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Installation automation and centralized management of IBM WebSphere Commerce environment

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Abstract

At the start of every IBM WebSphere Commerce project at Solteq Oyj the server and network infrastructure needs to be setup first and the software installed and configured before the project itself can fully start. The server and network infrastructure alone ordered from a third-party service provider usually takes days or even weeks depending on the size and complexity of the environment. One IBM WebSphere Commerce software stack installation and configuration can take a specialist a week or several weeks depending of the environment and architecture. One customer generally has multiple environments for testing, quality assurance and production so the process can take a significant amount of time which in turn generates costs.

Therefore, it was decided to explore the options to provision the environments from some of the most appealing public clouds and automate the infrastructure provisioning, software installation and configuration. Microsoft Azure was chosen by the assigner as the cloud provider for the thesis.

The Azure infrastructure automation was done using 3rd party automation tool that was already in use at Solteq Oyj for other automation related tasks and the automation tool was Azure compatible as well.

The goals of the thesis were partially achieved. The server and network infrastructure components were provisioned from the Microsoft's Azure cloud. Due to the surprising amount of work it took to automate the infrastructure from Azure using the chosen automation tool, the installation and configuration of the IBM WebSphere Commerce software stack was left out of the scope of the thesis.

Keywords/tags (subjects)

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Tiivistelmä

Jokaisen IBM WebSphere Commerce – sovelluskokonaisuudella tehtävän projektin alussa tarvitsee hankkia palvelin- ja verkkoinfrastruktuuri sekä asentaa ja konfiguroida sovelluskokonaisuus. Pelkässä palvelin- ja verkkoinfrastruktuurin tilausprosessissa kuluu useista päivistä viikkoihin ennen kuin infrastruktuuri on valmis tuotteiden asennusta varten. Itse tuotteiden asennus ja konfiguraatio vie yhdeltä asiantuntijalta yhdestä viikosta useisiin viikkoihin riippuen ympäristön monimutkaisuudesta ja arkkitehtuurista. Yhdellä asiakkaalla on tyypillisesti käytössään useampi ympäristö testausta, laadunvarmistusta ja tuotantokäyttöä varten, jolloin ympäristön infrastruktuurin, tuotteiden asennuksen sekä konfiguraation aika luo jo merkittävän kuluerän asiakkaalle projektissa.

Ajan ja rahan säästämiseksi ongelmaa on päätetty lähteä ratkaisemaan tutkimalla vaihtoehtoja palvelin- ja verkkoinfrastruktuurin provisiointiin julkisista pilvipalveluista käyttäen automaatisointia hyväksi. Opinnäytetyöhön automatisointia varten valittiin työnantajan puolesta Microsoft Azure – pilvipalvelu.

Azuren palvelin- ja verkkoinfrastruktuurin provisioinnin automaatisointiin valittiin kolmannen osapuolen työkalu joka oli jo valmiiksi käytössä erinäisten asioiden automatisoinnissa Solteq Oyj:llä. Työkalussa oli myöskin valmis tuki Azure automatisointiin.

Opinnäytetyön tavoitteisiin päästiin vain osittain. Palvelin- ja verkkoinfrastruktuurin komponentit saatiin provisioitua Azuressa. IBM WebSphere Commerce tuotteen asennus ja konfiguraatio jouduttiin rajaamaan pois opinnäytetyön laajuudesta, sillä palvelin- ja verkkoinfrastruktuurin provisionnin automatisointi valitulla työkalulla oli yllättävän työlästä ja aikaa vievää.

Avainsanat (asiasanat)

Automaatio, Azure

Muut tiedot

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Abbreviations

DMZ	Demilitarized Zone
FQDN	Fully Qualified Domain Name
IaaS	Infrastructure as a Service
IBM DB2	IBM DB2 database
IBM IHS	IBM HTTP Server
IBM SOLR	IBM WebSphere Commerce Search server
IBM WAS	IBM WebSphere Application Server
JSON	JavaScript Object Notation
NIC	Network Interface Card
NSG	Network Security Group
OS	Operating System
SSH	Secure Shell

VM	Virtual Machine
VNET	Virtual Network
WCS	WebSphere Commerce

1 Introduction

1.1 Objective

Due to the complexity of the IBM WebSphere Commerce software stack, installation and configuration of a single WebSphere Commerce environment can take one specialist up to two or three weeks if the network and server infrastructure is already up and running. This makes it difficult, expensive and time consuming to create new environments for customers or for demonstration and testing purposes.

The objective of this Bachelor's Thesis is to cut down the time required to create new IBM WebSphere Commerce environments from the scratch by deploying the infrastructure from Microsoft Azure cloud using automation tools and then installing the IBM WebSphere Commerce software stack products to the servers in Azure using automation tools. The automation tools also provide the means for centralized management of the servers and software products.

