



Transit VNet with the VM-Series

Deployment Guide

How to deploy a Transit VNet solution in Azure

<http://www.paloaltonetworks.com>

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Version History

Version number	Comments
1.0	Initial GitHub check-in

1. About

This document will guideline how to deploy a Transit VNet solution on Azure with the VM-Series. The Transit VNet uses a hub and spoke architecture to centralize commonly used services such as security and connectivity. 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>

Note: The Transit VNet with the VM-Series solution is considered advanced. It requires familiarity with Azure and the VM-Series next generation firewall. **This deployment has NOT been tested in Government.**

The deployment guide walks through the Palo Alto Networks ARM Templates to deploy a Transit VNet solution with the VM-Series firewalls in conjunction with, Application Gateways, Standard Load Balancers, Basic Load Balancers, and User Defined Route Tables. This solution does not include native bootstrapping, so you will be provided firewall configuration files for both the Hub and Spoke firewall pairs as well as detailed steps on how to apply the configuration files. The configuration files will be applied manually after the firewalls have been deployed.

The Transit VNet provides centralized secured outbound internet access and connectivity for all your Azure VNets. This secured outbound internet access is provided by two VM-Series firewall pairs positioned behind an Azure Standard any port load balancer in the Hub VNet. All outbound traffic originating from your Azure VNets 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 threats, outbound command-and-control and data exfiltration security becomes complex and cumbersome, oftentimes slowing deployments.

2. Topology

The Transit VNet solution 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

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

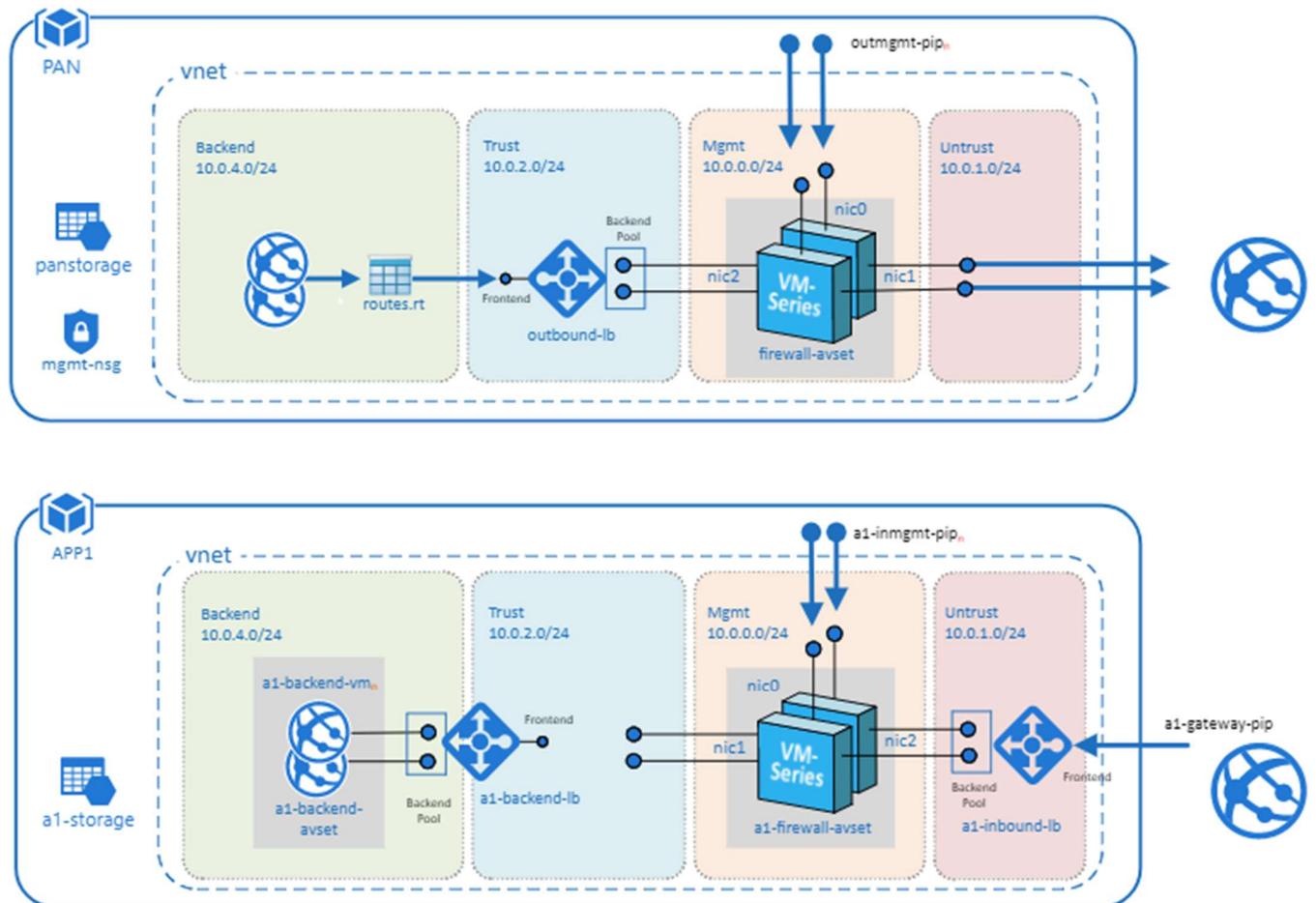


Figure 1

Hub Topology

In Figure 1 **PAN** represents the Hub VNet. 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

Spoke Topology

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In Figure 1 **APP1** represents the Spoke VNet. The spoke VNet allows an ingress point for all traffic destined to public facing resources. 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. A pair of VM-Series FWs in an availability 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 Internal Load Balancer. This is so all packets that are not destined to the spoke's VNet gets forwarded to the Hub Internal LB for routing.

The Spoke topology consists of

- 1 Application Gateway functioning as an external load balancer listening on port 80.
- Spoke subnets are 192.168.0.0/21 Spoke1, 192.168.8.0/21 Spoke2 and so on.
- 2 VM-Series Firewalls
- 1 Internal Load Balancer
- 2 Linux Web servers
- 1 UDR sending all default route traffic to the Hub VNet Standard Load Balancer.

