Transit VNet with the VM-Series 1.1

Deployment Guide

How to deploy a Transit VNet in Azure

http://www.paloaltonetworks.com

Last Update: September 2018

Table of Contents

Version History 3
1. About 4
2. Topology 5
3. Support Policy 8
4. Prerequisites 8
Service Principal Setup 8
Bootstrap Storage Account 9
Panorama Setup 9
5. Launch the Transit VNet Hub Template 11
Hub Input Parameters 14
6. Launch the Transit VNet Spoke Template 19
Spoke Input Parameters 22
Autoscale Settings 22
7. VNet Peering Verification 27
8. Inbound and Outbound Traffic Tests 29
9. Cleanup 32
10. Gotchas 33

Version History

Version number	Comments
1.1	Panorama is required for this deployment. Adds Bootstrapping to the hub, spoke and autoscaling to the spoke.

1. About

This document provides a step-by-step guide for deploying a Transit VNet with the VM-Series on Azure. The Transit VNet Hub provides centralized secured outbound internet access and connectivity for all your Azure VNet Spokes using two VM-Series firewall pairs positioned behind an Azure Standard (any port) load balancer in the Transit VNet hub. All outbound traffic originating from your Azure VNet spokes will be provided with a secure single point of exit from your cloud architecture by way of the Hub VNet. User Define Routes are used to route spoke traffic to the hub internal load balancer for packet forwarding to the hub VM-Series Firewalls. Traffic flowing through the VM-Series is protected from inbound and outbound threats, command-and-control malware, data exfiltration vulnerabilities and many other potential security concerns. For more details about the advantages of the hub and spoke topology please refer to this link:

https://docs.microsoft.com/en-us/azure/architecture/reference-architectures/hybrid-networking/hub-spoke

The Transit VNet addresses two common scalability requirements.

1. Scaling to secure many VNets: the hub and spoke design centralizes security in the hub, thereby reducing the number of firewalls deployed and the associated cost and management efforts. All spoke (VNet) traffic will transit the hub and as needed, spokes are added to address new Azure application deployments.
2. Autoscaling to address dynamic traffic needs: Deployed in one of the spokes, autoscaling for public facing workloads using VMSS and VM-Series metrics fed to Azure Application Insights. This architecture will automatically scale out as needed while providing security for public facing workloads.

Using ARM Templates, the guide walks through the deployment of the following components: The Transit VNet hub with the VM-Series firewalls in conjunction with, Application Gateways, Standard Load Balancers, Basic Load Balancers, and User Defined Route Tables. New additions to Version 1.1 include support for Azure autoscaling using Virtual Machine Scale Sets and native bootstrapping for the VM-Series. More information on bootstrapping in Azure can be found here:

https://www.paloaltonetworks.com/documentation/81/virtualization/virtualization/bootstrap-the-vm-series-firewall/bootstrap-the-vm-series-firewall-in-azure#idd51f75b8-e579-44d6-a809-2fafcfe4b3b6

if you have issues with this link please use the Bootstrap Instructions link on the GitHub ReadMe page https://github.com/PaloAltoNetworks/Azure-Transit-VNet/tree/master/Azure-Transit-VNET-1.1

Important Notes:

1. The Transit VNet with the VM-Series is considered advanced. It requires familiarity with Azure and the VM-Series next generation firewall.
2. The Transit VNet **requires Panorama** (physical or virtual) be deployed SEPERATELY, PRIOR to getting started. Panorama will be used to manage the VM-Series firewalls in the Virtual Machine Scale Sets within the spoke. Panorama will also be used for license deactivation, logging and reporting. More information on Panorama can be found here: https://www.paloaltonetworks.com/documentation/81/panorama
3. The Transit VNet with the VM-Series has NOT been tested in Azure Government.

Azure Application Insights for Autoscaling

In PAN-OS 8.1, support for natively publishing PAN-OS metrics to an Azure Application Insights instance was added. This allows you to monitor firewalls directly from the Azure portal. The Worker node deployed in the Transit Hub views PAN-OS published metrics via Azure Application Insights to determine if scaling is needed. The metrics that can be sent to Azure are

- Session Utilization %
- Total Active Sessions
- Dataplane CPU Utilization %
- Dataplane Packet Buffer Utilization %
- SSL Proxy Utilization %
- GlobalProtect Active Tunnels
- GlobalProtect Tunnel Utilization %

Virtual Machine Scale Sets for Autoscaling [VMSS]

In PAN-OS 8.1, support for VMSS was added and is used in this deployment scenario. Combined with Application Insights, VMSS allows you to pass information to Azure that can used to determine when an autoscaling event is needed. As mentioned previously, autoscaling in this deployment is not supported in the Transit Hub and is only supported in the Spoke. For more information on VMSS please see the link below.

https://docs.microsoft.com/en-us/azure/virtual-machine-scale-sets/overview

2. Topology

The Transit VNet deploys a classic hub-and-spoke architecture where the Hub and each spoke are deployed in separate VNets.

VNet Peering

For the different VNets to talk to each other, they must be peered in both the directions. VNet Peering works under the assumption that the peering networks **do not have overlapping subnets.** In this topology, when a VNet spoke is deployed, we will dynamically peer the spoke's VNet and the hub's VNet enabling traffic to flow between them. For additional information on VNet Peering please reference the link below

https://docs.microsoft.com/en-us/azure/virtual-network/virtual-network-peering-overview

Hub Topology

The Hub VNet consists of Mgmt , Untrust and Trust subnets. An Azure internal LB[Outbound-LB] used for outbound traffic and a pair of VM-Series FWs in an availability set. The Hub topology serves as the exit point of all non-return traffic for the Hub and Spoke topology.

The Hub topology consists of

- 2 VM-Series Firewalls
- 1 Standard internal Load Balancer
- Linux Worker Node
    - Worker node uses the Tabular storage table to keep track of the Azure VMSS table and Panorama device list. During a scale down event the worker node will deactivate the license in the Support Portal and remove the firewall from Panorama.
    - The worker node updates the NAT address object in the Spoke VM-series with the correct IP address of the spoke ILB.
    - The worker node will add the Azure instrumentation key for application insights into the Panorama template for reach new spoke deployment.
- 1 Tabular Storage Table
    - Stores VMSS device list data

Spoke Topology

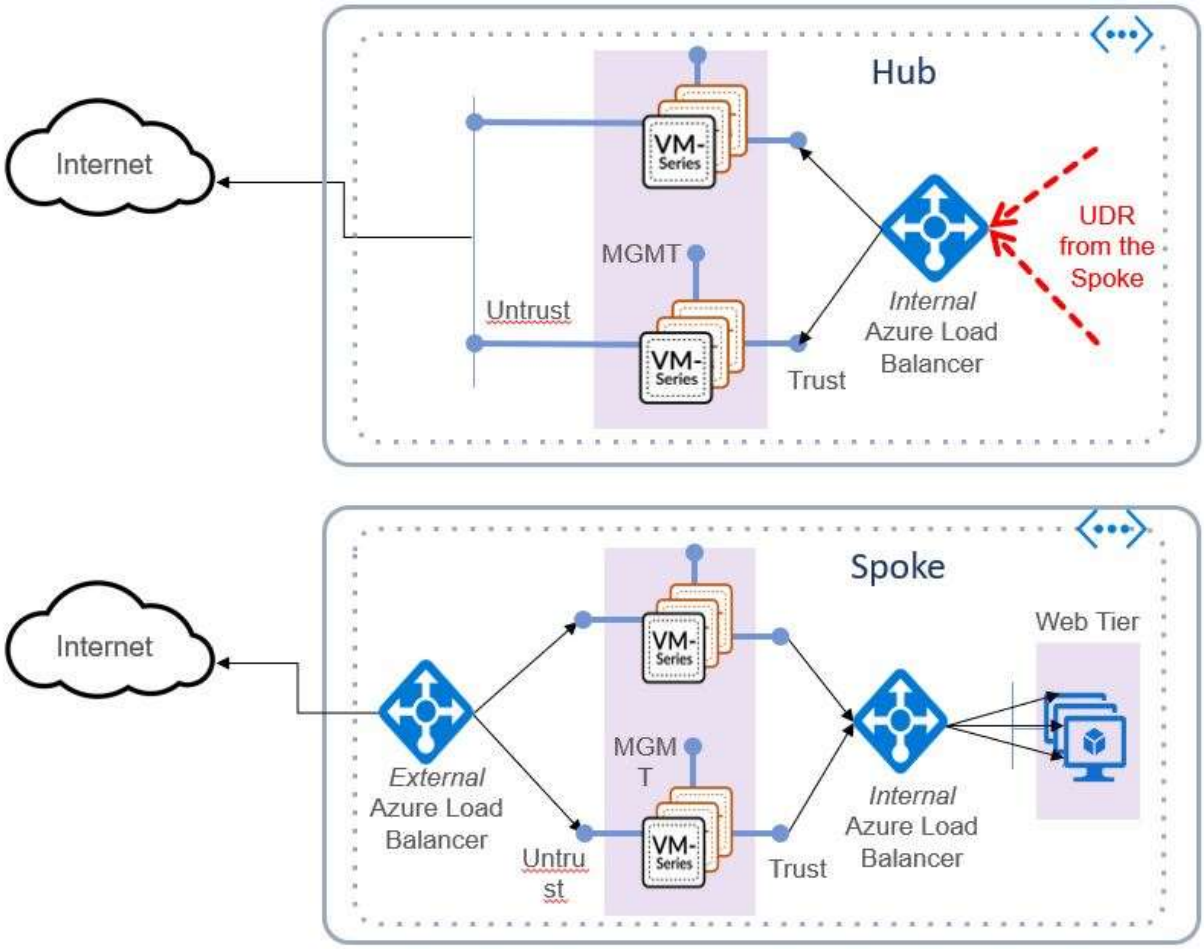
The spoke VNet provides an ingress point for all traffic destined to public facing workloads.[1] This spoke VNet is also where the VM-Series firewalls are autoscaled. The subnets consist of Mgmt, Untrust, Trust and Backend Subnets for the application servers. An Application Gateway doubles as a public facing load balancer and sits on the front end. VM-Series firewalls in a Virtual Machine Scale Set receive traffic from the public facing LB. An Internal LB sits behind the firewalls and sends traffic to the backend application servers. All return traffic egresses this same path. When a spoke subscribes to a hub, a UDR is also defined which has a default route to the Hub's Interal Load Balancer. This ensures all packets that are not destined to the spoke's VNet are forwarded to the Hub Internal LB for routing.

The Spoke topology consists of

[1] The term public facing workload refers to any server reachable from the internet. Web Server etc.

- 1 Application Gateway functioning as an external load balancer listening on port 80.
- Spoke subnets are 1921.168.0.0/21 Spoke1, 1921.168.8.0/21 Spoke2 and so on.
- Virtual Machine Scale Set with a VM-Series
- Availability Set for VM-Series
- 1 Internal Load Balancer
- 2 Linux Web servers
- 1 UDR sending all default route traffic to the Hub VNet Standard Load Balancer.
- 1 Bastion host
    - Used to connect to VM-Series firewalls in the VMSS via private Mgmt interface IP
- Application insights
    - Used to process VM-Series metrics used to determine scale in & scale out events

Hub & Spoke Topology



3. Support Policy

Community Supported

This template and deployment guide are released under an as-is, best effort, support policy. These scripts should be community supported and Palo Alto Networks will contribute our expertise as and when possible. We do not provide technical support or help in using or troubleshooting the components of the project through our normal support options such as Palo Alto Networks support teams, or ASC (Authorized Support Centers) partners and backline support options. The underlying product used (the VM-Series firewall) by the scripts or templates are still supported, but the support is only for the product functionality and not for help in deploying or using the template or script itself.