1.2 About the employer

Solteq Oyj is a Finnish mid-size company offering various information technology solutions, mainly focusing on multichannel and digital commerce. Solteq employs 450 experts in three countries and delivers solutions to customers around the world. (Strategy and focus areas, 2017) (Solteq in brief, 2017)

2 Technologies

2.1 Microsoft Azure

Microsoft Azure is Microsoft's public cloud which offers various solutions for Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). (Gailey, 2016)

Microsoft Azure is geographically very well available having datacenters in North America, South America, Canada, Europe, Asia and Australia which makes it appealing for services that require low latency and for services that need to be located on

specific locations for legal reasons. Not all the Azure datacenters offer the full range of Azure services however. (Azure regions, 2017) (Products available by region, 2017)

2.2 Azure IaaS components

2.2.1 Resource Groups

Resource groups are abstract containers for Azure resources. The purpose of Azure resource group is to provide the ability to group up resources for easier management. While creating a resource group, it is required to provide location where resource group is to be created, but resources within the resource group can be in multiple Azure locations. (Azure Resource Manager overview, 2017)

2.2.2 Virtual Networks

Virtual networks (VNETs) enable Azure resources to connect with each other within the VNET and also provide the means for isolation of resources since the VNETs are isolated from each other. VNETs make use of the public and private IP address spaces. VNET's resources with a private IP address can by default connect to the Internet since the private IP addresses are source network address translated to a public IP by Azure. VNETs can be connected to each other or on-premises networks. (Azure Virtual Network, 2017)

2.2.3 Subnets

VNETs can be segmented into one or more subnets and a portion of the VNET's address space allocated to each subnet. (Azure Virtual Network, 2017)

2.2.4 Network Interface Cards

Azure network interface card (NIC) is a configurable object that enables an Azure virtual machine to connect to the internet and other Azure resources. (Create, change, or delete network interfaces, 2017)

2.2.5 Public IP addresses

Azure public IP addresses are configurable objects that enable inbound connectivity to Azure resources from the Internet. (Create, change, or delete public IP addresses, 2017)

2.2.6 Network Security Groups

Azure Network Security Groups (NSGs) are lists of security rules and they can be associated subnets, VMs or NICs. NSGs contain some default rules. The rules are processed from the lowest to highest priority. By default, inbound traffic is only allowed from the VNET itself and from Azure Load Balancer. The last rule is a deny all inbound traffic rule. Outbound traffic is allowed to the resources within the VNET and to the Internet by default. (Filter network traffic with network security groups, 2017)

2.2.7 VPN Gateways

VPN gateways can be deployed to connect VNETs to each other or to connect a VNET to on-premises network. (About VPN Gateway, 2017)

2.2.8 Load Balancers

Azure Load Balancers are Layer 4 (TCP, UDP) load balancers that provide high availability and load balancing by distributing traffic to multiple instances. Load balancers are configured to monitor the health of the back-end services to determine which back end nodes traffic is routed to. (Azure Load Balancer overview, 2017)

2.2.9 Virtual Machines

Azure has a range of Linux and Windows operating systems available for virtual machine deployment. Azure VMs can be deployed with various resources, described in the table Azure virtual machine tiers. (Azure and Linux, 2017) (Overview of Windows virtual machines in Azure, 2017)

Table 1 Azure virtual machine tiers

TYPE	Sizes	Description

GENERAL PURPOSE	DSv2, Dv2, DS, D, Av2, A0-7,	Balanced CPU-to-memory ratio. Ideal for testing and development, small to medium databases, and low to medium traffic web servers.
COMPUTE OPTIMIZED	Fs, F	High CPU-to-memory ratio. Good for medium traffic web servers, network appliances, bath processes, and application servers.
MEMORY OPTIMIZED	GS, G, DSv2, DS, Dv2, D	High memory-to-core ratio. Great for relational database servers, medium to large caches, and in-memory analytics.
STORAGE OPTIMIZED	Ls	High disk throughput and IO. Ideal for Big Data, SQL, and NoSQL databases.
GPU	NV, NC	Specialized virtual machines targeted for heavy graphic rendering and video editing. Available with single or multiple GPUs.
HIGH PERFORMANCE COMPUTE	H, A8-11	Our fastest and most powerful CPU virtual machines with optional high-throughput network interfaces (RDMA).

(Sizes for Linux virtual machines in Azure, 2017)

2.2.10 Traffic Managers

Azure Traffic Manager can be deployed to manage distribution of network traffic to different Azure or external locations. Traffic manager does the distribution on DNS level and monitors the end points health status. (Overview of Traffic Manager, 2017)

There are four different traffic routing methods available: Priority, weighted, performance and geographic. ‘Priority’ method routes traffic to one prioritized location at a time, ‘Weighted’ can be used to route traffic to all locations evenly or with weights, ‘Performance’ routes traffic to endpoint with lowest latency and ‘Geographic’ is used to direct users to closest geographical endpoint determined by where their DNS query originates from. (Traffic Manager routing methods, 2017)

2.3 Azure Service Principal

Azure Service Principal enables authenticated applications to access and modify resources depending on the kind of permissions that have been assigned to the service principal. Use portal to create an (Use portal to create an Azure Active Directory application and service principal that can access resources, 2017)

2.4 IBM HTTP Server

IBM HTTP Server is a web server based on Apache HTTP Server and includes some IBM's custom enhancements and features. One of these features is the WebSphere Application Server Web server plug-in, which enables the IBM HTTP Server to forward HTTP requests to WebSphere Application Servers. (IBM HTTP Server, 2016)