Hub & Spoke Topology

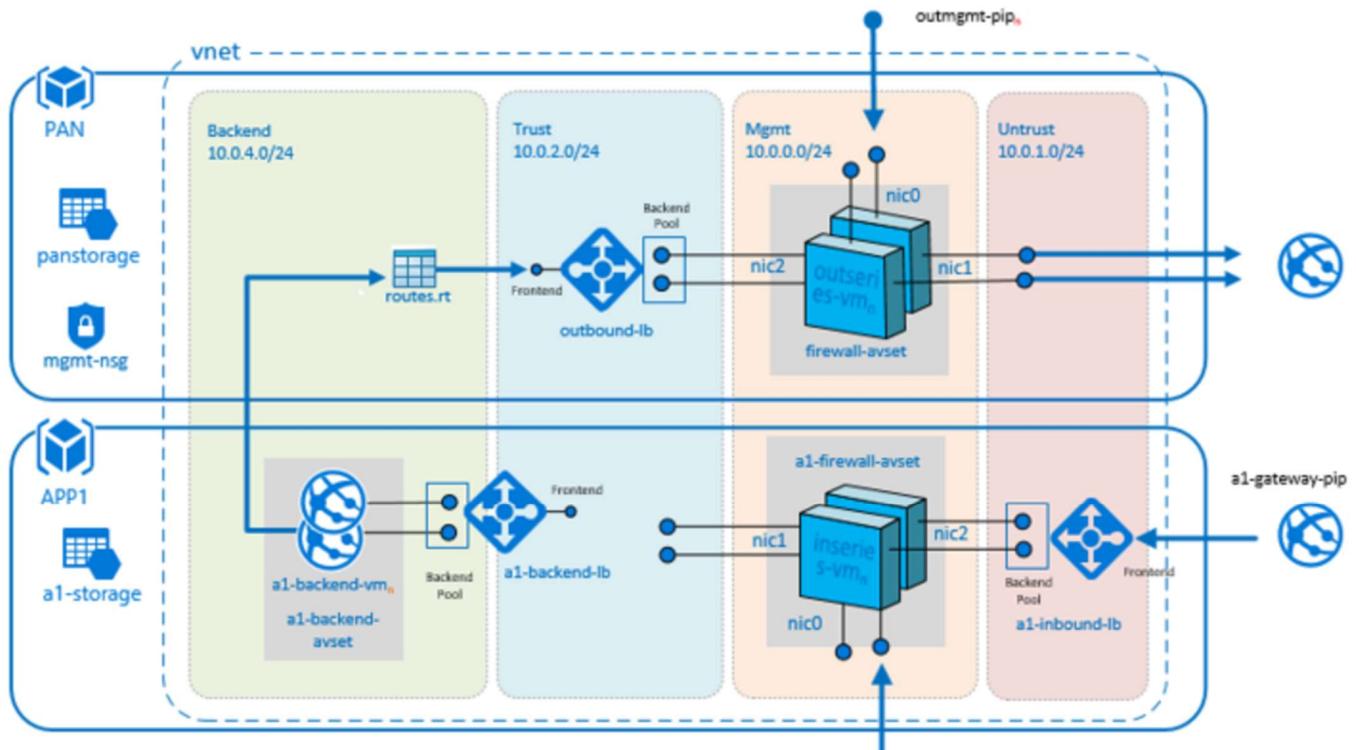


Figure 2

3. Support Policy

This solution is released under an as-is, best effort, support policy. These scripts should be seen as 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

Here are the prerequisites required to successfully launch this template:

1. AZURE account with appropriate permissions.
2. Clone or download the files from the following GitHub repository on to your local machine:
<https://github.com/PaloAltoNetworks/Azure-transit-VNet>
3. If the GitHub Repository has a deploy button you can deploy your templates using the button.



4. **To utilize the VM-Series logging features you must have a 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/80/virtualization/virtualization/license-the-vm-series-firewall/license-typesvm-series-firewalls/vm-series-firewall-in-amazon-web-services-aws-and-azure-licenses>
5. Please note that the Azure Standard Load Balancer is still in preview and you will need to sign up with Azure to access this resource before launching the template. For further information on this see the link below.
<https://docs.microsoft.com/en-us/azure/load-balancer/load-balancer-standard-overview>

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. 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 and select “**Create**”.

A screenshot of the Microsoft Azure portal interface. The top navigation bar shows "Microsoft Azure" and "Marketplace > Everything". On the left, there's a sidebar with "New" (highlighted), "Dashboard", "All resources", "Resource groups", "App Services", and "SQL databases". The main area is titled "Marketplace" with a search bar "Search resources, services and docs". A dropdown menu under "Marketplace" shows "Everything" selected. Below it are categories: "Compute", "Networking", "Storage", and "Web + Mobile". A search bar "Template Deployment" is present. The results table has columns: NAME, PUBLISHER, and CATEGORY. One result is listed: "Template deployment" by Microsoft, categorized under Compute.

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

The screenshot shows the Microsoft Azure portal interface. The top navigation bar includes 'New > Marketplace > Everything > Template deployment > Custom deployment'. On the left sidebar, under the 'New' section, 'Virtual machines' is highlighted with a red box and the number '6'. The main content area is titled 'Custom deployment' with the sub-instruction 'Deploy from a custom template'. Below this, a section titled 'Learn about template deployment' contains links for 'Read the docs' and 'Build your own template in the editor', with the latter being highlighted by a red arrow. Another section titled 'Common templates' lists options like 'Create a Linux virtual machine', 'Create a Windows virtual machine', 'Create a web app', and 'Create a SQL database'.