4. Prerequisites

The prerequisites required to successfully launch this template are listed below:

1. **Permissions**
   AZURE account with appropriate permissions.
2. **Download appropriate files**
   Clone or download the files from the following GitHub repository on to your local machine:
   https://github.com/PaloAltoNetworks/Azure-transit-VNet

3. **Valid License**
   Without a valid VM-Series Firewall license you will not see any data in the traffic logs. If you don't have a license provided by Palo Alto Networks, please select **bundle1** or **bundle2** in the template parameters for licensing. For more information on licensing please see the link below.
   https://www.paloaltonetworks.com/documentation/81/virtualization/virtualization/license-the-vm-series-firewall

4. **Service Principal and Active Directory Application Setup**
   You will need to set up an Azure Active Directory application and service principal account. Follow the link below for details. Make note of your Subscription ID, Azure Application ID, Application Secret Key, and Tenant ID.
   https://docs.microsoft.com/en-us/azure/azure-resource-manager/resource-group-create-service-principal-portal#check-azure-subscription-permissions

   Retrieve Azure Tenant ID
   https://docs.microsoft.com/en-us/azure/active-directory/develop/active-directory-howto-tenant

5. Bootstrap Storage Account

Storage accounts setup for bootstrapping in the spoke. Bootstrapping in the Hub is optional. Be sure to take the .xml configuration files from the Hub and change it to bootstrap.xml for bootstrapping. For the spoke you will not need a bootstrap.xml file because it will receive it's configuration from Panorama. It is recommended to create a separate resource group for your bootstrap storage account. See bootstrap instructions below.
https://www.paloaltonetworks.com/documentation/81/virtualization/virtualization/bootstrap-the-vm-series-firewall/bootstrap-the-vm-series-firewall-in-azure#idd51f75b8-e579-44d6-a809-2fafcfe4b3b6

Creating the bootstrap package
https://www.paloaltonetworks.com/documentation/81/virtualization/virtualization/bootstrap-the-vm-series-firewall

6. Bootstrap init-cfg.txt for Spoke VM-Series

A sample init-cfg.txt is provided below with explanation –

```
type=dhcp-client
ip-address=
default-gateway=
netmask=
ipv6-address=
ipv6-default-gateway=
hostname=
vm-auth-key=PanoramaVmAuthKey
panorama-server=PanoramaIP
panorama-server-2=
tplname=<spoke_name> + ”-tmplstk”
dgname=<spoke_name> + ”-dg”
dns-primary=8.8.8.8
dns-secondary=208.67.222.222
op-command-modes=
dhcp-send-hostname=yes
dhcp-send-client-id=yes
dhcp-accept-server-hostname=yes
dhcp-accept-server-domain=yes
```

7. Panorama Setup

Panorama 8.1 will be used for the spoke deployment to manage the VM-Series firewalls in the Virtual Machine Scale Set. Panorama will also be used for license deactivation, as well as logging and reporting. You must allow access to port 3978 to the Mgmt interface of the Panorama for any

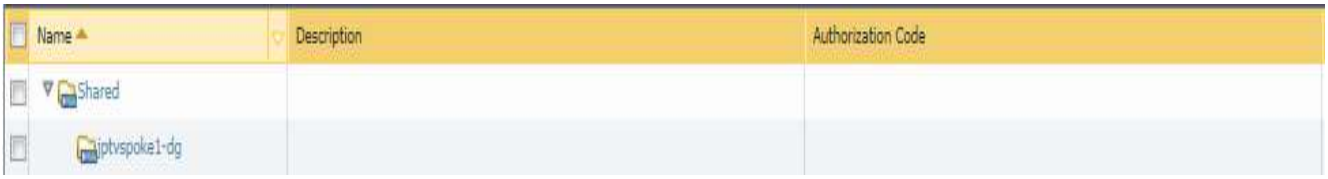
device security the Panorama. Port 443 and SSH can be locked down to the IP you will manage your Panorama from.
https://www.paloaltonetworks.com/documentation/81/panorama/panorama_adminguide/set-up-panorama/set-up-the-panorama-virtual-appliance#55656

8. **Panorama VM Auth Key**
   To authenticate the API, we need a Panorama API Key. The following link will walk you through generating an API Key.
   https://www.paloaltonetworks.com/documentation/81/pan-os/xml-api/get-started-with-the-pan-os-xml-api/get-your-api-key

9. **Enabling XML API access in Panorama**
   To program Panorama and deactivate VM Licenses, you need to enable XML API access in Panorama. As a best practice, create a new role with just API access to perform this. The steps to do this can be found here.
   https://www.paloaltonetworks.com/documentation/81/pan-os/xml-api/get-started-with-the-pan-os-xml-api/enable-api-access
10. **License Deactivation Key**
    We require a License Deactivation API Key and the "Verify Update Server Identity" to be enabled to deactivate the license keys from Panorama. The License Deactivation Key should be obtained from Palo Alto Customer Support Portal. Steps on how to activate this can be found below.
    https://www.paloaltonetworks.com/documentation/81/virtualization/virtualization/license-the-vm-series-firewall/deactivate-the-licenses/install-a-license-deactivation-api-key

11. **Panorama Template and Device Group Name**
    For every spoke that is launched, a corresponding Device Group, Template and Template Stack needs to be created in Panorama. Use the name of your Azure Spoke resource group to name your template and Device Group. For example, if the resource group of your spoke in Azure is named jptvspoke1, then name your device group jptvspoke1-dg and name your template stack jptvspoke1-tmplstk. The template should have all the configuration and added to the template stack.

Name	Description	Type	Stack	Devices
jptvspoke1		template		
jptvspoke1-tmplstk		template-stack	jptvspoke1	3g2pb000000



12. Panorama Device Group NAT Object

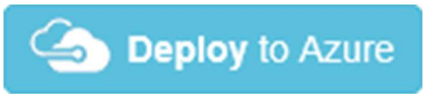
The Device Group should also have an address object called **ILB_NAT_ADDR** created with a random IP address which will be re-programmed by the worker node monitoring script.

13. Panorama Template and Device Group Configuration

You can use the **appgw-sample.xml** snapshot configuration in the GitHub spoke folder as an example of how to configure your device group and template in Panorama. Load this configuration on to a firewall without committing to view the settings while you configure your Panorama. To avoid issues always validate your configuration prior to attempting a push or bootstrap. See **Gotchas** section below.

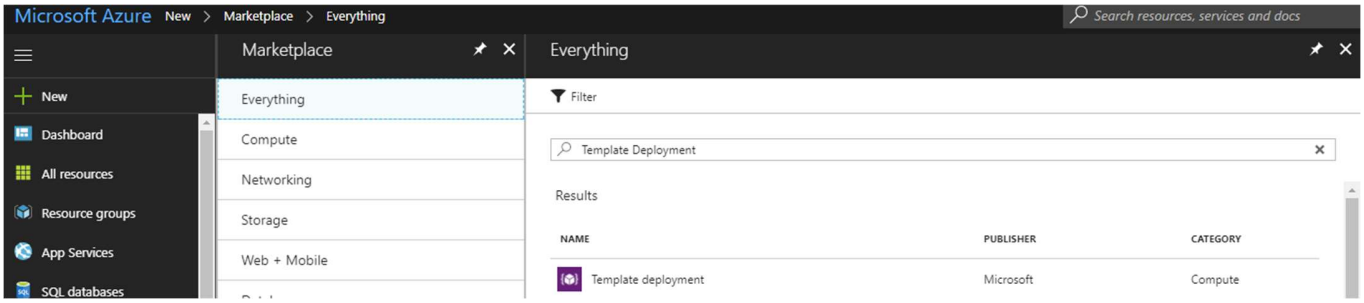
5. Launch the Transit VNet Hub Template

There are multiple ways to deploy your template. You can use Azure CLI, PowerShell, Deploy to Azure button or you can deploy the template manually. If the GitHub Repository has a **Deploy to Azure** button you can deploy the template by clicking the deploy button for each template. Before launching be sure to take the **working_hub_config.xml** and rename it bootstrap.xml for use when bootstrapping VM-Series in the Hub. The steps below will walk you through how to launch the ARM template manually.

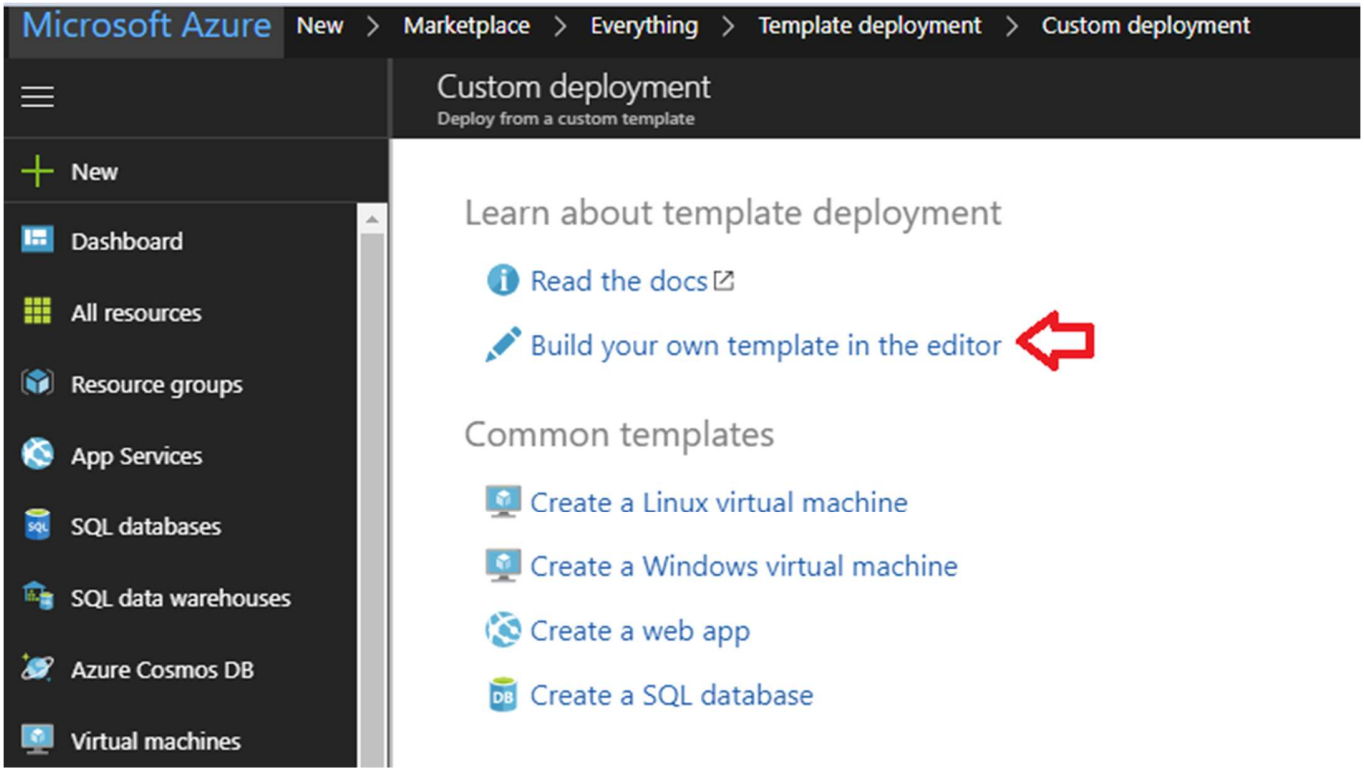


In the Azure Resource Manager console you can launch the **azureDeployInfra.json** file directly from the Azure Portal. To do this click **"New"** then search **"Template Deployment"**, click the Template Deployment

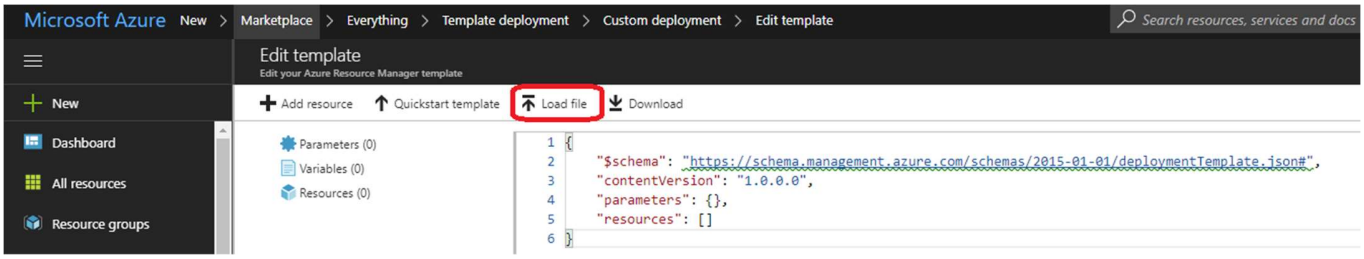
icon an select **“Create”.**



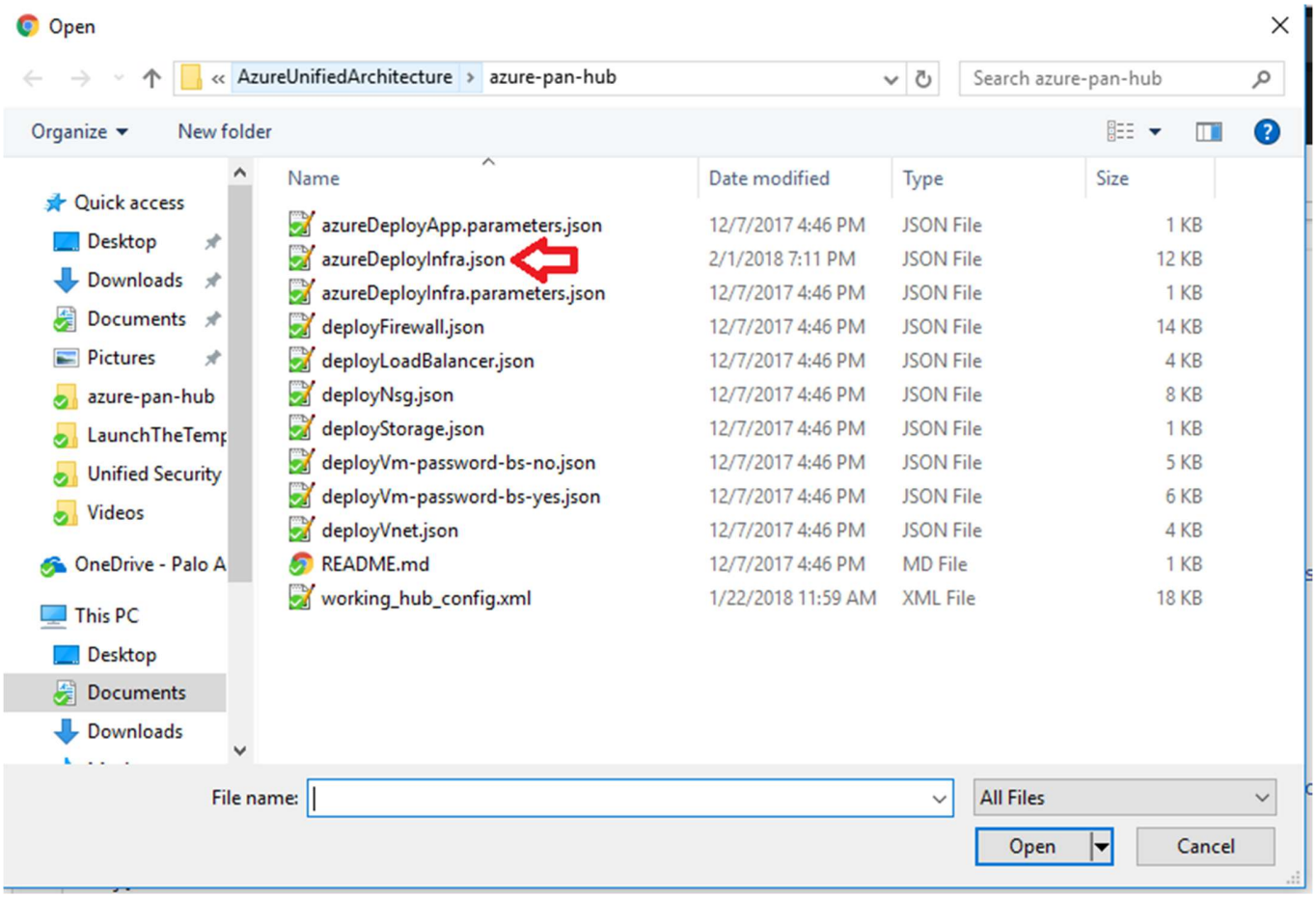
In the next screen click “Build your own template in the editor”



Select **“Load File”**



Select **"azureDeployInfra.json"** file from the Azure-Transit-VNet/azure-pan-hub directory that you cloned from GitHub, then click **"Save"** to bring up the parameters.