The plugin provides load balancing capabilities, performance improvements by caching and serving the static content and increased security since the WebSphere Application Servers do not need to be directly accessible from an untrusted network, such as the Internet. (Understanding the WebSphere Application Server Web server plug-in, 2017)

2.5 IBM WebSphere Application Server

IBM WebSphere Application Server (WAS) is a Java and Java EE application server software, which main function is to provide the platform for running various Java and Java EE applications on top of it. (WebSphere Application Server, 2017)

2.6 IBM WebSphere Commerce

IBM WebSphere Commerce (WCS) is an omni-channel E-commerce platform written mostly in Java. WebSphere Commerce is highly customizable and contains a broad selection of tools to match the requirements of wide variety of business-to-business and business-to-customer E-commerce. (WebSphere Commerce, 2017) (WebSphere Commerce product overview, 2017)

2.7 IBM WebSphere Commerce Search server

IBM WebSphere Commerce Search server is a Java search engine application running on top of the WebSphere Application server. IBM WebSphere Commerce Search is built on Apache Solr and Apache Lucene frameworks. (WebSphere Commerce Search, 2017)

2.8 IBM DB2

IBM DB2 is an SQL, XML and JSON compatible relational database management system (RDBMS). IBM DB2 can be installed on Linux, Windows and some UNIX based operating systems, such as IBM AIX. (System requirements for IBM DB2 for Linux, UNIX, and Windows, 2013) (Database Administration Concepts and Configuration Reference, 2015) (Work with JSON documents, 2017)

2.9 JavaScript Object Notation

JavaScript Object Notation (JSON) is a standardized, text-based data representation format. JSON is human readable and supports representing the following types: strings, numbers, Booleans, null, objects and arrays. (Crockford, D. The application/json Media Type for JavaScript Object Notation (JSON), 2006)

3 Planning

Because each of the possible future customer cases might have different kinds of needs in terms of redundancy, capacity and architecture it was mandatory to create an automation solution that would scale horisontally with ease. The Network Diagram below represents a possible production environment setup with two Azure regions where items 1.X represent a resource group in the East US region and items 2.X a resource group in the West Europe.

