and Hub to On-Premises (Bi-Direction)

6.2 CONNECTIVITY BETWEEN HUB TO TWO SPOKES (BI-DIRECTIONAL)

Figure 6.2.1: Connectivity between Spoke1 and Spoke2 to hub

Figure 6.2.2: Connectivity between hub to Spoke1 and Spoke2.

6.3 CONNECTIVITY BETWEEN TWO SPOKES (BI-DIRECTION)


```
Administrator: Windows PowerShell
Windows PowerShell
Copyright (C) Microsoft Corporation. All rights reserved.

Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\jainamspoke1vm> hostname
Jainam-Spoke1-V
PS C:\Users\jainamspoke1vm> ipconfig

Windows IP Configuration


Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : eq1zxbj53kveplxhvgtp02dfec.rx.internal.cloudapp.net
   Link-local IPv6 Address . . . . . : fe80::466e:8578:4950:6a36%6
   IPv4 Address. . . . . . . . . . . : 10.1.0.4
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.1.0.1
PS C:\Users\jainamspoke1vm> ping 10.2.0.4

Pinging 10.2.0.4 with 32 bytes of data:
Reply from 10.2.0.4: bytes=32 time=2ms TTL=127
Reply from 10.2.0.4: bytes=32 time=2ms TTL=127
Reply from 10.2.0.4: bytes=32 time=2ms TTL=127
Reply from 10.2.0.4: bytes=32 time=2ms TTL=127

Ping statistics for 10.2.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 2ms, Average = 2ms
PS C:\Users\jainamspoke1vm> tracert 10.2.0.4

Tracing route to 10.2.0.4 over a maximum of 30 hops

  1     1 ms      *        1 ms  10.0.1.4
  2     2 ms     1 ms      1 ms  10.2.0.4

Trace complete.
PS C:\Users\jainamspoke1vm>
```



```
Administrator: Windows PowerShell
Windows IP Configuration


Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : akubcddcu20upise4kw0syjcge.rx.internal.cloudapp.net
   Link-local IPv6 Address . . . . . : fe80::683f:be54:1231:c11f%6
   IPv4 Address. . . . . . . . . . . : 10.2.0.4
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.2.0.1
PS C:\Users\jainamspoke2vm> ping 10.1.0.4

Pinging 10.1.0.4 with 32 bytes of data:
Reply from 10.1.0.4: bytes=32 time=23ms TTL=127
Reply from 10.1.0.4: bytes=32 time=2ms TTL=127
Reply from 10.1.0.4: bytes=32 time=11ms TTL=127
Reply from 10.1.0.4: bytes=32 time=2ms TTL=127

Ping statistics for 10.1.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 2ms, Maximum = 23ms, Average = 9ms
PS C:\Users\jainamspoke2vm> tracert 10.1.04

Tracing route to 10.1.0.4 over a maximum of 30 hops

  1     1 ms      *       <1 ms  10.0.1.4
  2     3 ms     1 ms      1 ms  10.1.0.4

Trace complete.
PS C:\Users\jainamspoke2vm> tracert 10.1.0.4

Tracing route to 10.1.0.4 over a maximum of 30 hops

  1    <1 ms      *        1 ms  10.0.1.4
  2     2 ms     1 ms      1 ms  10.1.0.4

Trace complete.
```

Figure 6.3: Connectivity Between Two Spoke (Bi-Direction)