Hub Input Parameters

a. Most of the **parameters** are self-explanatory and should be left at the defaults
b. **Resource Group** – Always create a new resource Group. The hub template does not work in an existing resource group
c. **Location** – Use the location where your bootstrap storage account is created.
d. **Virtual Network Name** – This will be the name of the hub VNet
e. **Virtual Network Address Prefix** – Use a network address which will not be used in the spoke deployment. The defaults should suffice.
f. **Load Balancer IP** – Use a static IP for Load Balancer in the Trust network. Remember this address since it is used as an input parameter for the spoke template.
g. **Network Security Group Inbound Src IP** – This is the IP you will allow explicit access to the management interface of the virtual machines. For security purposes be sure to set **Security Group Inbound IP** for mgmt access to the firewall.
h. **Image Version** – For image version you must use at minimum PAN-OS 81.1 so select latest.
i. **Firewall Model** – If you select BYOL you must receive licensing directly from Palo Alto Networks or reseller.
j. **Username** and **password** that is entered by default for the devices is: **user:**pandemo **password:**Dem0pa$$w0rd
k. **Subscription ID** – See Step 4 listed in prerequisites
l. **App ID** – See Step 4 listed in prerequisites
m. **Tenant ID** – See Step 4 listed in prerequisites
n. **Panorama IP** – IP address for the previously deployed Panorama
o. **Panorama API Key** – See step 9 listed in prerequisites
p. **Bootstrap Storage Account** – See step 5 listed in prerequisites
q. **Storage Account Access Key** – See step 5 listed in prerequisites
r. **Storage Account File Share** – See step 5 listed in prerequisites
s. **Storage Account File Share Directory** – See step 5 listed in prerequisites
t. It could take up to 10 minutes to complete the launch or longer depending on Azure.

TEMPLATE

Customized template
9 resources

Edit template | Edit parameters | Learn more

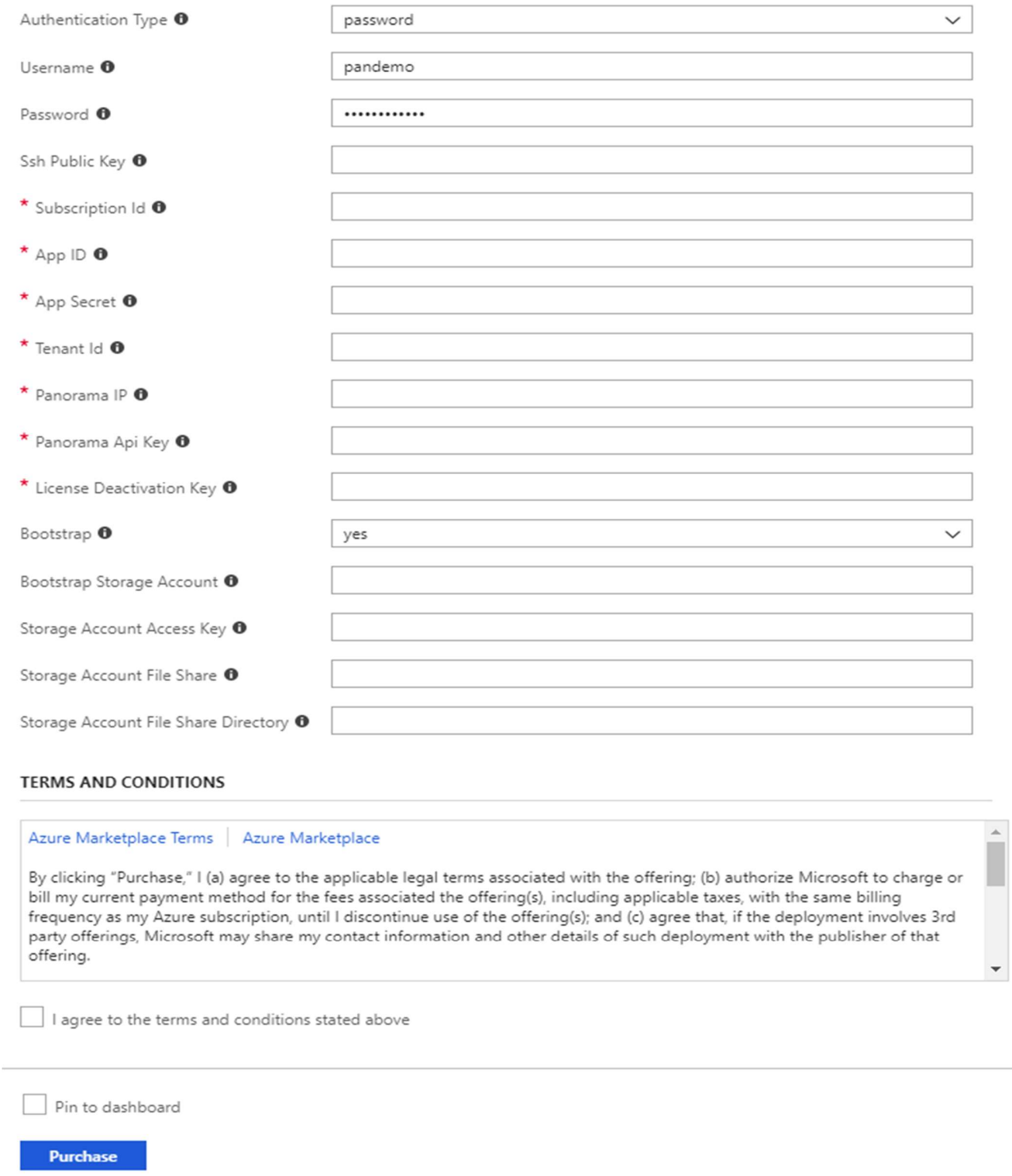
BASICS

* Subscription	AzureTME
* Resource group	Create new / Use existing
	Create a resource group
* Location	East US

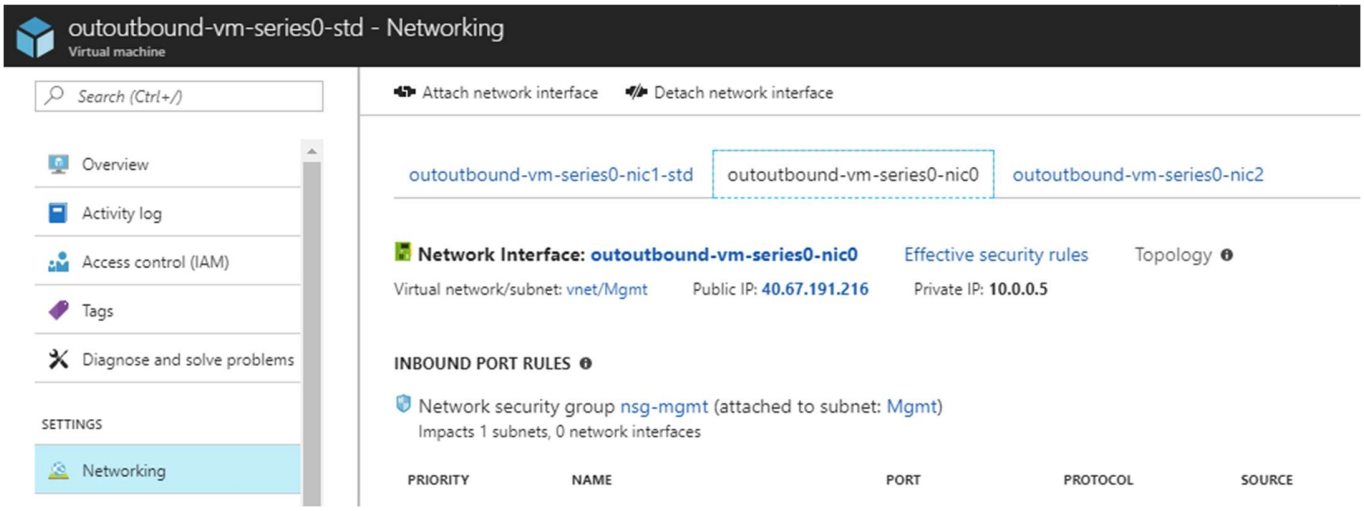
SETTINGS

Virtual Network Name	hub-vnet
Virtual Network Address Prefix	10.0.0.0/16
Mgmt Subnet Prefix	10.0.0.0/24
Untrusted Subnet Prefix	10.0.1.0/24
Trusted Subnet Prefix	10.0.2.0/24
Load Balancer IP	10.0.2.4
Storage Name	Enter a globally unique name
Storage Type	Standard_LRS
Mgmt Public IP Dns	Enter a globally unique name
* Network Security Group Inbound IP	
Image Version	latest
Firewall Model	byol
Firewall Vm Size	Standard_D3_v2
Authentication Type	password

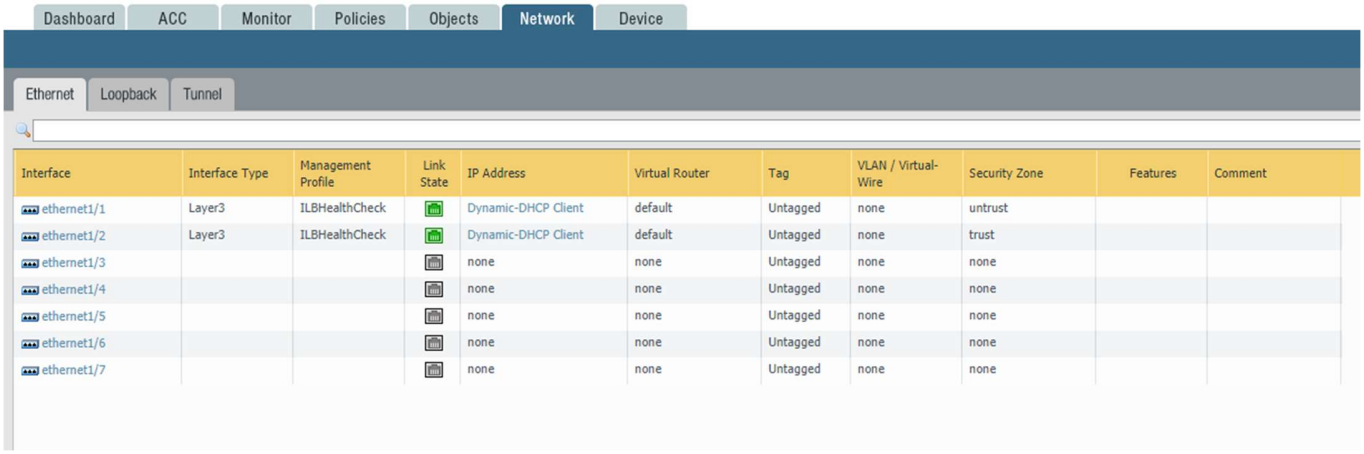
Acknowledge the terms and conditions and click "**Purchase**"