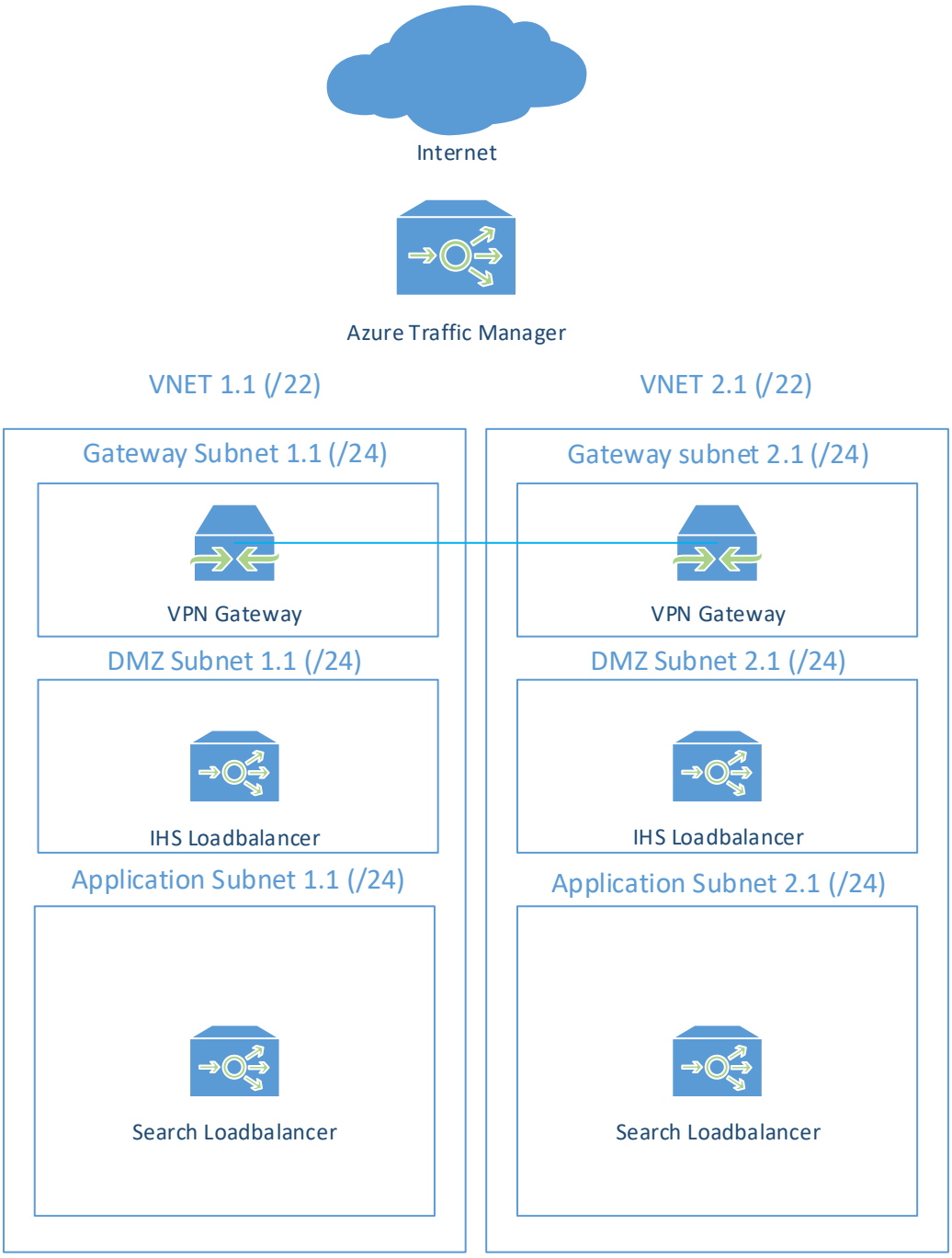


Figure 1 Network Diagram

The Azure traffic manager will be responsible for determing which location is currently the active location for serving the web store. This essentially means that only one location at a time is serving content to end users and other location(s) are for failover purposes. The store DNS name will point Azure traffic manager address with a CNAME record and the Traffic Manager will have the load balancers located on the DMZ subnet configured as the Traffic Manager endpoints.

Resource groups, VNETs and every item within the VNET will be created as well a for each Azure region used. Each VNET contains three subnets: Gateway subnet, DMZ Subnet and Application subnet. There is room for one extra subnet per VNET in the /22 subnet mask. The VNETS and subnets could have much smaller network masks for more optimal IP addressing, but company policy preferred /24 subnet masks for ease of management and the /22 subnet mask for VNETs was chosen because of this preference.

Each gateway subnet contains one 'Standard' VPN gateway, which enables to establish a site-to-site VPN connection between VNETs in different Azure regions and if necessary, site-to-site VPN connections between Azure VNETs and on-premises sites. (Create a Site-to-Site connection in the Azure portal, 2017)

The DMZ subnet contains one "Internet facing" load balancer for load balancing traffic coming from Azure Traffic manager to all of the IHS servers. This needs to be a internet facing loadbalancer since Azure Traffic Manager end points need to point to a public IP address item of the DMZ loadbalancer. (Traffic Manager endpoints, 2017) (Internet facing load balancer overview, 2016)

Application subnet contains one internal load balancer for load balancing HTTP requests for Commerce search servers. Load balancing traffic between IBM IHS and IBM WAS servers is handled by IBM IHS Plugin, which is installed and configured on the IBM IHS servers. (Internal load balancer overview, 2017) (Installing and configuring the plug-in for IBM HTTP Server for WebSphere Application Server on z/OS, 2017)

As described inFigure 2 Server Architecture diagram below, the DMZ subnet contains the frontend IBM IHS webserver virtual machines and the application subnet contains the backend IBM WAS, IBM SOLR, and IBM DB2 virtual machines. The DMZ zone separation is done with Azure Network Security Groups which are associated to the subnets. (Filter network traffic with network security groups, 2016)