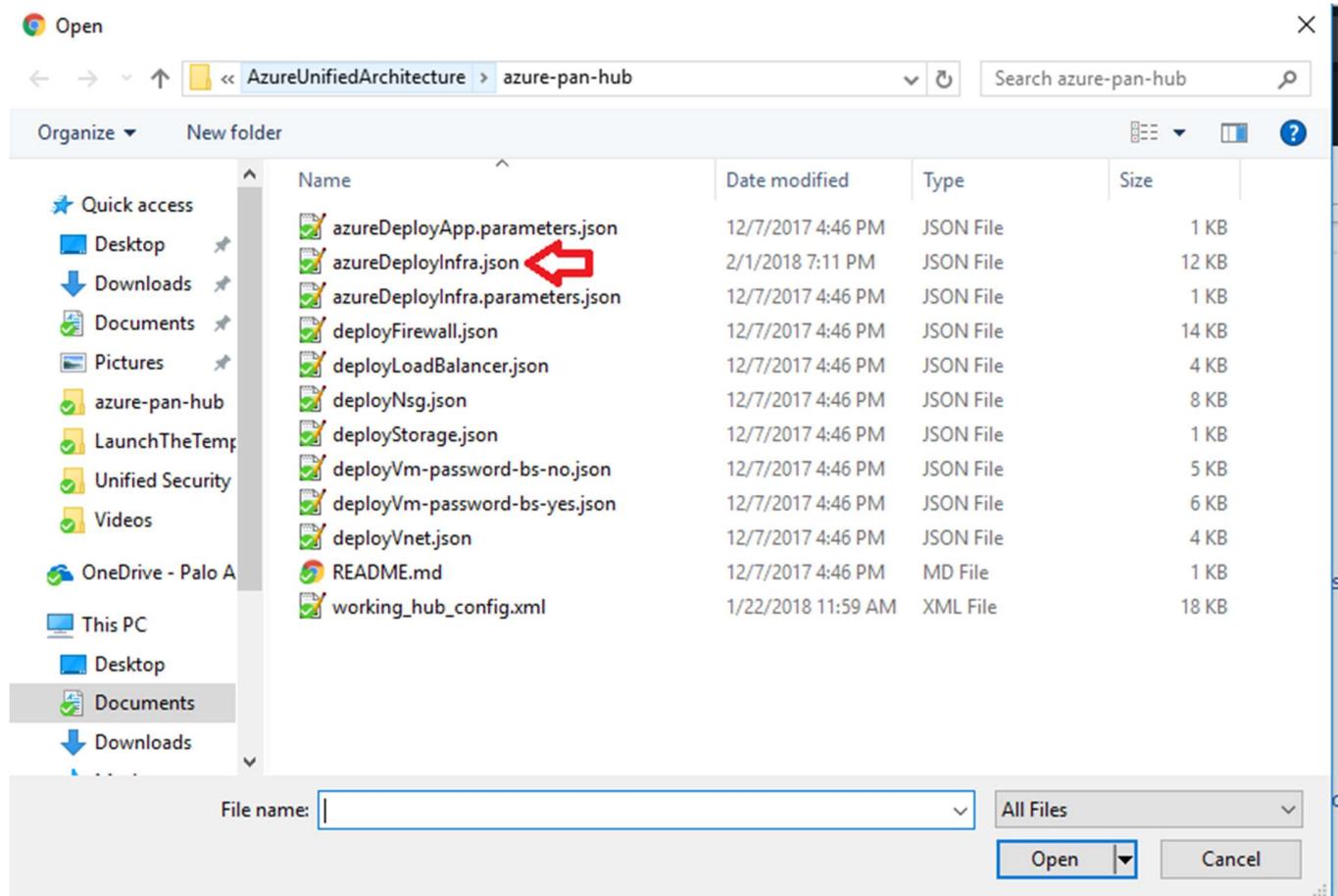
Select “Load File”

The screenshot shows the 'Edit template' page within the Azure portal. The URL in the address bar is 'Microsoft Azure New > Marketplace > Everything > Template deployment > Custom deployment > Edit template'. The left sidebar shows 'New' and 'Virtual machines'. The main area is titled 'Edit template' with the sub-instruction 'Edit your Azure Resource Manager template'. It features buttons for 'Add resource', 'Quickstart template', 'Load file' (which is highlighted with a red box), and 'Download'. Below these are sections for 'Parameters (0)', 'Variables (0)', and 'Resources (0)'. To the right is a code editor window displaying the beginning of an ARM template:

```
1 [ {  
2     "$schema": "https://schema.management.azure.com/schemas/2015-01-01/deploymentTemplate.json#",  
3     "contentVersion": "1.0.0.0",  
4     "parameters": {},  
5     "resources": []  
6 } ]
```

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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.



- 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 a location where Standard Load Balancer Preview feature is enabled. List of regions is found here - <https://docs.microsoft.com/en-us/azure/load-balancer/load-balancer-standard-overview#region-availability>
- d. **Hub Load Balancer Sku** – Use the **Standard** SKU type which will load balance all outbound TCP traffic.
- e. **Network Security Group Name** is the NSG that is attached to the Firewall's Management subnet
- f. **Network Security Group Inbound Src IP** – This is the IP you will allow explicit access to the management interface of the virtual machines.
- g. **Virtual Network Name** – Use a unique name which will not be used in the spoke VNet deployment. Remember this name since it is an input parameter for the spoke template.
- h. For security purposes be sure to set **Security Group Inbound IP** for mgmt access to the firewall.
- i. **Virtual Network Address Prefix** – Use a network address which will not be used in the spoke deployment.
- j. **Virtual Network Name** – Use a unique name which will not be used in the spoke VNet deployment. Remember this name since it is an input parameter for the spoke template.
- k. **Virtual Network Address Prefix** – Use a network address which will not be used in the spoke deployment.
- l. **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.
- m. **Firewall Model** – The template default will work unless a larger size is required.
- n. It could take up to 5 minutes to complete the launch or It could take longer depending on Azure.
- o. **Username** and **password** that is entered by default for the devices is:
user:pandemo password:Dem0pa\$\$w0rd

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Custom deployment
Deploy from a custom template

TEMPLATE

Customized template
5 resources

Edit template Edit parameters Learn more

BASICS

* Subscription: AzureTME

* Resource group: Create new (radio button selected) Use existing
Create a resource group

* Location: Central US

SETTINGS

Hub Load Balancer Sku: Standard

Storage Name: Enter a globally unique name

Mgmt Public IP Dns: Enter a globally unique name

Network Security Group Name: nsg

Network Security Group Inbound IP: 0.0.0.0/0 

Av Set Name: outbound-avset

Storage Type: Standard_LRS

Virtual Network Name: vnet

Virtual Network Address Prefix: 10.0.0.0/16

Mgmt Subnet Name: Mgmt

Mgmt Subnet Prefix: 10.0.0.0/24

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Acknowledge the terms and conditions and click “Purchase”

Untrusted Subnet Name 	Untrust
Untrusted Subnet Prefix 	10.0.1.0/24
Trusted Subnet Name 	Trust
Trusted Subnet Prefix 	10.0.2.0/24
Mgmt Public IP Name 	mgmt-pip
Load Balancer Name 	outbound-lb
Load Balancer IP 	10.0.2.4
Firewall Model 	byol  use bundle1 or bundle2 if you do NOT have a byol license.
Firewall Vm Name 	outbound-vm-series
Firewall Vm Size 	Standard_D3_v2
Authentication Type 	password
Username 	pandemo
Password 
Ssh Public Key 	

TERMS AND CONDITIONS

this template. Prices and associated legal terms for any Marketplace offerings can be found in the [Azure Marketplace](#); both are subject to change at any time prior to deployment.

Neither subscription credits nor monetary commitment funds may be used to purchase non-Microsoft offerings. These purchases are billed separately.

If any Microsoft products are included in a Marketplace offering (e.g. Windows Server or SQL Server), such products are licensed by Microsoft and not by any third party.