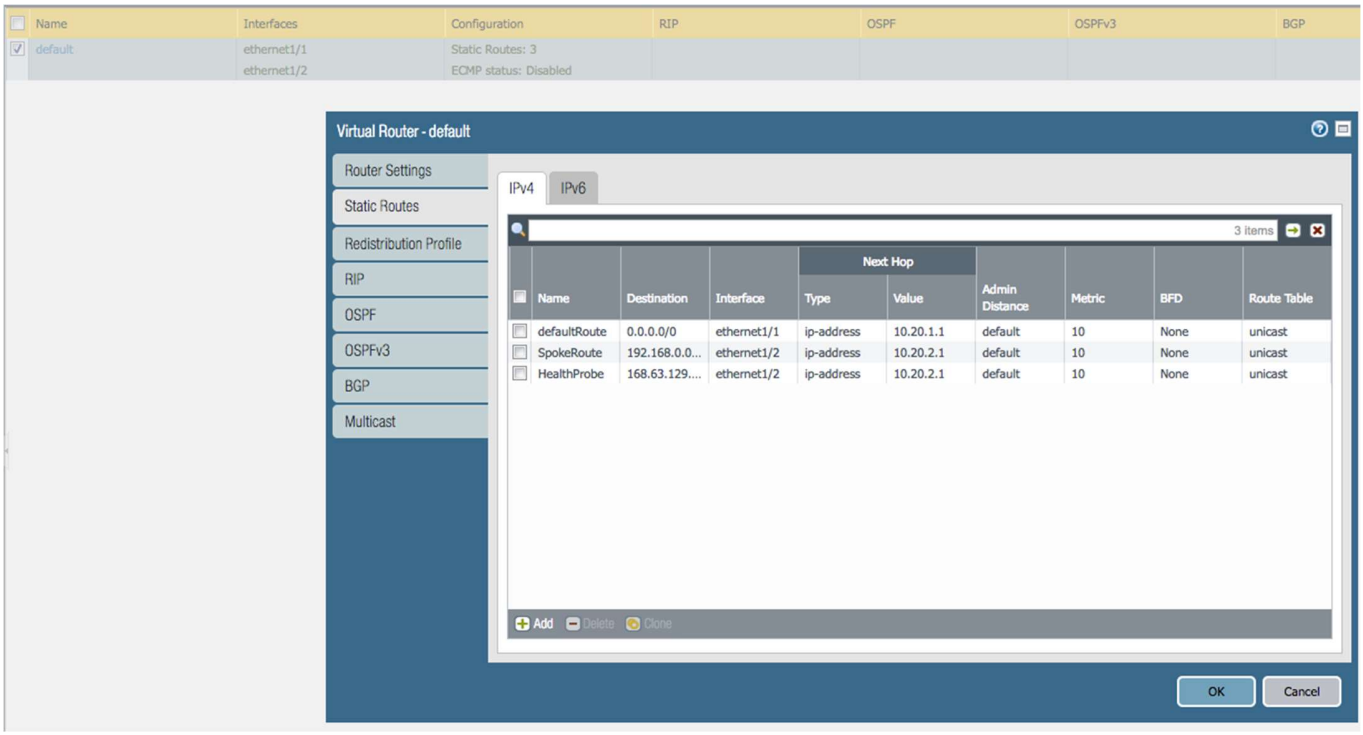
Once the firewalls have launched, locate the **Management** interface public IP address in Azure.



Log into the hub firewalls using **HTTPS.** Make sure your ethernet1/1 and Ethernet1/2 interfaces now show green.



Verify the **virtual router** has the following configuration.

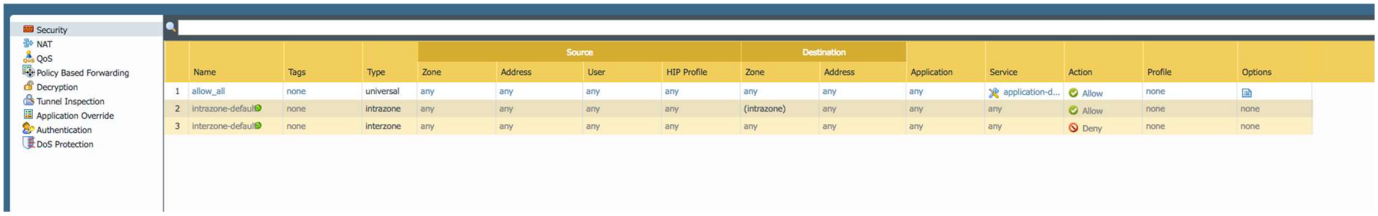


DefaultRoute: is to forward all outbound traffic to the untrust interface so that it egresses out of the Azure network.

SpokeRoute: is to forward all the inbound traffic and inter-spoke traffic back to the Trust interface so that it reaches the appropriate Spoke (application server). Note that the Network address of the all the spokes VNets should be part of this network address. If a new spoke is added whose network address is not part of this network address, then a new route needs to be added in the config to forward that traffic to the Trust interface.

HealthProbe: is to respond to the health probe packets generated by the Internal Load Balancer. For this lab the health check is configured to port 22 on the firewall Trust interface.

An **allow-all** security policy is created to forward all traffic. This should be modified to accommodate your policy preferences.



Verify that you have a **NAT rule** on the hub firewall for outbound traffic

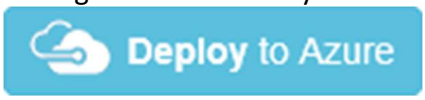
6. Launch the Transit VNet Spoke Template

Spoke Template Options

Azuredeploy.json – This launches the spoke template with VM-Series firewalls sandwiched between an external and internal load balancer. This provides secured external access to public facing workloads with return traffic egressing the spoke VNet. All internal originating traffic will be forwarded to the Hub VNet as the exit route to provide secure outbound access.Configuration options for VMSS allow you to deploy a spoke for the purposes of autoscaling to secure public facing traffic.

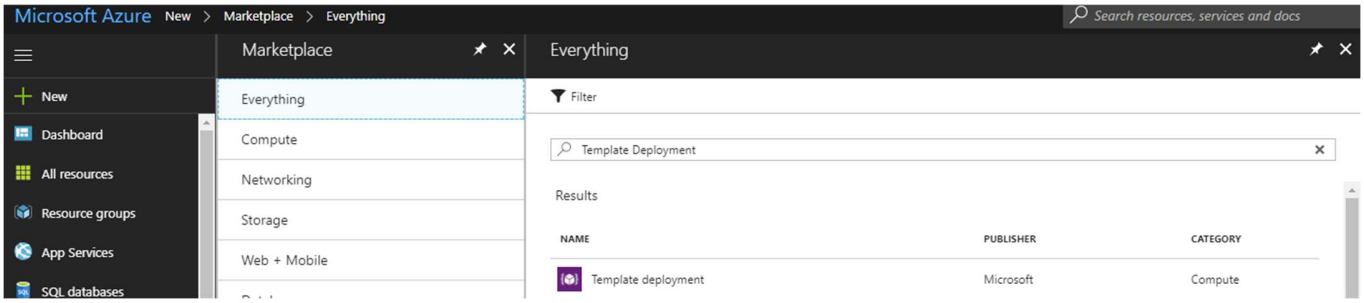
Azuredeploy-no-firewall.json – Launches the spoke template with no firewalls but still launches application servers. This scenario would NOT provide security using the VM-Series for public facing workloads. All internal originating traffic will be forwarded to the Hub VNet as the exit route to provide secure outbound access.

There are multiple ways to deploy your template. You can use Azure CLI, PowerShell, Deploy to Azure button or you can deploy the template manually. If the GitHub Repository has a **Deploy to Azure** button you can deploy your template by clicking the deploy button for each template. For the spoke you will not need a bootstrap.xml file because it will receive its configuration from Panorama. Below I will walk you through how to launch your ARM template manually.

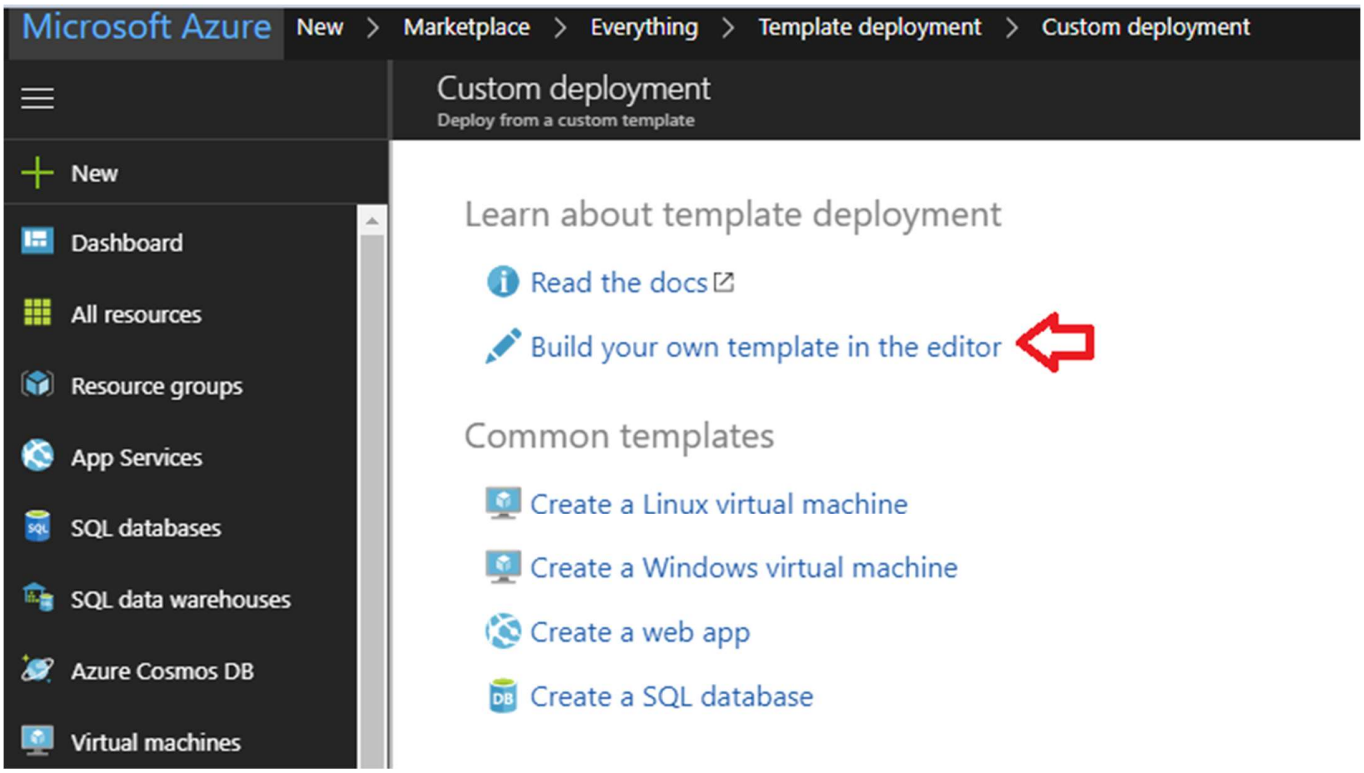


From the Azure-Transit-VNet/azure-pan-spoke GitHub repository that you cloned, launch the **azuredeploy.json** file directly from the Azure Portal. You may need to bring up two azure portal browsers in order to locate information needed to fill out the parameters when launching this template. To do this

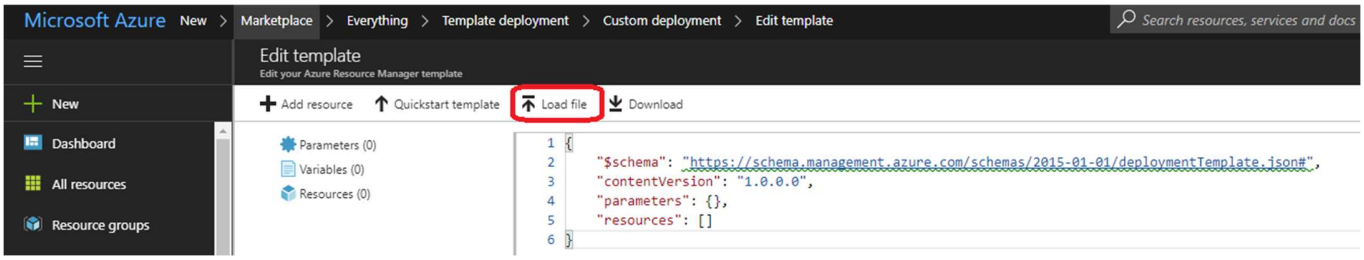
click **“New”** then search **“Template Deployment”**, click the Template Deployment icon an select **“Create”.**



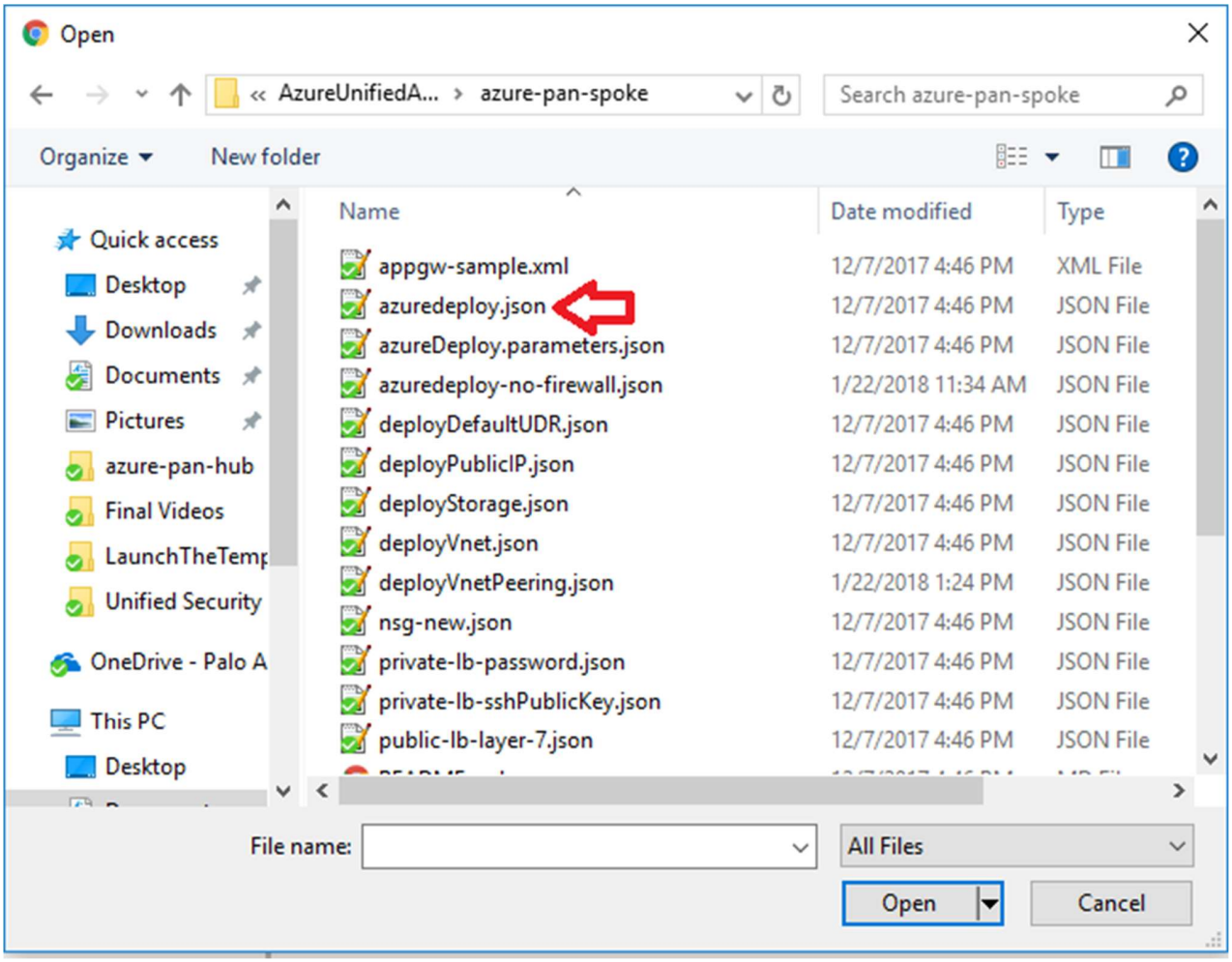
In the next screen click **“Build your own template in the editor”**