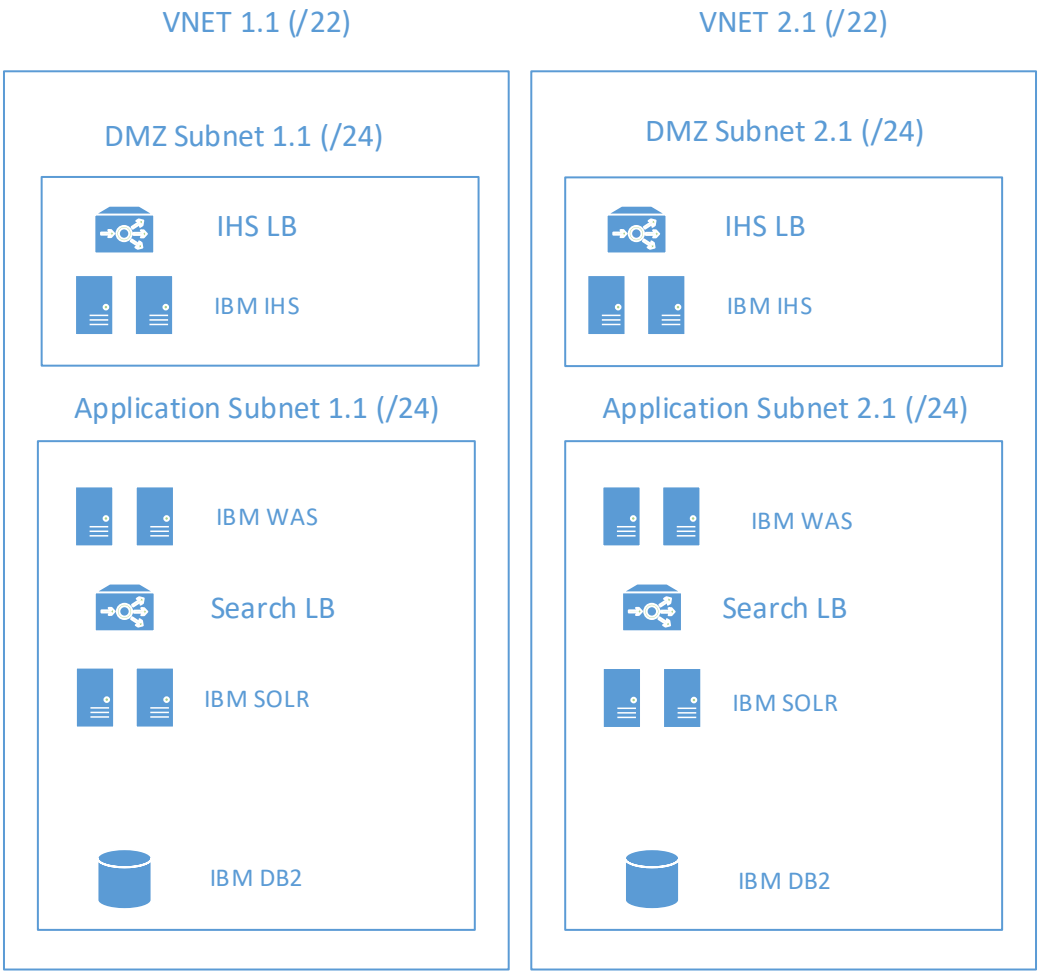


Figure 2 Server Architecture

Each separate tier of the IBM WebSphere Commerce stack (IHS, WAS, SOLR, DB2) can be scaled horizontally within the subnets to provide redundancy and load balancing. Each tier of the stack belongs to a separate Azure availability group to ensure Azure maintenance and possible hardware failures will not take down all the virtual machines in the tier. (Manage the availability of Linux virtual machines, 2017)

All of the VMs have an Azure Network Interface Card associated to them to be able to connect to the Internet and with other VMs. The IBM IHS and IBM SOLR servers also have a public IP address associated to the Network Interface since it is required by load balancer back end configuration. (Create, change, or delete network interfaces, 2017) Implementation

4 Implementation

The Azure Developer subscription used for this Bachelor's Thesis had a limitation of four cores maximum and the minimum amount of cores per Azure virtual machine is one. Solteq's Commerce Software stack server architecture requires a minimum of four separate servers for one environment. Therefore, the environment setup is limited to having the needed four servers in one location without any server redundancy or load balancing as described in Figure 3 Environment diagram below. Second search load balancer has also been left out since it has neither back nor front end servers.