I agree to the terms and conditions stated above

Pin to dashboard

Purchase

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

outbound-vm-series0-std - Networking

Virtual machine

Search (Ctrl+ /)

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

SETTINGS

Networking

Attach network interface Detach network interface

outbound-vm-series0-nic1-std **outbound-vm-series0-nic0** outbound-vm-series0-nic2

Network Interface: **outbound-vm-series0-nic0** Effective security rules Topology

Virtual network/subnet: vnet/Mgmt Public IP: **40.67.191.216** Private IP: **10.0.0.5**

INBOUND PORT RULES

Network security group **nsg-mgmt** (attached to subnet: **Mgmt**) Impacts 1 subnets, 0 network interfaces

PRIORITY	NAME	PORT	PROTOCOL	SOURCE
----------	------	------	----------	--------

Log into the hub firewalls using **HTTPS**. Locate the **working_hub_config.xml** configuration snapshot and import this configuration into both firewalls. This is in the Hub directory that you exported from GitHub.

Dashboard ACC Monitor Policies Objects Network Device

Management Operations Services Interfaces Telemetry Content-ID WildFire Session HSM

Configuration Management

Revert: Revert to last saved configuration
Revert to running configuration
Save: Save named configuration snapshot
Save candidate configuration
Load: Load named configuration snapshot
Load configuration version
Export: Export named configuration snapshot
Export configuration version
Export device state
Import: Import named configuration snapshot
Import device state

Import Named Configuration

Import File: Select a file Browse... OK Cancel

Open

azure-pan-hub

Name	Date modified	Type	Size
azureDeployApp.parameters.json	12/7/2017 4:46 PM	JSON File	1 KB
azureDeployInfra.json	2/1/2018 7:11 PM	JSON File	12 KB
azureDeployInfra.parameters.json	12/7/2017 4:46 PM	JSON File	1 KB
deployFirewall.json	12/7/2017 4:46 PM	JSON File	14 KB
deployLoadBalancer.json	12/7/2017 4:46 PM	JSON File	4 KB
deployNsg.json	12/7/2017 4:46 PM	JSON File	8 KB
deployStorage.json	12/7/2017 4:46 PM	JSON File	1 KB
deployVm-password-bs-no.json	12/7/2017 4:46 PM	JSON File	5 KB
deployVm-password-bs-yes.json	12/7/2017 4:46 PM	JSON File	6 KB
deployVnet.json	12/7/2017 4:46 PM	JSON File	4 KB
README.md	12/7/2017 4:46 PM	MD File	1 KB
working_hub_config.xml	1/22/2018 11:59 AM	XML File	18 KB

File name: working_hub_config.xml Open Cancel

Palo Alto Networks Transit VNet with the VM-Series Deployment Guide

Once you load the configuration and commit the changes make sure your ethernet1/1 and Ethernet1/2 interfaces now show green.

Interface	Interface Type	Management Profile	Link State	IP Address	Virtual Router	Tag	VLAN / Virtual-Wire	Security Zone	Features	Comment
ethernet1/1	Layer3	ILBHealthCheck	Up	Dynamic-DHCP Client	default	Untagged	none	untrust		
ethernet1/2	Layer3	ILBHealthCheck	Up	Dynamic-DHCP Client	default	Untagged	none	trust		
ethernet1/3			Up	none	none	Untagged	none	none		
ethernet1/4			Up	none	none	Untagged	none	none		
ethernet1/5			Up	none	none	Untagged	none	none		
ethernet1/6			Up	none	none	Untagged	none	none		
ethernet1/7			Up	none	none	Untagged	none	none		

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

Name	Destination	Interface	Type	Value	Admin Distance	Metric	BFD	Route Table
defaultRoute	0.0.0.0/0	ethernet1/1	ip-address	10.20.1.1	default	10	None	unicast
SpokeRoute	192.168.0.0/16	ethernet1/2	ip-address	10.20.2.1	default	10	None	unicast
HealthProbe	168.63.129.0/24	ethernet1/2	ip-address	10.20.2.1	default	10	None	unicast

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

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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.

Name	Tags	Type	Source				Destination				Application	Service	Action	Profile	Options	
1	allow_all	none	universal	any	any	any	any	any	any	any	any	any	application-d...	Allow	none	none
2	intrazone-default	none	intrazone	any	any	any	any	(intrazone)	any	any	any	any	any	Allow	none	none
3	interzone-default	none	interzone	any	any	any	any	any	any	any	any	any	any	Deny	none	none

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

Original Packet											Translated Packet	
	Name	Tags	Source Zone	Destination Zone	Destination Interface	Source Address	Destination Address	Service	Source Translation	Destination Translation		
1	hubNatRule	none	trust	untrust	ethernet1/1	any	any	any	dynamic-ip-and-port	none		

6. Launch the Transit VNet Spoke Template

Spoke Template Options

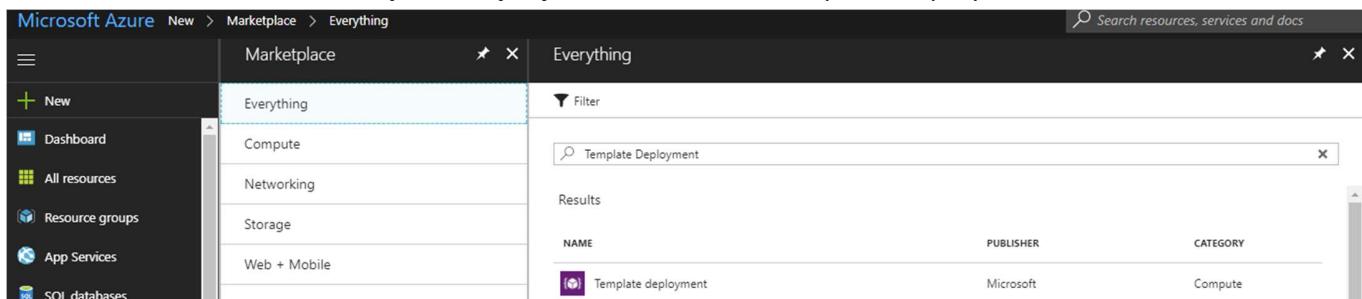
Azuredeploy.json – This launches the spoke template with VM-Series firewalls sandwiched between an external and internal load balancer. This provides secured external access to public facing workloads with return traffic egressing the spoke VNet. All internal originating traffic will be forwarded to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

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. This template will be available soon.

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. 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 and select “**Create**”.



The screenshot shows the Microsoft Azure portal interface. The left sidebar has a "New" button highlighted. The main area is titled "Marketplace" with a search bar containing "Template Deployment". A search result for "Template deployment" by Microsoft is listed, showing it's a Compute category template.