Select **"Load File"**



Select **"azuredeploy.json"** file from the Azure-Transit-VNet/azure-pan-spoke directory that you cloned from GitHub, then click **"Save"** to bring up the parameters.



Spoke Input Parameters

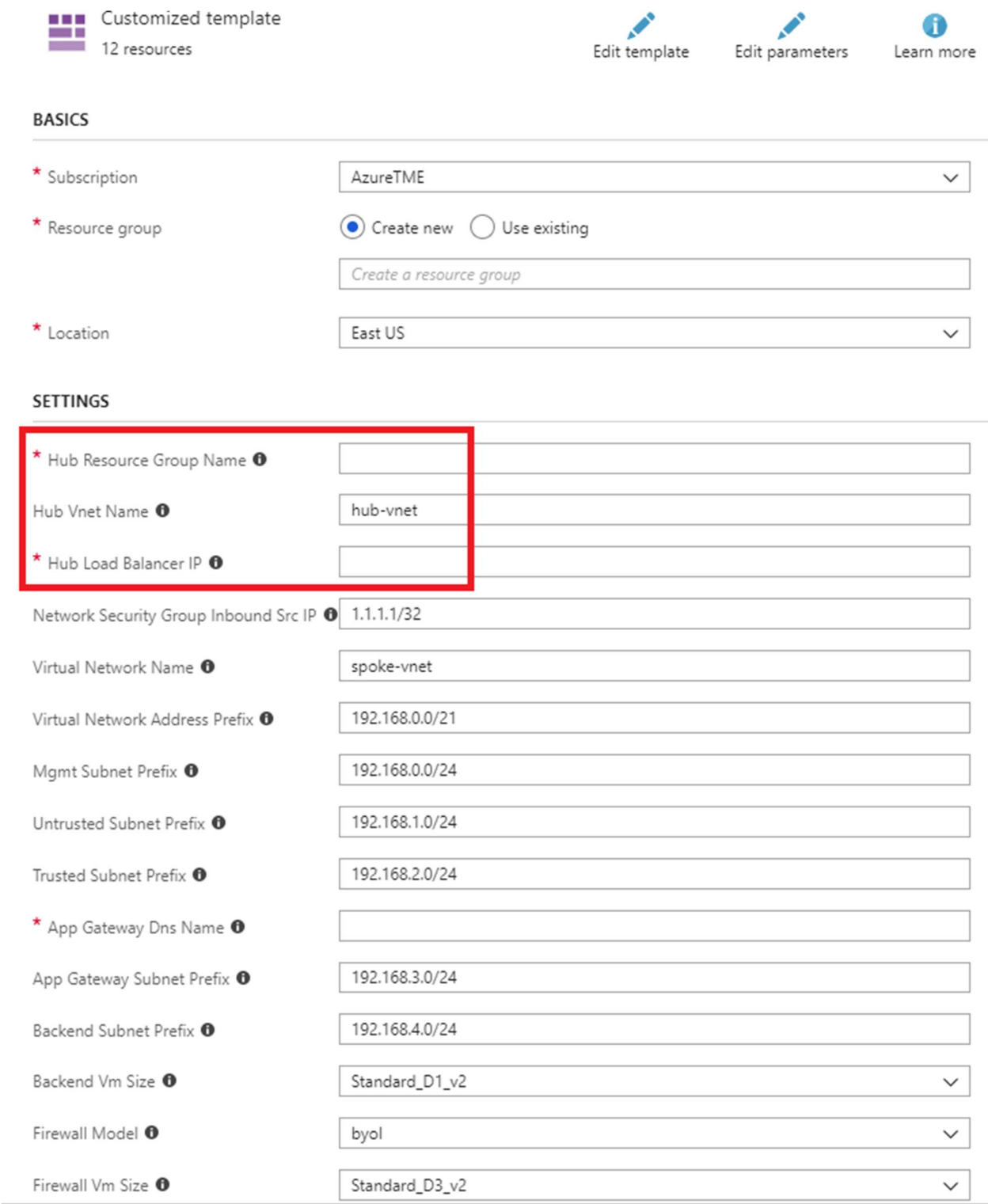
a. Most of the **parameters** are self-explanatory and should be left at the defaults
b. **Resource Group** – Create a new Resource Group. This template does not work with existing resource groups.
c. **Location** – It should be the same location as the hub since VNet peering does not work well across regions.
d. **Hub Resource Group Name** – Give the Resource Group name of the hub created resource group.
e. **Hub VNet Name** – Use the exact VNet name of the hub created earlier.
f. **Hub Load Balancer IP** – Use the static IP given to the Load Balancer in the created in the hub template. You can find this information in the load balancer settings
g. **Network Security Group Inbound Src IP** – This is the IP you will allow explicit access to the management interface of the virtual machines.
h. **Virtual Network Address Prefix** – This network address should be the subnet of the network address given in the "SpokeRoute" in the hub's firewall configuration.
i. **Mgmt, Trust and Untrust** subnets should be subnets of the VNet subnet created in the previous step.
j. **Firewall VM Size** - Choose the Firewall Model and Size based on requirements. Use Standard D3 or D3 v2.
k. **SSH Public Key** – If using a password then leave this section blank.
l. **Bootstrap Storage Account** – See step 5 listed in prerequisites
m. **Storage Account Access Key** – See step 5 listed in prerequisites
n. **Storage Account File Share** – See step 5 listed in prerequisites
o. **Storage Account File Share Directory** – See step 5 listed in prerequisites

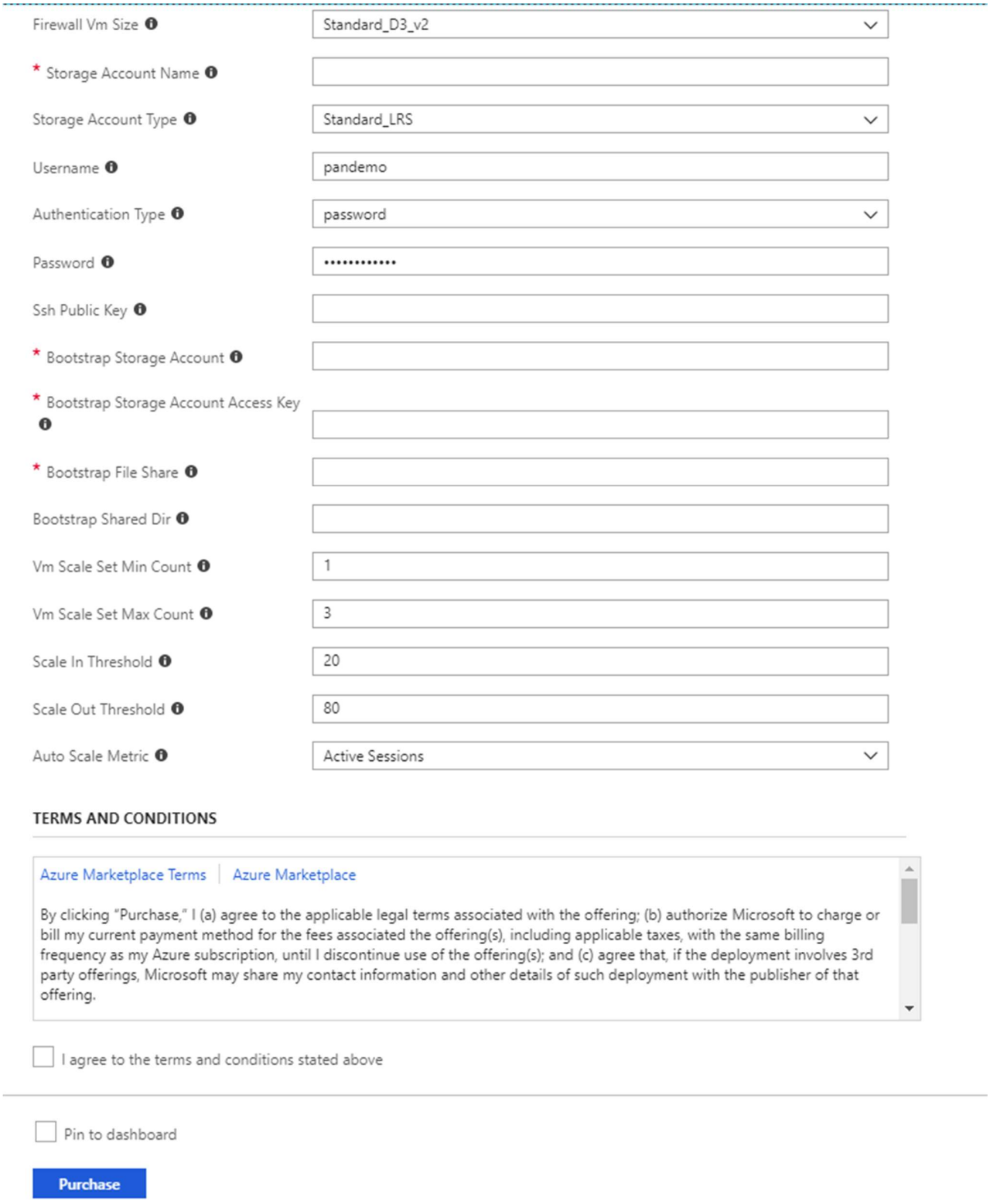
AutoScale Settings

The autoscale metric by default is set to active session. Active session allows you to leverage the number of VM-Series sessions supported to calculate a threshold to trigger an autoscale event. It is recommended to start at a higher metric to allow yourself time to learn your traffic patterns while allowing time to scale when needed. These metrics are adjustable so that you can fine tune your scaling metrics based on your traffic behavior. You will need to apply the same methodology when applying any supported autoscale metrics listed in this deployment guide. A threshold calculated at 70% should provide enough ceiling for you to learn your traffic patterns while still providing the agility needed to scale when needed.