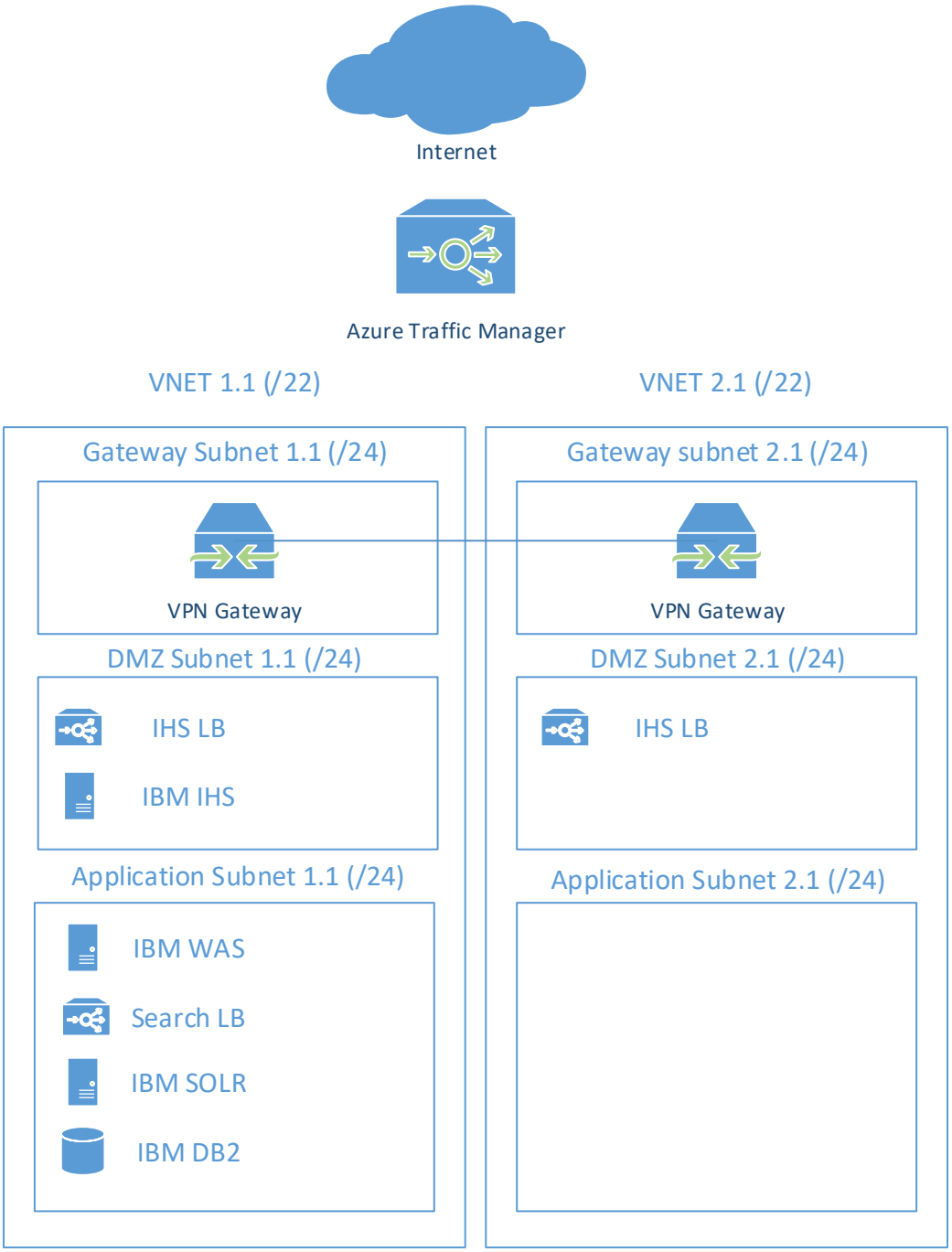


Figure 3 Environment diagram

4.1 Setting up Azure for external automation tools

To be able to use external automation tools with Azure, either Azure AD credentials or Azure Service Principal can be used to authenticate. Azure Service Principal is setup in a following way using Linux command line tools on a Debian (Release 8.7, Jessie) machine. (Installing Node.js via package manager, 2016) (How to create and test Azure Service Principal using Azure CLI, 2016) (Install the Azure CLI, 2016) (Use

portal to create an Azure Active Directory application and service principal that can access resources, 2017)

Install Python pip

apt-get install python-pip

Install npm using python pip

pip install npm

Install nodejs and azure-cli

curl -sL https://deb.nodesource.com/setup_6.x | sudo -E bash –
apt-get install nodejs
npm install -g azure-cli

Start azure-cli and login

azure login

The CLI program prompts to go to the given URL. The code provided by the program must be submitted and it then prompts to login with the user's Active Directory username/password.

After successfully logging in, list available Azure subscriptions

azure account list

info: Executing command account list
data: Name Id Current State
data: ---------- ---------- ------- --------
data: Pay-As-You-Go ***57b59d1e-325d-429d-82f6-eac33da9e1ec*** *true Enabled*
info: account list command OK

Set subscription to create the Service Principal to

azure account set " Pay-As-You-Go"

Create the App, the URL's don't really matter since they won't be used. Keep the password safe since it will be used as "client_secret" when authenticating to Azure using the Service principal. Also save the AppId, which will be the "client_id" parameter required by the automation tool.

*azure ad app create --name "AutomationApp" --home-page "http://localhost/AutomationApp" --password "****MySecureAutomationPassword****" --identifier-uris http://localhost/AutomationApp*

info: Executing command ad app create
+ Creating application AutomationApp
data: AppId: 561ed153-e81b-4cac-9399-f534af0bae65
data: ObjectId: 3f41b37d-bbae-4dbd-9694-8a2bdac7450c
data: DisplayName: AutomationApp
data: IdentifierUris: 0=http://localhost/AutomationApp
data: ReplyUrls:
data: AvailableToOtherTenants: False
data: HomePage: http://localhost/AutomationApp
info: ad app create command OK

Create a service principal for the app.

*azure ad sp create --applicationId **561ed153-e81b-4cac-9399-f534af0bae65***

info: Executing command ad sp create
+ Creating service principal for application 561ed153-e81b-4cac-9399-f534af0bae65
data: Object Id: 4853b87f-dcf3-4154-87af-db1af116e9b1
data: Display Name: AutomationApp
data: Service Principal Names:
data: 561ed153-e81b-4cac-9399-f534af0bae65
data: http://localhost/AutomationApp

Assign role for the Service Principal. The following example will give 'contributor' rights to the whole subscription. This could also be targeted to resource group level for more restrictive permissions.

*azure role assignment create --objectId "**4853b87f-dcf3-4154-87af-db1af116e9b1**" --roleName "Contributor" --scope "/subscriptions/**57b59d1e-325d-429d-82f6-eac33da9e1ec**"*

info: Executing command role assignment create
+ Finding role with specified name
data: RoleAssignmentId : /subscriptions/57b59d1e-325d-429d-82f6-eac33da9e1ec/providers/Microsoft.Authorization/roleAssignments/ca948a06-0f0c-4028-8e80-4a796ff43a11
data: RoleDefinitionName : Contributor
data: RoleDefinitionId : b24988ac-6180-42a0-ab88-20f7382dd24c
data: Scope : /subscriptions/57b59d1e-325d-429d-82f6-eac33da9e1ec
data: Display Name : AutomationApp
data: SignInName : undefined
data: ObjectId : 4853b87f-dcf3-4154-87af-db1af116e9b1
data: ObjectType : ServicePrincipal

data:
+

It should now be possible to login using the service principal. The AD user is logged out with the following command:

azure logout example.user@exampleorganization.com

Show subscription information to get the tenant ID.

azure account show "Pay-As-You-Go"

info: Executing command account show
data: Name : Pay-As-You-Go
data: ID : 57b59d1e-325d-429d-82f6-eac33da9e1ec
data: State : Enabled
*data: Tenant ID : **7b77f463-808e-42e4-8dc8-5d5e67f8574e***
data: Is Default : true
data: Environment : AzureCloud
data: Has Certificate : No
data: Has Access Token : Yes
data: User name : example.user@exampleorganization.com
data:
info: account show command OK

Login with Service Principal using Azure CLI. Specify AppId as the “username”, Tenant ID from previous command output as the “tenant” and password that was set while creating the app.