NAME	PUBLISHER	CATEGORY
Template deployment	Microsoft	Compute

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

Microsoft Azure New > Marketplace > Everything > Template deployment > Custom deployment

Custom deployment
Deploy from a custom template

New

- Dashboard
- All resources
- Resource groups
- App Services
- SQL databases
- SQL data warehouses
- Azure Cosmos DB
- Virtual machines

Learn about template deployment

- Read the docs
- Build your own template in the editor

Common templates

- Create a Linux virtual machine
- Create a Windows virtual machine
- Create a web app
- Create a SQL database

Select “Load File”

Microsoft Azure New > Marketplace > Everything > Template deployment > Custom deployment > Edit template

Edit template
Edit your Azure Resource Manager template

New

- Dashboard
- All resources
- Resource groups

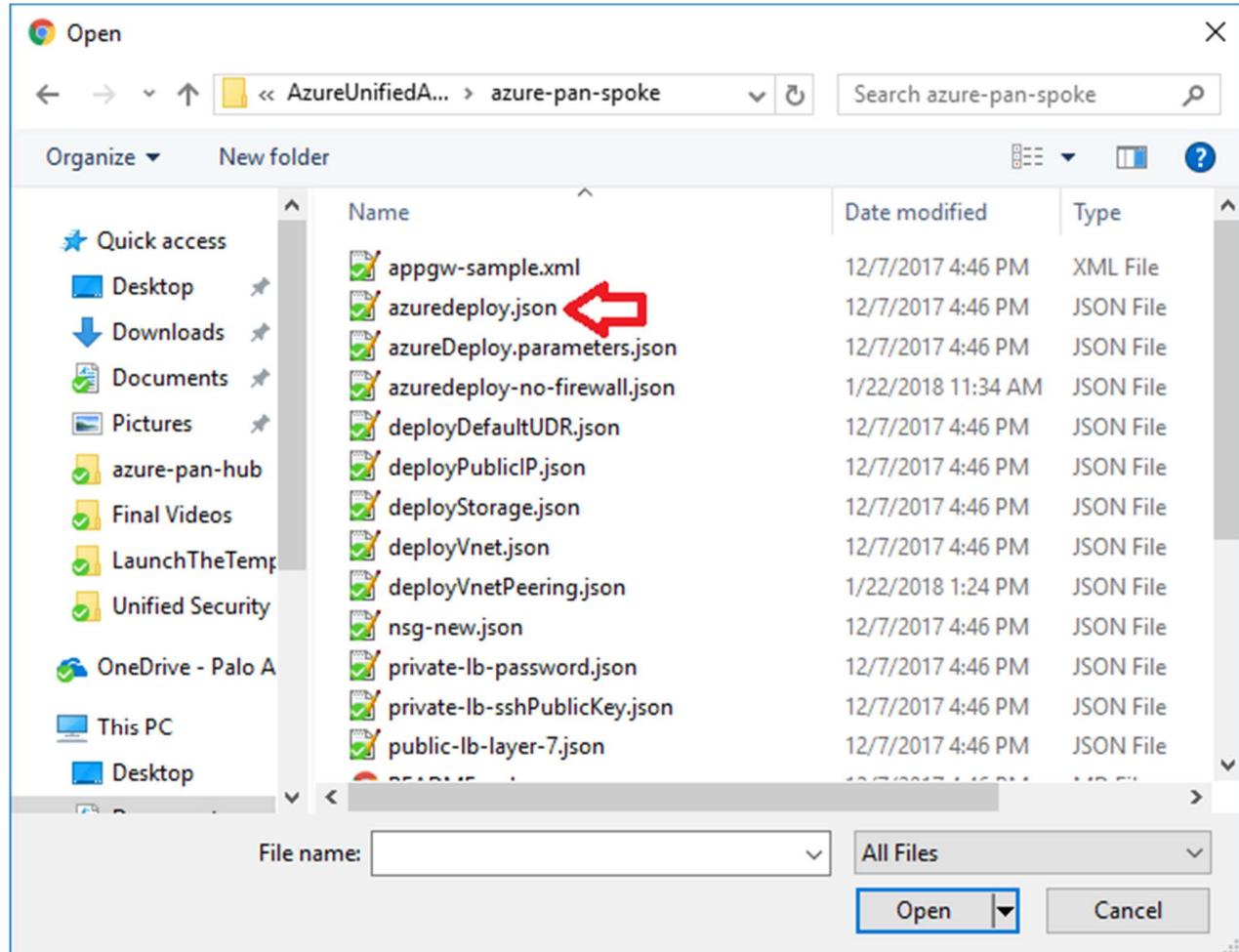
Add resource Quickstart template Load file Download

Parameters (0) Variables (0) Resources (0)

```
1 {
2   "$schema": "https://schema.management.azure.com/schemas/2015-01-01/deploymentTemplate.json#",
3   "contentVersion": "1.0.0.0",
4   "parameters": {},
5   "resources": []
6 }
```

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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.



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- 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 Name** – The security group name for mgmt access
- h. **Network Security Group Inbound Src IP** – This is the IP you will allow explicit access to the management interface of the virtual machines.
- i. **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.
- j. **Mgmt, Trust and Untrust** subnets should be subnets of the VNet subnet created in the previous step.
- k. **Firewall VM Size** - Choose the Firewall Model and Size based on requirements. Use Standard D3 or D3 v2.
- l. **SSH Public Key** – If using a password then leave this section blank.

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Custom deployment
Deploy from a custom template

BASICS

* Subscription: AzureTME

* Resource group: Create new (radio button selected) | Use existing
Create a resource group

* Location: Central US

SETTINGS

* Hub Resource Group Name: hubrg ✓

Hub Vnet Name: hubvnet

* Hub Load Balancer IP: 10.0.2.4 ✓

Network Security Group Name: nsg-mgmt

Network Security Group Inbound Src IP: 0.0.0.0/0

Virtual Network Name: spoke-vnet

Virtual Network Address Prefix: 192.168.0.0/16

Mgmt Subnet Name: Mgmt

Mgmt Subnet Prefix: 192.168.0.0/24

Untrusted Subnet Name: Untrust

Untrusted Subnet Prefix: 192.168.1.0/24

Trusted Subnet Name: Trust

Trusted Subnet Prefix: 192.168.2.0/24

App Gateway Name: myAppGw

* App Gateway Dns Name: (empty field)