6.4 CONNECTIVITY BETWEEN ON-PREMISES TO TWO SPOKES (BI-DIRECTION)

```
Administrator: Windows PowerShell
PS C:\Users\jainamonpremvm> hostname
Jainam-Onprem-V
PS C:\Users\jainamonpremvm> ipconfig

Windows IP Configuration


Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : 3jkh33cpffietdavmaecevdwdc.bx.internal.cloudapp.net
   Link-local IPv6 Address . . . . . : fe80::52d6:7d8d:23df:c0d7%5
   IPv4 Address. . . . . . . . . . . : 10.3.0.4
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.3.0.1

PPP adapter S2S:

   Connection-specific DNS Suffix  . :
   Autoconfiguration IPv4 Address. . : 169.254.0.29
   Subnet Mask . . . . . . . . . . . : 255.255.0.0
   Default Gateway . . . . . . . . . :
PS C:\Users\jainamonpremvm> ping 10.1.0.4

Pinging 10.1.0.4 with 32 bytes of data:
Reply from 10.1.0.4: bytes=32 time=238ms TTL=127
Reply from 10.1.0.4: bytes=32 time=237ms TTL=127
Reply from 10.1.0.4: bytes=32 time=237ms TTL=127
Reply from 10.1.0.4: bytes=32 time=237ms TTL=127

Ping statistics for 10.1.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 237ms, Maximum = 238ms, Average = 237ms
PS C:\Users\jainamonpremvm> tracert 10.1.0.4

Tracing route to 10.1.0.4 over a maximum of 30 hops

  1    <1 ms    <1 ms    <1 ms  Jainam-Onprem-V.3jkh33cpffietdavmaecevdwdc.bx.internal.cloudapp.net [10.3.0.4]
  2    234 ms   234 ms   234 ms  10.1.0.4

Trace complete.
PS C:\Users\jainamonpremvm> _
```

```
Administrator: Windows PowerShell
PS C:\Users\jainamspoke1vm> hostname
Jainam-Spoke1-V
PS C:\Users\jainamspoke1vm> ipconfig

Windows IP Configuration


Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : eq1zxbj53kveplxhvgtp02dfec.rx.internal.cloudapp.net
   Link-local IPv6 Address . . . . . : fe80::466e:8578:4950:6a36%5
   IPv4 Address. . . . . . . . . . . : 10.1.0.4
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.1.0.1
PS C:\Users\jainamspoke1vm> ping 10.3.0.4

Pinging 10.3.0.4 with 32 bytes of data:
Reply from 10.3.0.4: bytes=32 time=234ms TTL=127
Reply from 10.3.0.4: bytes=32 time=236ms TTL=127
Reply from 10.3.0.4: bytes=32 time=234ms TTL=127
Reply from 10.3.0.4: bytes=32 time=234ms TTL=127

Ping statistics for 10.3.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 234ms, Maximum = 236ms, Average = 234ms
PS C:\Users\jainamspoke1vm> tracert 10.3.0.4

Tracing route to 10.3.0.4 over a maximum of 30 hops

  1    234 ms   234 ms   234 ms  169.254.0.29
  2    234 ms   235 ms   234 ms  10.3.0.4

Trace complete.
PS C:\Users\jainamspoke1vm> _
```

Figure 6.4.1: Connectivity Between On-Premises to Spoke-1 (Bi-Direction)

```
Trace complete.
PS C:\Users\jainamonpremvm> ping 10.2.0.4

Pinging 10.2.0.4 with 32 bytes of data:
Reply from 10.2.0.4: bytes=32 time=477ms TTL=127
Reply from 10.2.0.4: bytes=32 time=236ms TTL=127
Reply from 10.2.0.4: bytes=32 time=237ms TTL=127
Reply from 10.2.0.4: bytes=32 time=236ms TTL=127

Ping statistics for 10.2.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 236ms, Maximum = 477ms, Average = 296ms
PS C:\Users\jainamonpremvm> tracert 10.2.0.4

Tracing route to 10.2.0.4 over a maximum of 30 hops

  1    <1 ms    <1 ms    <1 ms  Jainam-Onprem-V.3jkh33cpffietdavmaecevdwdc.bx.internal.cloudapp.net [10.3.0.4]
  2   236 ms   236 ms   236 ms  10.2.0.4

Trace complete.
PS C:\Users\jainamonpremvm>
```

```
> Administrator: Windows PowerShell
  1    1 ms    <1 ms    <1 ms  10.0.0.4

Trace complete.
PS C:\Users\jainamspoke2vm> hostname
Jainam-Spoke2-V
PS C:\Users\jainamspoke2vm> ipconfig

Windows IP Configuration


Ethernet adapter Ethernet:

   Connection-specific DNS Suffix  . : akubcddcu20upise4kw0syjcge.rx.internal.cloudapp.net
   Link-local IPv6 Address . . . . . : fe80::683f:be54:1231:c11f%3
   IPv4 Address. . . . . . . . . . . : 10.2.0.4
   Subnet Mask . . . . . . . . . . . : 255.255.255.0
   Default Gateway . . . . . . . . . : 10.2.0.1
PS C:\Users\jainamspoke2vm> ping 10.3.0.4

Pinging 10.3.0.4 with 32 bytes of data:
Reply from 10.3.0.4: bytes=32 time=244ms TTL=127
Request timed out.
Request timed out.
Reply from 10.3.0.4: bytes=32 time=236ms TTL=127

Ping statistics for 10.3.0.4:
    Packets: Sent = 4, Received = 2, Lost = 2 (50% loss),
Approximate round trip times in milli-seconds:
    Minimum = 236ms, Maximum = 244ms, Average = 240ms
PS C:\Users\jainamspoke2vm> ping 10.3.0.4

Pinging 10.3.0.4 with 32 bytes of data:
Reply from 10.3.0.4: bytes=32 time=236ms TTL=127
Reply from 10.3.0.4: bytes=32 time=236ms TTL=127
Reply from 10.3.0.4: bytes=32 time=237ms TTL=127
Reply from 10.3.0.4: bytes=32 time=236ms TTL=127

Ping statistics for 10.3.0.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 236ms, Maximum = 237ms, Average = 236ms
PS C:\Users\jainamspoke2vm> tracert 0.3.0.4

Tracing route to 0.3.0.4 over a maximum of 30 hops

  1  Transmit error: code 1231.

Trace complete.
PS C:\Users\jainamspoke2vm>
```