*azure login --service-principal --username "**561ed153-e81b-4cac-9399-f534af0bae65**" --password " **MySecureAutomationPassword**" --tenant "**7b77f463-808e-42e4-8dc8-5d5e67f8574e**"*

info: Executing command login
info: Added subscription Pay-As-You-Go
info: Setting subscription "Pay-As-You-Go" as default
+
info: login command OK

Test provisioning Resource Group

azure group create sptestrg westus

info: Executing command group create
+ Getting resource group sptestrg
+ Creating resource group sptestrg
info: Created resource group sptestrg
data: Id: /subscriptions/57b59d1e-325d-429d-82f6-

```
eac33da9e1ec/rsourceGroups/sptestrg
data:    Name:              sptestrg
data:    Location:          westus
data:    Provisioning State:  Succeeded
data:    Tags: null
data:
info:    group create command OK
```

4.2 Azure

The Azure related tasks in the following subchapters are executed by running the automation script listed in Appendix 9. Automation script.

4.2.1 Resource Groups

Resource groups are provisioned in a task named “Create Resource Group” listed in Appendix 1. Network tasks. The variables referred to in the task can be found in Appendix 2. Network variables.

The task iterates a list of dictionaries called ‘resourcegroups’ where each dictionary within the list contains set of variables for the task execution. Below is the JSON representation of the list of dictionaries. Dictionary variables are explained in the table Resource group variables.

```
"resourcegroups": [
 {
  "location": "eastus",
  "name": "eh_automation_rg01"
 },
 {
  "location": "westeurope",
  "name": "eh_automation_rg02"
 }
],
```

Table 2 Resource group variables

VARIABLE	EXPLANATION
LOCATION	Azure region where the resource group is to be provisioned
NAME	Name of the resource group

(Azure Resource Manager overview, 2017)

4.2.2 Virtual Networks

Virtual Networks are provisioned in a task named “Create vnet” listed in Appendix 1. Network Tasks. The variables referred to in the task can be found in Appendix 2. Network Variables.

The task iterates a list of dictionaries called ‘virtualnetworks’ where each dictionary within the list contains set of variables for the task execution. Below is the JSON representation of the list of dictionaries. Dictionary variables are explained in the table Virtual Network variables.

```
"virtualnetworks": [
 {
  "cidr": "10.15.0.0/22",
  "name": "eh_automation_vn01",
  "resource_group": "eh_automation_rg01"
 },
 {
  "cidr": "10.15.4.0/22",
  "name": "eh_automation_vn02",
  "resource_group": "eh_automation_rg02"
 }
]
```

Table 3 Virtual Network variables

VARIABLE	EXPLANATION
CIDR	Network address and mask of the virtual network
NAME	Name of the virtual network
RESOURCE_GROUP	Resource group the virtual network is to be associated with

(Create your first virtual network, 2017)

4.2.3 Network Security Groups

Virtual Networks are provisioned in a task named “Create security groups” listed in Appendix 1. Network Variables. The variables referred to in the task can be found in Appendix 2. Network Variables.

Task iterates through a list of dictionaries called ‘NSGs. Each dictionary contains the variables related to Network Security Group.

The ‘rules’ is another list of dictionaries. Each dictionary in the list contains configuration for the rule itself.’.

Below is the JSON example representation of the NSGs list of dictionaries. The example contains only two network security groups which both have two rules defined. Variables related to the NSG itself are explained in the table Network Security Group variables. Variables related to the rule dictionaries are explained in the table Network Security Group rule variables.

```
"NSGs": [
  {
    "name": "eh_automation_dmznsg01",
    "resource_group": "eh_automation_rg01",
    "rules": [
     {
       "access": "Allow",
       "destination_port_range": 22,
       "direction": "Inbound",
       "name": "eh_automation_Allow_SSH",
       "priority": 100,
       "protocol": "Tcp"
     },
     {
       "access": "Allow",
       "destination_port_range": 80,
       "direction": "Inbound",
       "name": "eh_automation_Allow_HTTP",
       "priority": 200,
       "protocol": null
     }
 ]
},
{
    "name": "eh_automation_appnsg01",
    "resource_group": "eh_automation_rg01",
    "rules": [
     {
       "access": "Allow",
       "destination_port_range": 22,
       "direction": "Inbound",
       "name": "eh_automation_Allow_SSH_from_DMZ1",
       "priority": 100,
       "protocol": "Tcp",
```

```
        "source_address_prefix": "10.15.1.0/24"
      },
      {
        "access": "Allow",
        "destination_port_range": 22,
        "direction": "Inbound",
        "name": "eh_automation_Allow_SSH_from_DMZ2",
        "priority": 101,
        "protocol": "Tcp",
        "source_address_prefix": "10.15.5.0/24"
      }
    ]
  }
},
```

Table 4 Network Security Group variables

VARIABLE	EXPLANATION
NAME	The name of the network security group
RESOURCE_GROUP	Resource group the network security group is to be associated with
RULES	List of dictionaries containing the rules

Table 5 Network Security Group rule variables

VARIABLE	EXPLANATION
ACCESS	type of the rule, either allow or deny
DESTINATION_PORT_RANGE	TCP port
DIRECTION	Direction of the traffic, either inbound or outbound
NAME	Name of the rule
PRIORITY	Priority of the rule, must be unique within the network security group. Rules are considered in ascending order from lowest priority to highest.
SOURCE_ADDRESS_PREFIX	Source subnet address of the traffic

(Filter network traffic with network security groups, 2016)

4.2.4 DMZ and Application Subnets

Subnets are provisioned in tasks named “Create a DMZ subnet” and “Create application subnet” listed in Appendix 1. Network Tasks. The variables referred to in the task can be found in Appendix 2. Network Variables.