Palo Alto Networks Transit VNet with the VM-Series Deployment Guide

App Gateway Subnet Name 	AppGWSubnet
App Gateway Subnet Prefix 	192.168.3.0/24
Internal Load Balancer Name 	myPrivateLB
Backend Subnet Name 	backendSubnet
Backend Subnet Prefix 	192.168.4.0/24
Backend Vm Size 	Standard_D1
Firewall Model 	byol
	 <p>use bundle1 or bundle2 if you do NOT have a byol license</p>
Firewall Vm Name 	VM-Series
Firewall Vm Size 	Standard_D3
* Mgmt Public IP Address Name 	
* Storage Account Name 	
Storage Account Type 	Standard_LRS
* Username 	
Authentication Type 	password
Password 	
Ssh Public Key 	

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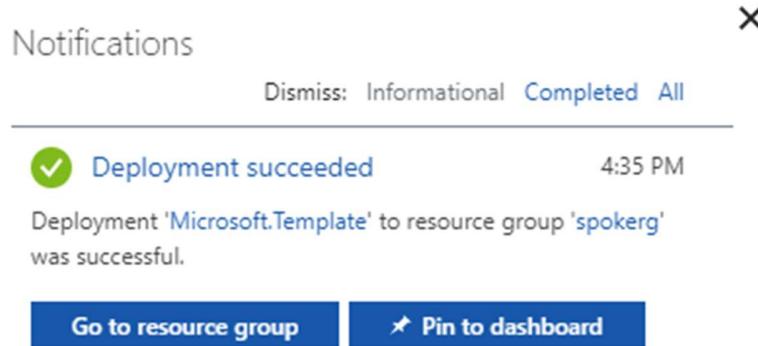
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Palo Alto Networks Transit VNet with the VM-Series Deployment Guide

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



Log into the spoke firewalls using **HTTPS**. Locate the **appgw-sample.xml** configuration snapshot and import this configuration into both firewalls. This is in the Spoke directory that you exported from GitHub. For Spoke2 use the **appgw-sample2.xml** configure file.

A screenshot of the Palo Alto Networks Device Management interface. The top navigation bar includes tabs for Dashboard, ACC, Monitor, Policies, Objects, Network, and Device. The Device tab is selected. Below the navigation bar, there are sub-tabs for Management, Operations, Services, Interfaces, Telemetry, ContentID, WildFire, Session, and HSM. A "Configuration Management" sidebar on the left lists options like Revert, Save, Load, Export, and Import. A modal dialog titled "Import Named Configuration" is open, prompting the user to "Select a file" and providing "OK" and "Cancel" buttons. To the right of the dialog is a file browser window titled "Open". The browser shows a file structure under "AzureUnifiedArchite..." with a folder named "azure-pan-spoke". Inside this folder are several files: appgw-sample.xml, azuredeploy.json, azureDeploy.parameters.json, azureDeploy-no-firewall.json, deployDefaultUDR.json, deployPublicIP.json, deployStorage.json, deployVNet.json, deployVNetPeering.json, nsg-new.json, private-lb-password.json, private-lb-sshPublicKey.json, public-lb-layer-7.json, and README.md. The "appgw-sample.xml" file is highlighted. The file browser also includes a search bar, a toolbar with icons for organizing, creating new folders, and filtering, and buttons for "Open" and "Cancel".

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Once you load the configuration and commit the changes. Once you have committed the changes make sure your ethernet1/1 and Ethernet1/2 interfaces now show green

The screenshot shows the Network tab in the Palo Alto Networks management interface. The interface table lists the following details for each port:

Interface	Interface Type	Management Profile	Link State	IP Address	Virtual Router	Tag	VLAN / Virtual-Wire	Security Zone	Features	Comment
ethernet1/1	Layer3		Dynamic-DHCP Client	default	Untagged	none	untrust			
ethernet1/2	Layer3		Dynamic-DHCP Client	default	Untagged	none	trust			
ethernet1/3			none	none	Untagged	none	none			
ethernet1/4			none	none	Untagged	none	none			
ethernet1/5			none	none	Untagged	none	none			
ethernet1/6			none	none	Untagged	none	none			
ethernet1/7			none	none	Untagged	none	none			

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

The screenshot shows the configuration of the 'default' virtual router. Under the 'Static Routes' tab, there is one static route entry:

Name	Destination	Interface	Type	Value	Admin Distance	Metric	BFD	Route Table
appgw	0.0.0.0/0	ethernet1/1	ip-address	192.168.1.1	default	10	None	unicast

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.

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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.

			Source				Destination							
	Name	Tags	Type	Zone	Address	User	HIP Profile	Zone	Address	Application	Service	Action	Profile	Options
1	allow_all	none	universal	any	any	any	any	any	any	any	x application-d...	Allow	none	grid
2	intrazone-default	none	intrazone	any	any	any	any	(intrazone)	any	any	any	Allow	none	none
3	interzone-default	none	interzone	any	any	any	any	any	any	any	🚫 Deny	none	none	none

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

	Original Packet								Translated Packet	
	Name	Tags	Source Zone	Destination Zone	Destination Interface	Source Address	Destination Address	Service	Source Translation	Destination Translation
1	ilb	none	any	fw untrust	any	any	firewall-untrust...	any	dynamic-ip-and-port ethernet1/2	address: internal-load-balancer-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.

Virtual networks	
Palo Alto Networks	
 Add	 Columns
 More	
<input type="text" value="Filter by name..."/>	
2 items	
NAME	↑↓
 spoke-vnet	
 vnet	

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Then select **Peerings**

The screenshot shows the 'vnet - Peerings' blade in the Azure portal. The left sidebar contains several navigation links: Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Address space, Connected devices, Subnets, DNS servers, and Peerings. The 'Peerings' link is highlighted with a light blue background. The main area of the blade is currently empty, showing a search bar at the top.

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.