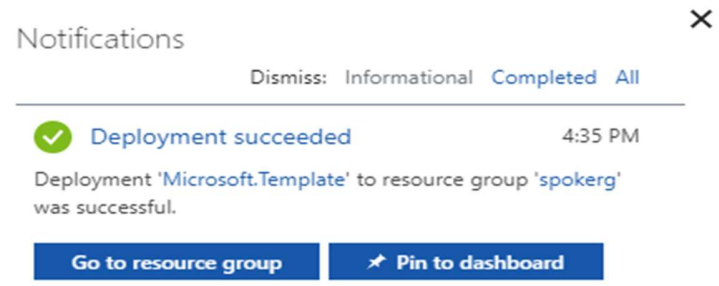
p. **VM Scale Set Min Count** – Customize based on preference
q. **VM Scale Set Max Count** – Customize based on preference
r. **Scale In Threshold** – Customize based on preference
s. **Scale Out Threshold** – Customize based on preference
t. **Auto Scale Metric** – Customize based on preference
   For more information on Azure Virtual Machine Scale Sets please see the following link
   https://docs.microsoft.com/en-us/azure/virtual-machine-scale-sets/overview

Steps P-T are used to deploy a spoke for autoscaling. If autoscaling is not in use, these should be left blank/at zero. -

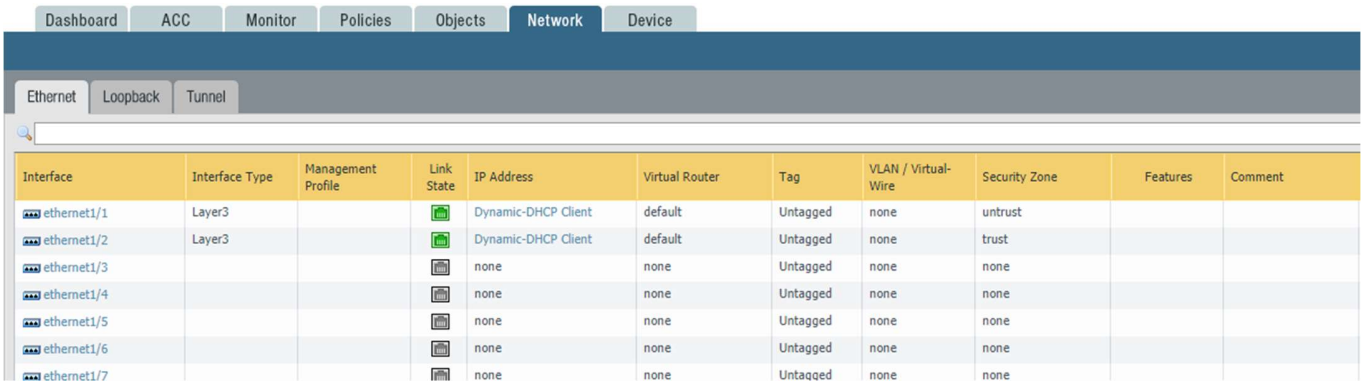

Customized template
12 resources
Edit template
Edit parameters
Learn more
BASICS
* Subscription
AzureTME
* Resource group
Create new
Use existing
Create a resource group
* Location
East US
SETTINGS
* Hub Resource Group Name
Hub Vnet Name
hub-vnet
* Hub Load Balancer IP
Network Security Group Inbound Src IP
1.1.1.1/32
Virtual Network Name
spoke-vnet
Virtual Network Address Prefix
192.168.0.0/21
Mgmt Subnet Prefix
192.168.0.0/24
Untrusted Subnet Prefix
192.168.1.0/24
Trusted Subnet Prefix
192.168.2.0/24
* App Gateway Dns Name
App Gateway Subnet Prefix
192.168.3.0/24
Backend Subnet Prefix
192.168.4.0/24
Backend Vm Size
Standard_D1_v2
Firewall Model
byol
Firewall Vm Size
Standard_D3_v2


Firewall Vm Size
Standard_D3_v2
* Storage Account Name
Storage Account Type
Standard_LRS
Username
pandemo
Authentication Type
password
Password
Ssh Public Key
* Bootstrap Storage Account
* Bootstrap Storage Account Access Key
* Bootstrap File Share
Bootstrap Shared Dir
Vm Scale Set Min Count
1
Vm Scale Set Max Count
3
Scale In Threshold
20
Scale Out Threshold
80
Auto Scale Metric
Active Sessions
TERMS AND CONDITIONS
Azure Marketplace Terms
Azure Marketplace
By clicking "Purchase," I (a) agree to the applicable legal terms associated with the offering; (b) authorize Microsoft to charge or bill my current payment method for the fees associated the offering(s), including applicable taxes, with the same billing frequency as my Azure subscription, until I discontinue use of the offering(s); and (c) agree that, if the deployment involves 3rd party offerings, Microsoft may share my contact information and other details of such deployment with the publisher of that offering.
I agree to the terms and conditions stated above
Pin to dashboard
Purchase

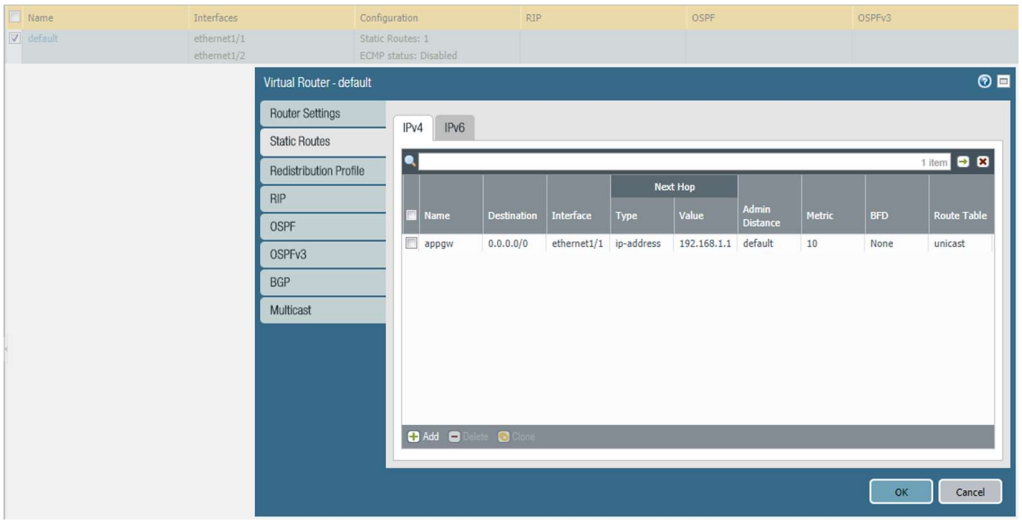
Once the Spoke template has successfully launched you will see Deployment succeeded.



Log into the spoke firewalls using **HTTPS.** Make sure your ethernet1/1 and Ethernet1/2 interfaces now show green



Verify the spoke firewall **virtual router** has the following configuration.

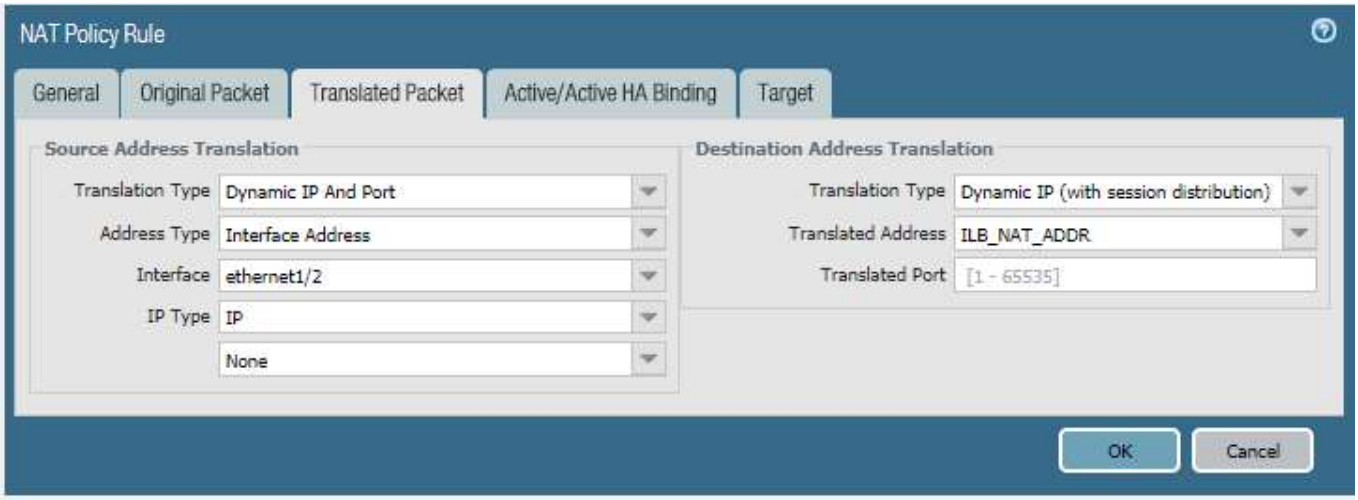


appgw: is to forward all traffic originating from the firewall to the untrust interface. Traffic originating from spoke resources behind the firewall will egress through the Hub VNet.

An **allow-all** security policy on the firewall is created to receive all traffic although the application gateway load balancer only listens for port 80. This should be modified to accommodate your policy preferences.

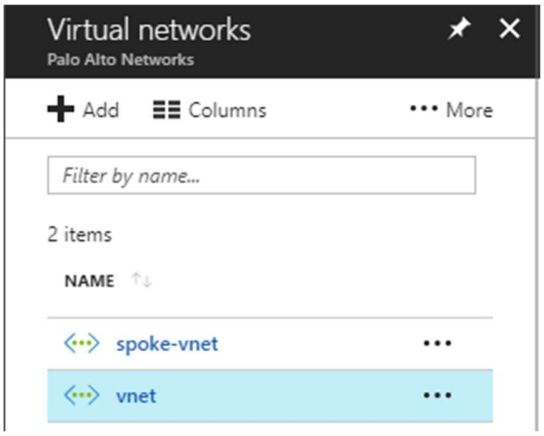
Verify that you have a **NAT rule** on the spoke firewall for inbound traffic

In order for your NAT policy to work your translated packet for source and destination should be configured as follows. Do NOT use Static IP

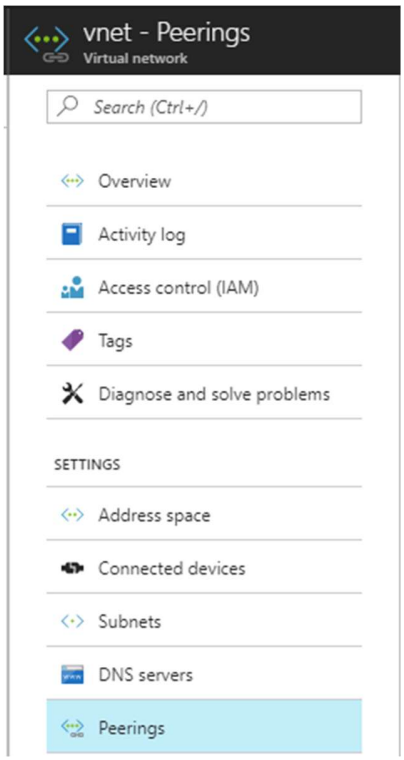


7. VNet Peering Verification

Within Azure Portal verify that **VNet Peering** has been configured automatically between the Hub VNet and Spoke VNet. To check this in Azure navigate to Virtual Networks > select the VNet **name.**



Then select **Peerings**



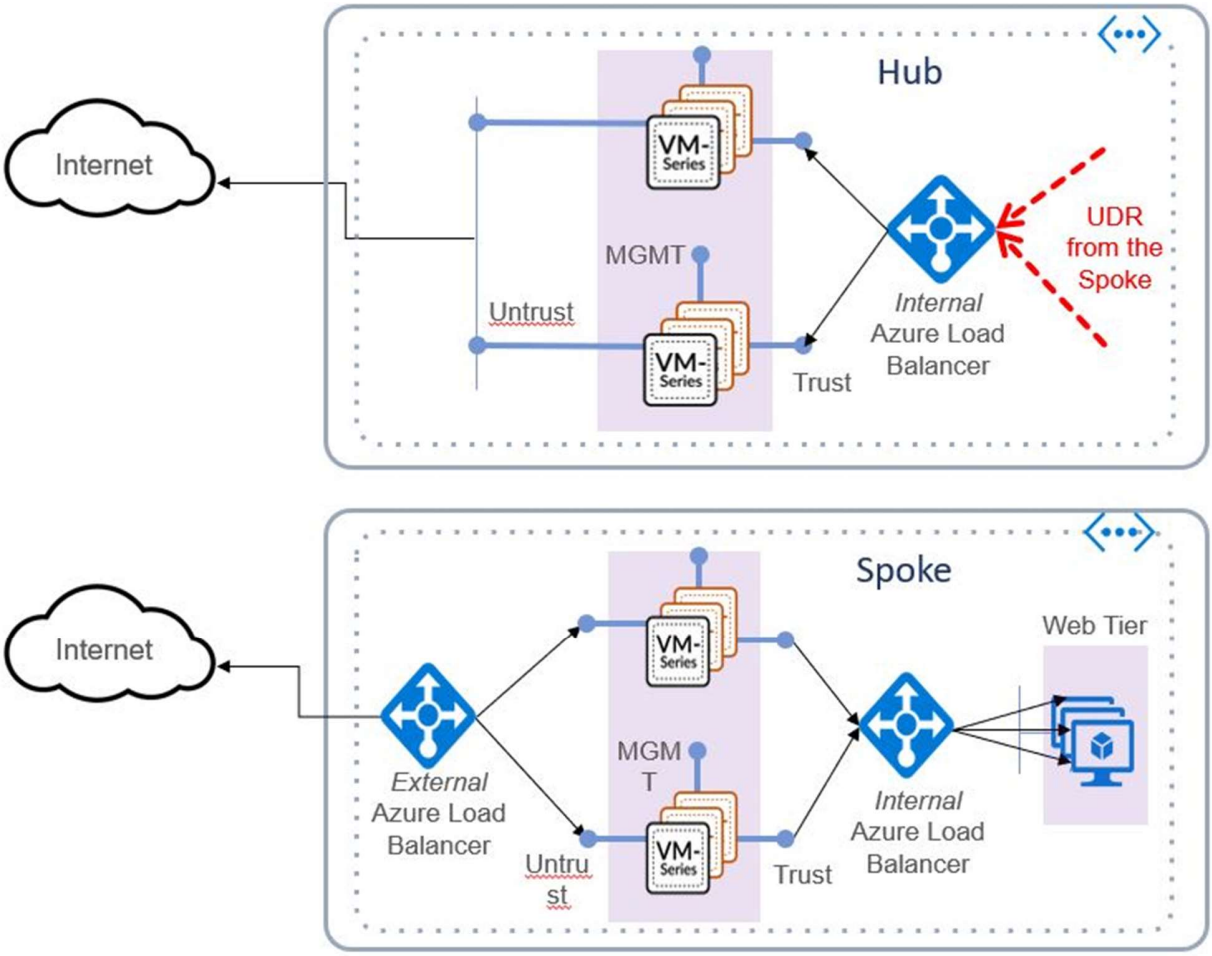
Here you should see the name of the peer **VNet** with a status of connected. **Gateway Transit** should be disabled. Check this on both the hub and spoke VNet.