Figure 6.4.2: Connectivity Between On-Premises to Spoke-2 (Bi-Direction)

CHAPTER 7 – LIMITATIONS AND FUTURE SCOPE

7.1 LIMITATIONS

- Complexity and Expertise: Setting up a network with S2S tunneling and Transit VNet peering requires advanced networking knowledge and expertise. It may be challenging for less experienced IT personnel to configure and troubleshoot the setup effectively.

- Network Latency: S2S tunneling and Transit VNet peering introduce additional networkhops, potentially leading to increased latency compared to a direct connection. This canimpact application performance and user experience, especially for real-time or latency-sensitive applications.

- Scalability: As the number of Spoke VMs or on-premises environments increases, managing and scaling the network architecture can become complex. It may require additional resources, monitoring, and potential redesigns to maintain optimal performance.

- Dependency on Cloud Provider: The project relies on a specific cloud provider's networking features for S2S tunneling and Transit VNet peering. This can create vendor lock-in and limit portability if there is a need to migrate the infrastructure to a different cloud provider in the future.

7.2 FUTURE SCOPES

- Enhanced Scalability: As the project involves using Transit VNet peering, it can beeasily expanded to accommodate more Spoke VMs without modifying the On-premises setup. This allows for seamless integration of additional resources as the network grows.

- Redundancy and High Availability: Implementing redundancy mechanisms like active-active tunnels and dual-hub designs can ensure high availability for the S2Sconnectivity. This approach minimizes downtime and ensures continuous communication even in the event of failures.

- Network Segmentation: Future enhancements may involve further segmenting thenetwork using Virtual WAN or other technologies, allowing better control and isolation of traffic between different business units or departments.

- Hybrid Cloud Extension: The current setup connects an on-premises environment to asingle cloud hub. Future scopes may include extending connectivity to multiple cloudproviders or regions, creating a more robust hybrid cloud infrastructure.

CHAPTER 8 – CONCLUSION

8.1 CONCLUSION

In conclusion, developing a to-do list application as part of an internship task within a team hasbeen a rewarding experience. The project has provided valuable insights into software development, teamwork, and project management. Through collaboration and effective communication, the team successfully designed and implemented a functional and user-friendlyto-do list application. Each team member had the opportunity to enhance their technical skills through the practical application of software development principles and techniques. This included front-end and back-end development, database management, user interface design. Working as a team allowed for a dynamic exchange of ideas, problem-solving, and mutual support. Team members leveraged their individual strengths and collaborated to overcome challenges and create an efficient and robust application. The to-do list application developed during the internship task holds significant value for users, offering a practical tool to improveproductivity, task management, and organization. The application has the potential to positivelyimpact individuals and teams by streamlining their workflow and facilitating efficient task completion.

CHAPTER 9 – REFERENCE

9.1 REFERENCES:

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