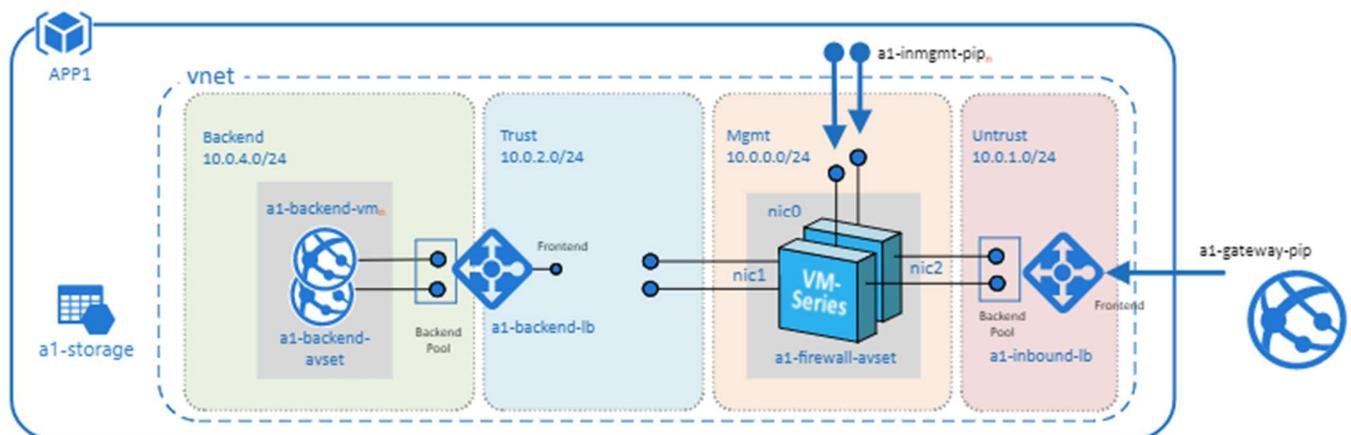
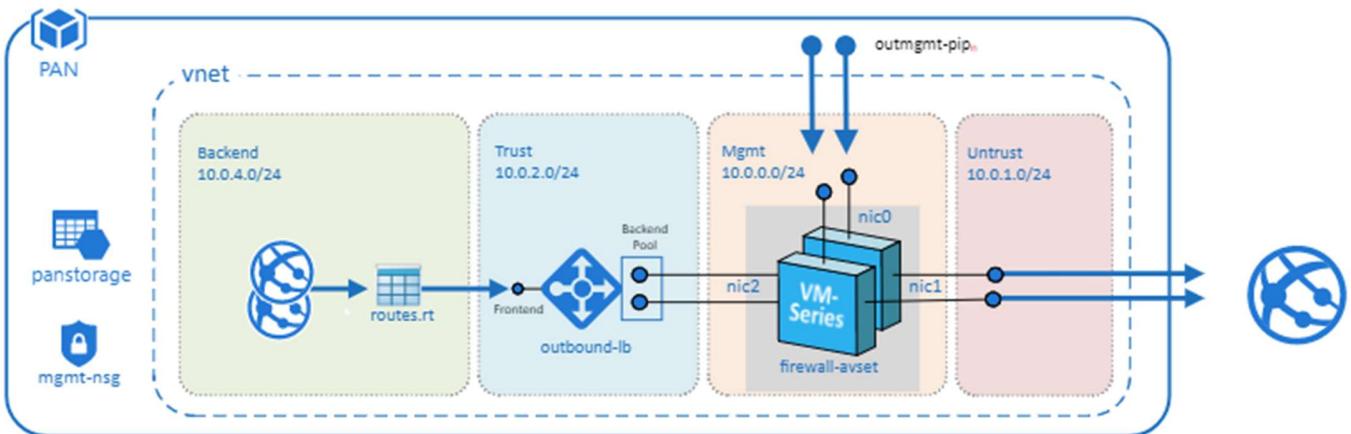
NAME	PEERING STATUS	PEER	GATEWAY TRANSIT	...
vnet-spoke-vnetvnet-peering	Connected	spoke-vnet	Disabled	...

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.

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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**”

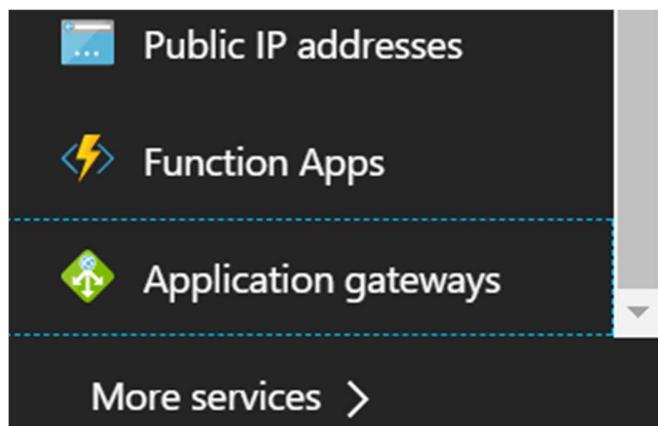
+ Add			
Search routes			
NAME	ADDRESS PREFIX	NEXT HOP	
defaultRoute	0.0.0.0/0	10.0.2.4	...
mgmt-traffic	.0.0/16	Internet 	...

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.

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Application gateways
Palo Alto Networks

Add Columns Refresh Assign Tags

Subscriptions: 1 of 2 selected

NAME	PUBLIC IP ADDR...	PRIVATE IP ADD...	RESOURCE GROUP
js-waf-appgw1	13.93.203.139	-	js-waf-appgw1
myAppGw	52.165.180.7	-	spokerg
myAppGw-jstestuuid1	104.45.230.21	-	jstestuuid1

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

Application gateways
Palo Alto Networks

Add Columns Refresh Assign Tags

Subscriptions: 1 of 2 selected

NAME	PUBLIC IP ADDR...	PRIVATE IP ADD...	RESOURCE GROUP
js-waf-appgw1	13.93.203.139	-	js-waf-appgw1
myAppGw	52.165.180.7	-	spokerg
myAppGw-jstestuuid1	104.45.230.21	-	jstestuuid1

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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.



The screenshot shows a web browser window displaying the 'Apache2 Ubuntu Default Page'. The page features the Ubuntu logo at the top left, followed by the word 'ubuntu' in lowercase. A red banner across the middle contains the text 'It works!' in white. Below the banner, a paragraph explains that this is the default welcome page for testing the Apache2 server. It mentions that if you can read this page, it means the server is working properly. It also advises replacing the default file at /var/www/html/index.html before continuing. A section titled 'Configuration Overview' follows, explaining the layout of the configuration files. A code block shows the directory structure: /etc/apache2/, containing apache2.conf (the main config), ports.conf (listening ports), mods-enabled (modules), conf-enabled (global config), and sites-enabled (virtual host config). A bulleted list details the purpose of each component, mentioning helpers like a2enmod, a2dismod, a2ensite, a2dissite, a2enconf, and a2disconf.

① 52.165.180.7

Apache2 Ubuntu Default Page

It works!

This is the default welcome page used to test the correct operation of the Apache2 server after installation on Ubuntu systems. It is based on the equivalent page on Debian, from which the Ubuntu Apache packaging is derived. If you can read this page, it means that the Apache HTTP server installed at this site is working properly. You should **replace this file** (located at `/var/www/html/index.html`) before continuing to operate your HTTP server.

If you are a normal user of this web site and don't know what this page is about, this probably means that the site is currently unavailable due to maintenance. If the problem persists, please contact the site's administrator.