8. Inbound and Outbound Traffic Tests

Once you have confirmed that both the Hub and Spoke templates were successfully deployed, you have imported and loaded the firewall configuration and confirmed VNet Peering, you will want to test your proof of concept with live traffic.

Outbound Traffic Test

As per the diagram all traffic originating from within the Azure VNets will exit through the Hub VNet.



One way to test this setup is to originate traffic from a backend Linux VM deployed in the spoke to www.google.com by using wget www.google.com. From there check the traffic logs of the Hub firewalls for www.google.com traffic or web-browsing traffic if using another port 80 based website for wget tests. You will need a license to see logs in the traffic logs or you can edit the template to use PAYG1 or PAYG2.

By default, you will not be able to access the Linux servers in the spoke. To access the Linux devices you will need to add a public IP address to one of the Spoke backend Linux servers. Then add a route on the

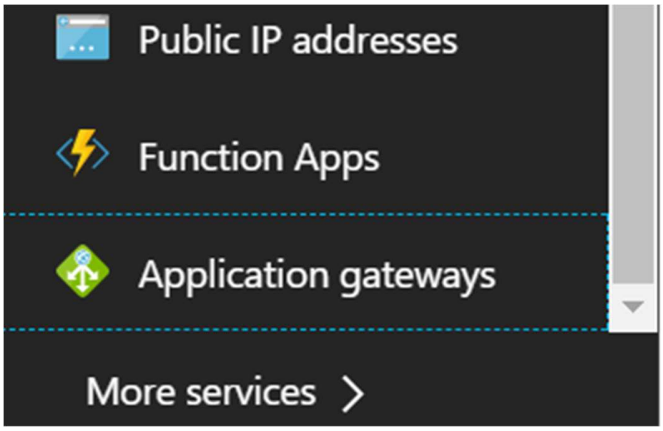
UDR named "**defaultBackendUDR**" for mgmt traffic, that will allow your public IP address with a next hop of "**Internet**"

Another way to accomplish this would be to install a **Bastion Host** or **Jump Box** into the Backend Subnet and SSH from that device.

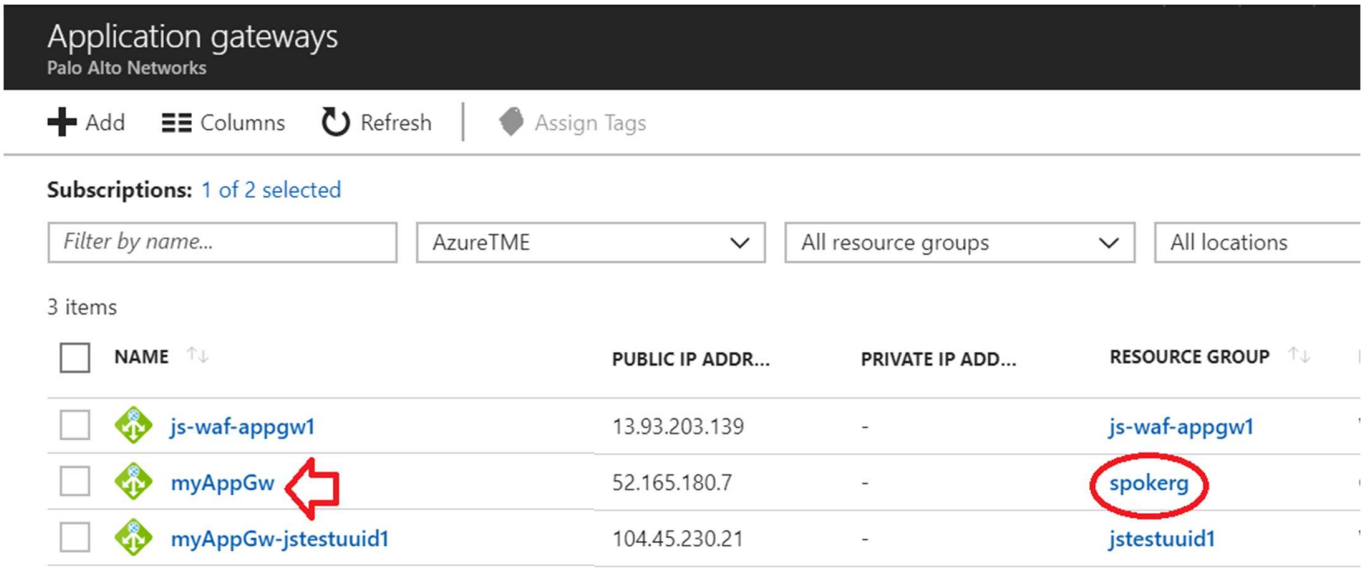
Inbound Traffic Test

When launching the spoke template with firewalls, the spoke VNet will have an Application Gateway (External LB), A set of firewalls and an internal Load balancer. This allows the spoke to host its own public facing workloads. Once you have launched the Spoke template with firewalls you can test access to the public facing workload by

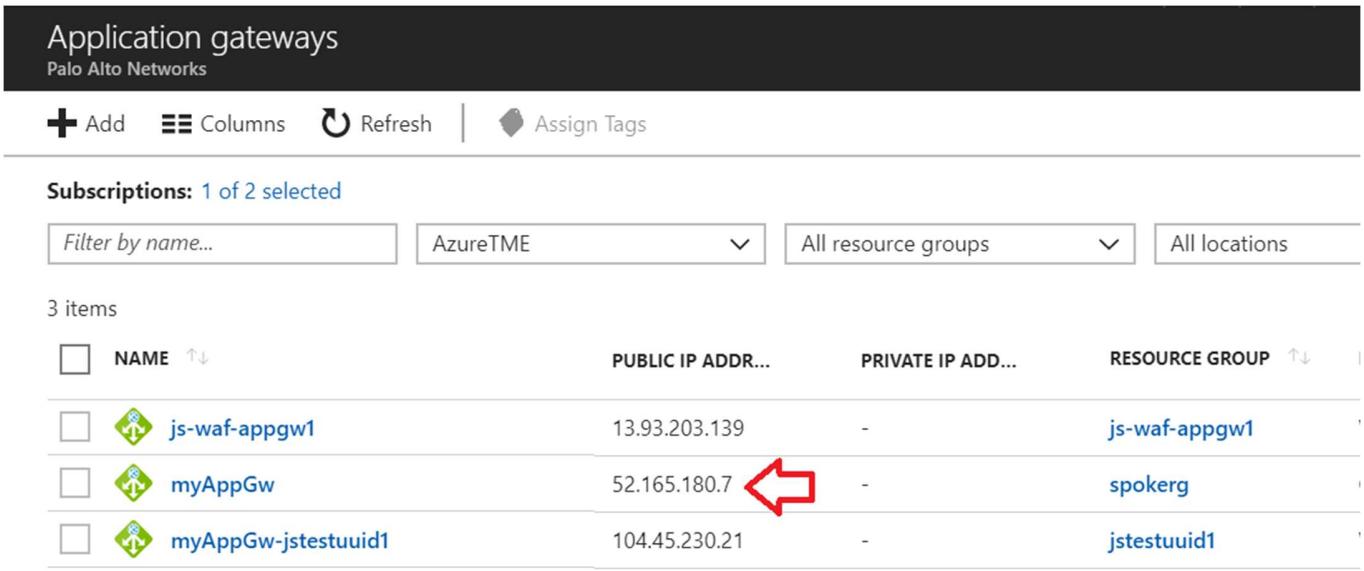
Navigating to **"Application gateways"** within the Azure Portal



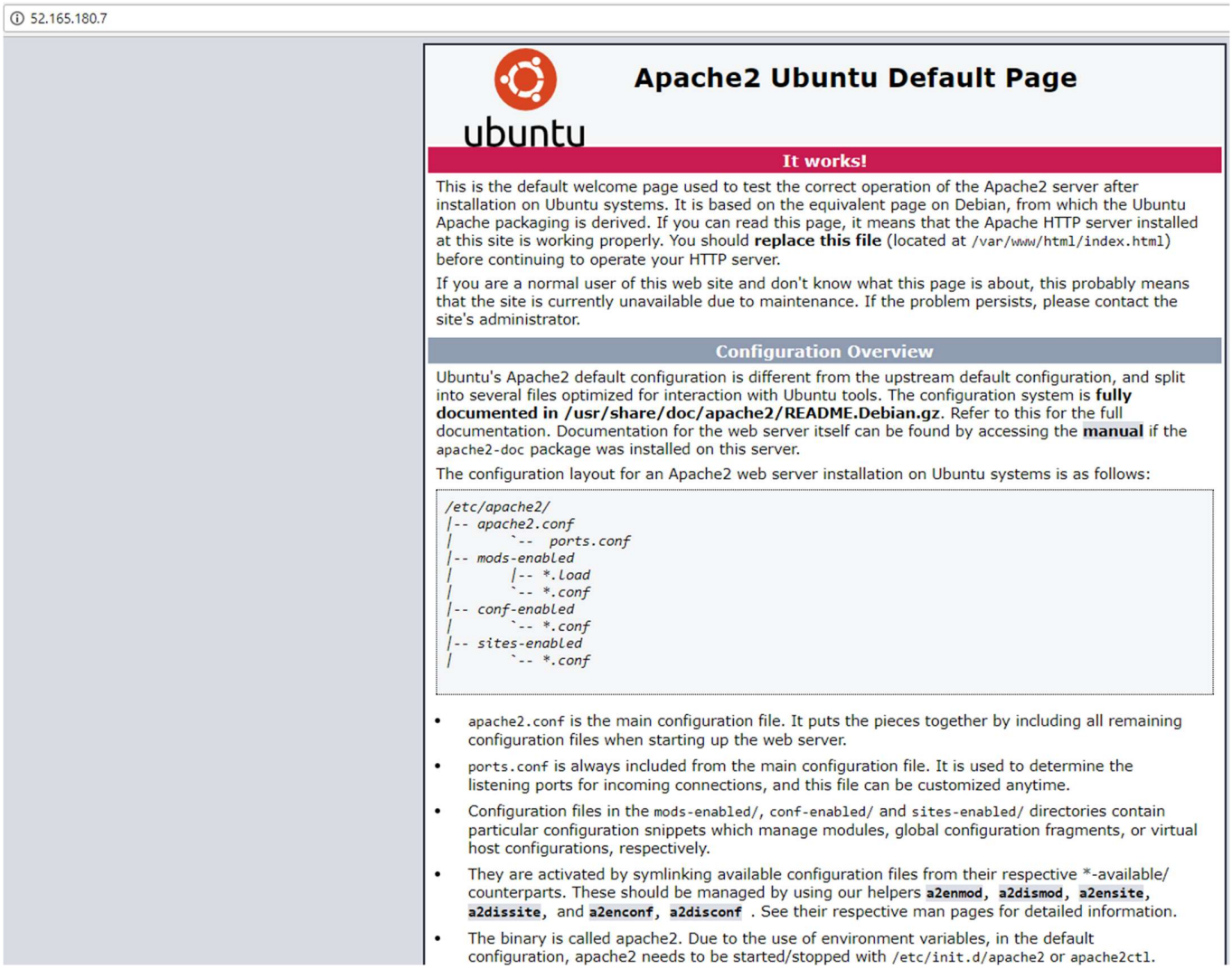
Selecting the name of your **Application Gateway** that was created when you launched the Transit VNet Spoke template. You can find the name of your **Resource Group** to help you differentiate from any other Application Gateways.



Locale the **Public IP address** for your Application Gateway.



Place the **Public IP address** in your web browser. This IP address is the public facing IP of the Application Gateway Load Balancer. You will see the default Ubuntu Page.

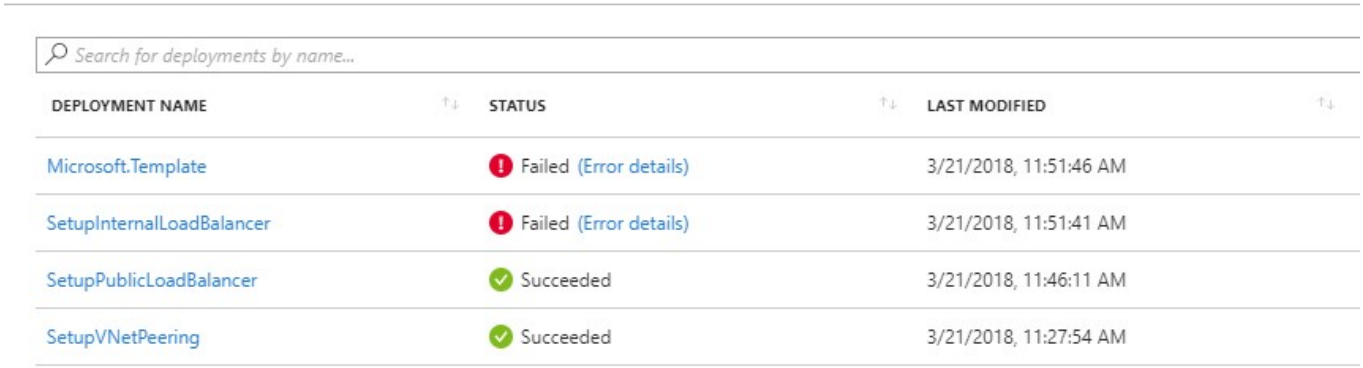


9. Cleanup

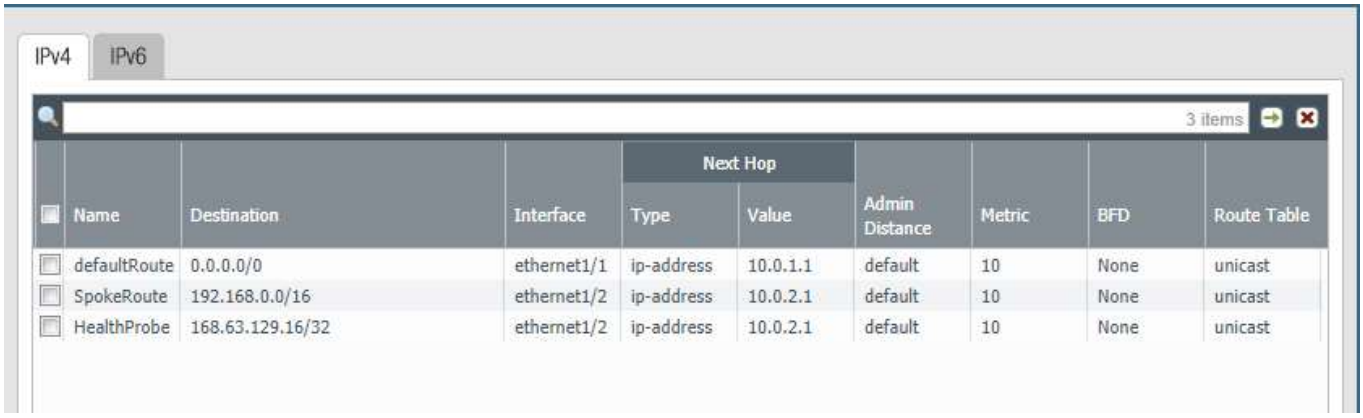
You can clean up the setup by deleting the **resource groups** for both the hub and spoke deployments. Once you have deleted the resource groups for both the hub and spoke you will have successfully deleted all resources created in this deployment.

10. Gotchas

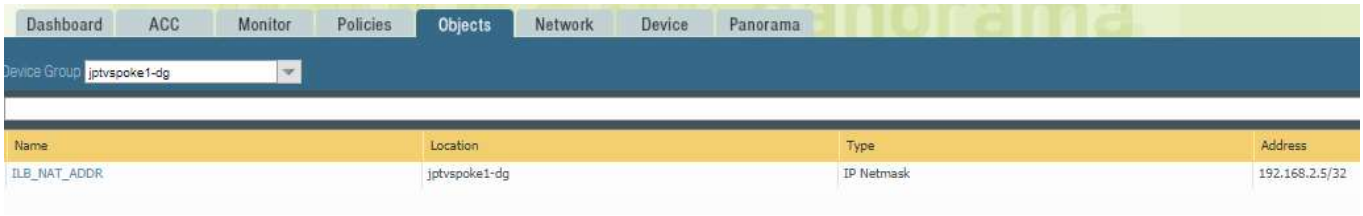
1. To successfully deploy your **spoke template**, the hub **VM-Series** firewalls must but up, running and configured or the deployment will fail. This means you must import your configuration snapshot file before launching your spoke template.



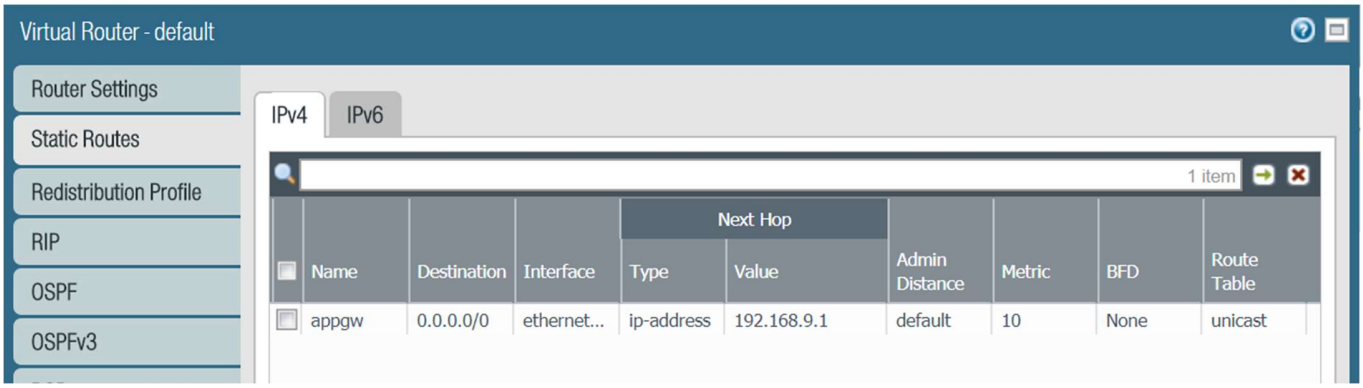
2. **When adding a new spoke**, if the subnet does not fall within the 1921.168.0.0/16 pre-configured route, be sure to add the new spoke subnet to the hub firewall VM-Series static route table. Clone the spoke route configuration and change the destination route



3. **Address objects** are statically defined in the configuration snapshot file. After the deployment of the spoke, the worker node will populate this object with the correct address.

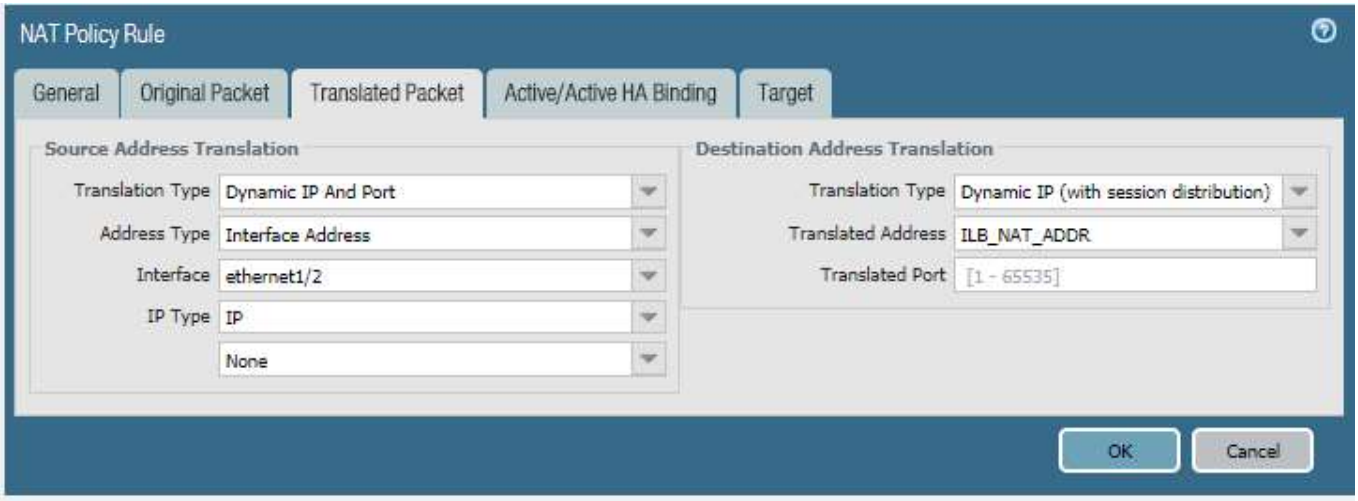


4. When adding additional spokes using the firewall template you must change the spoke firewall **Default Route** to point to the untrust Azure system gateway for the subnet of the Untrust Interface.

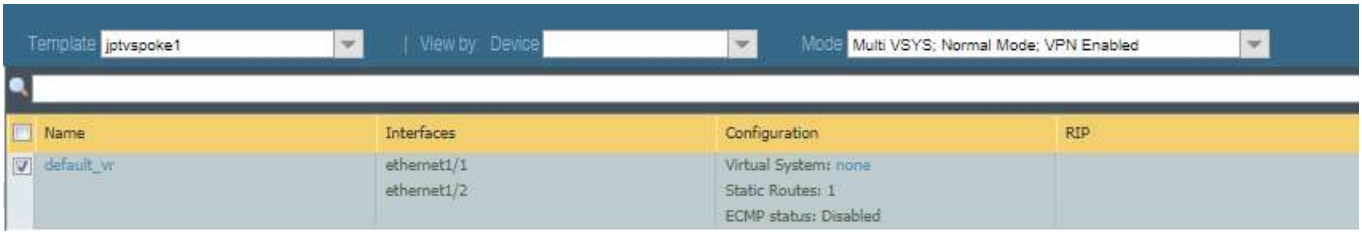


5. Anytime you delete and redeploy a spoke **VNet**, it's always best practice to delete the peering configuration from within the hub VNet. The Azure system route table re-calculates after peering is established. To add new routes, you must remove the peering association, add the new routes then recreate the peering association.

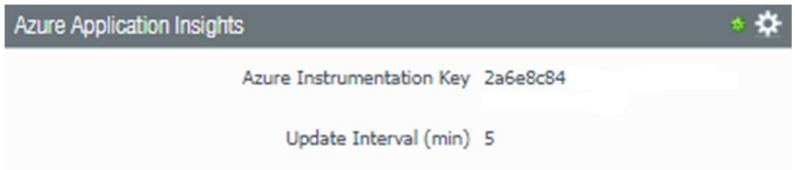
6. Your **NAT policy** in Panorama will fail to push to the firewall unless your translated packet for source and destination looks like the screenshot below. For Destination do NOT use static.



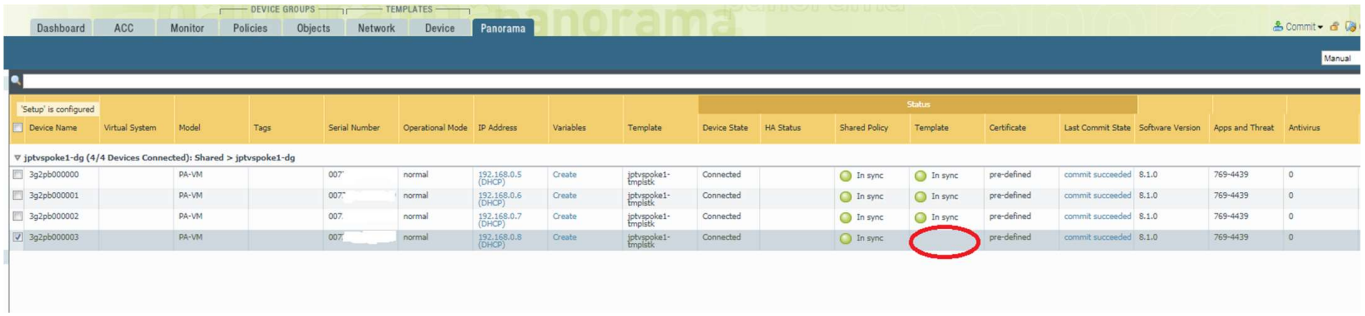
7. Be sure to **never** name something on Panorama the same as what is already configured locally on the firewall. For example if you name your virtual route in the Panorama Template “default”, your Panorama push to devices will fail because the local firewall has a default virtual route. Use something like default_vr instead.



8. If you are not seeing any **Metrics** being populated within the Metric view within application insights double check your instrumentation key within the Panorama Template Configuration.



9. After the VM-Series in the VMSS bootstraps it will receive the settings to connect to Panorama. Once connected the device group and template configuration will be pushed to the firewall. After this takes place it is important to note that Panorama does NOT commit. What this means is that after your bootstrap firewall receives its device group and template configuration it will work as designed HOWEVER a commit will still need to take place on Panorama to preserve the firewall in the device list. If a scale event takes place and a firewall is added you will know because, although the template has been pushed to the firewall it will not show in sync in panorama. See below.



You will want to perform a Panorama commit to avoid an unexpected reboot which will then cause the Panorama to lose its candidate configuration.

10. **When issue #9 happens**, you can check the worker node logs to see data. From the Hub resource group locate the worker node public IP address and log in using the pandemo user account and password.
Type $sudo bash
Type # cd /root
Type cat worker.log | grep boot
You will see output like the following.

[2018-06-22 02:45:07,716] [INFO] (MainThread) VM 3g2pb000003 found in VMSS but not in Panorama. May be not yet booted.

11. **The worker node handles delicensing**. You can check the /root/worker.log for information on delicensed VM's
[2018-06-19 21:20:13,324] [INFO] (MainThread) The following VMs need to be delicensed [{'serial': u'007xxxxxxxxxxx', 'hostname': u'3g2pb000001', 'name': u'007xxxxxxxxxxx '}]

12. You can check the worker.log for issues with **API calls** to Panorama as well.

13. The following output in the worker.log would signify that Panorama is not accessible or the **API key used is incorrect**

    [2018-06-27 06:05:08,661] [INFO] (MainThread) Executed URL https://23.991.1341.105/api/?type=config&action=get&key=xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx=&xpath=/config/devices/entry[@name='localhost.localdomain']/device-group/entry[@name='jptvspoke1-dg']/devices
    [2018-06-27 06:07:18,818] [ERROR] (MainThread) Execution of cmd failed with <urlopen error [Errno 110] Connection timed out>
    [2018-06-27 06:07:18,819] [INFO] (MainThread) Getting device list from DG jptvspoke1-dg failed <urlopen error [Errno 110] Connection timed out>

14. If the Hub resource group worker node is powered off, the script needed to maintain the relationship between Panorama and the VMSS does not automatically restart. To restart this cronjob do the following.
    #crontab -l
    You should see
    /tmp/monitor/monitor.py