Configuration Overview

Ubuntu's Apache2 default configuration is different from the upstream default configuration, and split into several files optimized for interaction with Ubuntu tools. The configuration system is **fully documented in `/usr/share/doc/apache2/README.Debian.gz`**. Refer to this for the full documentation. Documentation for the web server itself can be found by accessing the **manual** if the `apache2-doc` package was installed on this server.

The configuration layout for an Apache2 web server installation on Ubuntu systems is as follows:

```
/etc/apache2/
|-- apache2.conf
|   '-- ports.conf
|-- mods-enabled
|   '-- *.Load
|   '-- *.conf
|-- conf-enabled
|   '-- *.conf
|-- sites-enabled
|   '-- *.conf
```

- `apache2.conf` is the main configuration file. It puts the pieces together by including all remaining configuration files when starting up the web server.
- `ports.conf` is always included from the main configuration file. It is used to determine the listening ports for incoming connections, and this file can be customized anytime.
- Configuration files in the `mods-enabled/`, `conf-enabled/` and `sites-enabled/` directories contain particular configuration snippets which manage modules, global configuration fragments, or virtual host configurations, respectively.
- They are activated by symlinking available configuration files from their respective `*-available/` counterparts. These should be managed by using our helpers `a2enmod`, `a2dismod`, `a2ensite`, `a2dissite`, and `a2enconf`, `a2disconf`. See their respective man pages for detailed information.
- The binary is called `apache2`. Due to the use of environment variables, in the default configuration, `apache2` needs to be started/stopped with `/etc/init.d/apache2` or `apache2ctl`.

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

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

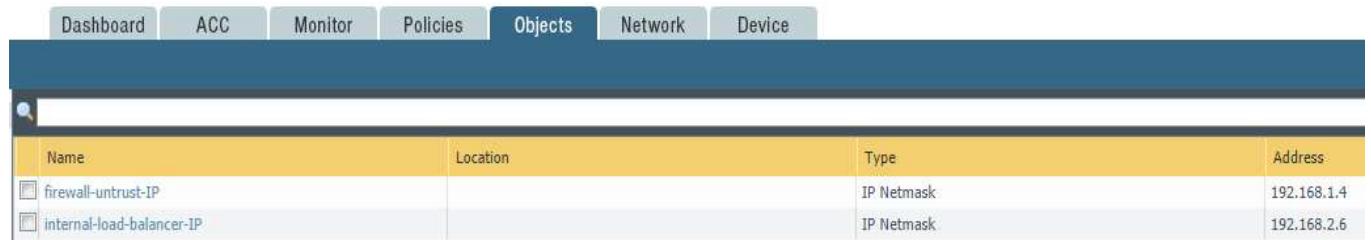
Search for deployments by name...		
DEPLOYMENT NAME	STATUS	LAST MODIFIED
Microsoft.Template	❗ Failed (Error details)	3/21/2018, 11:51:46 AM
SetupInternalLoadBalancer	❗ Failed (Error details)	3/21/2018, 11:51:41 AM
SetupPublicLoadBalancer	✅ Succeeded	3/21/2018, 11:46:11 AM
SetupVNetPeering	✅ Succeeded	3/21/2018, 11:27:54 AM

When adding a new spoke, if the subnet does not fall within the 192.168.0.0/16 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

Name	Destination	Interface	Next Hop		Admin Distance	Metric	BFD	Route Table
			Type	Value				
defaultRoute	0.0.0.0/0	ethernet1/1	ip-address	10.0.1.1	default	10	None	unicast
SpokeRoute	192.168.0.0/16	ethernet1/2	ip-address	10.0.2.1	default	10	None	unicast
HealthProbe	168.63.129.16/32	ethernet1/2	ip-address	10.0.2.1	default	10	None	unicast

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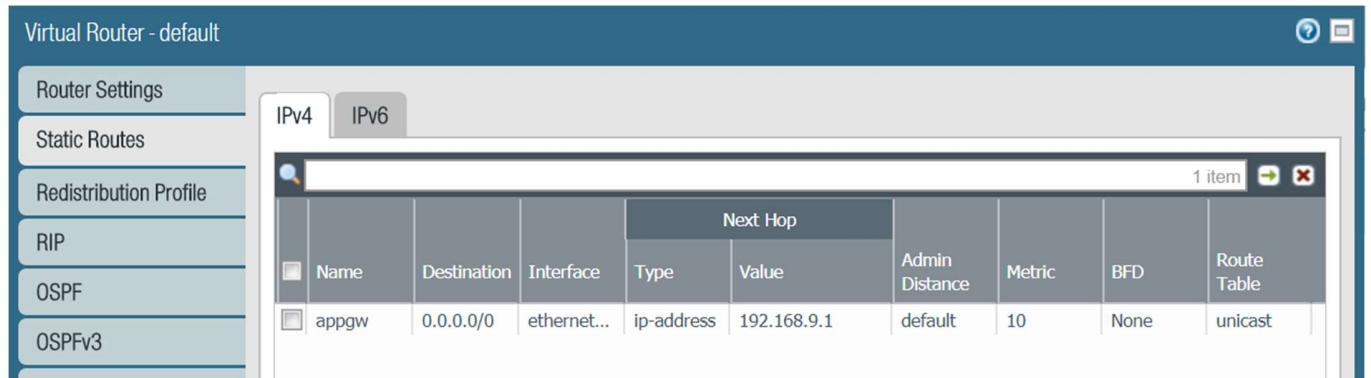
Address objects are statically defined in the configuration snapshot file. They must be manually updated in each subsequent spoke deployment or traffic will NOT route properly.



The screenshot shows the 'Objects' tab selected in the navigation bar. Below it is a search bar and a table listing two address objects:

Name	Location	Type	Address
firewall-untrust-IP		IP Netmask	192.168.1.4
internal-load-balancer-IP		IP Netmask	192.168.2.6

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.



The screenshot shows the 'Virtual Router - default' configuration page. On the left, there's a sidebar with options like Router Settings, Static Routes, Redistribution Profile, RIP, OSPF, and OSPFv3. The main area is titled 'IPv4' and shows a table of static routes:

Name	Destination	Interface	Type	Value	Admin Distance	Metric	BFD	Route Table
appgw	0.0.0.0/0	ethernet...	ip-address	192.168.9.1	default	10	None	unicast

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.

SetupVNetPeering	! Failed (Error details)	3/21/2018, 12:40:02 PM	8 seconds
SetupVMSeries	✓ Succeeded	3/21/2018, 12:39:39 PM	5 minutes 58 seconds
VMSeries-Firewall-VM1	✓ Succeeded	3/21/2018, 12:39:29 PM	4 minutes 48 seconds
VMSeries-Firewall-VM0	✓ Succeeded	3/21/2018, 12:37:52 PM	3 minutes 12 seconds