The task ‘Create a DMZ subnet’ iterates through a list of dictionaries called ‘DMZ_subnets’ and the ‘Create application subnet’ iterates the ‘app_subnets’ list of dictionaries. Both tasks have identical variable structure and could be perhaps combined into a single task ‘Create subnets’ that would iterate both lists of dictionaries. JSON representation of both lists of dictionaries is provided below. Dictionary variables are explained in the table DMZ and application subnet variables

```
"DMZ_subnets": [
 {
  "cidr": "10.15.1.0/24",
  "location": "eastus",
  "name": "eh_automation_dmzsn01",
  "resource_group": "eh_automation_rg01",
  "vnet": "eh_automation_vn01"
 },
 {
  "cidr": "10.15.5.0/24",
  "location": "westeurope",
  "name": "eh_automation_dmzsn02",
  "resource_group": "eh_automation_rg02",
  "vnet": "eh_automation_vn02"
 }
],
"app_subnets": [
 {
  "cidr": "10.15.2.0/24",
  "location": "eastus",
  "name": "eh_automation_appsn01",
  "resource_group": "eh_automation_rg01",
  "vnet": "eh_automation_vn01"
 },
 {
  "cidr": "10.15.6.0/24",
  "location": "westeurope",
  "name": "eh_automation_appsn02",
  "resource_group": "eh_automation_rg02",
  "vnet": "eh_automation_vn02"
 }
],
```

Table 6 DMZ and application subnet variables

VARIABLE	EXPLANATION
CIDR	Network address and subnet mask of the subnet
LOCATION	Azure region of the subnet, same as the resource group location
NAME	Name of the subnet
RESOURCE_GROUP	Resource group subnet is to be associated with
VNET	Virtual network the subnet will be created into

(Create a virtual network with multiple subnets, 2017)

4.2.5 Gateway Subnets

Subnets are provisioned in a task named ‘Create a gateway subnet’ listed in Appendix 1. Network Tasks. The variables referred to in the task can be found in Appendix 2. Network Variables.

The task iterates the list of dictionaries called ‘gateway_subnets’ represented in JSON format below. The variables required to create the subnets itself are the same as the ones needed for creating DMZ and application subnets.

In addition, the dictionaries contain the variables needed for creating VPN gateways. These could be separated into a list of dictionaries of their own and the subnets could be iterated with one task for creating all the required subnets for consistency with the rest of the automation solution.

```
"gateway_subnets": [
  {
    "allocation_method": "Dynamic",
    "cidr": "10.15.0.0/24",
    "connected_to_gw": "eh_automation_vpngw02",
    "connection_routingweight": "3",
    "connectionname": "eh_automation_vnet2vnet01",
    "enableBGP": "false",
    "gateway_name": "eh_automation_vpngw01",
    "gatewaytype": "Vpn",
    "location": "eastus",
```

```
    "name": "GatewaySubnet",
    "publicIP": "eh_automation_vpngw_ip01",
    "resource_group": "eh_automation_rg01",
    "rg_of_connected_gw": "eh_automation_rg02",
    "sharedkey": "asdasdasdasd",
    "sku": "Standard",
    "vnet": "eh_automation_vn01",
    "vpntype": "RouteBased"
   },
   {
    "allocation_method": "Dynamic",
    "cidr": "10.15.4.0/24",
    "connected_to_gw": "eh_automation_vpngw01",
    "connection_routingweight": "3",
    "connectionname": "eh_automation_vnet2vnet02",
    "enableBGP": "false",
    "gateway_name": "eh_automation_vpngw02",
    "gatewaytype": "Vpn",
    "location": "westeurope",
    "name": "GatewaySubnet",
    "publicIP": "eh_automation_vpngw_ip02",
    "resource_group": "eh_automation_rg02",
    "rg_of_connected_gw": "eh_automation_rg01",
    "sharedkey": "asdasdasdasd",
    "sku": "Standard",
    "vnet": "eh_automation_vn02",
    "vpntype": "RouteBased"
   }
  ],
```


4.2.6 Gateway Public IP addresses

Public IP addresses for VPN gateways are provisioned in a task named ‘Create public IP for Network Gateway’ listed in Appendix 1. Network Tasks. The variables referred to in the task can be found in Appendix 2. Network Variables.

The task iterates ‘public_ips’ list of dictionaries which is represented in JSON format below. The dictionary variables are explained in the table Gateway public IP address variables.


```
"public_ips": [
   {
    "allocation_method": "Dynamic",
    "name": "eh_automation_vpngw_ip01",
    "resource_group": "eh_automation_rg01"
   },
```

```
  {
   "allocation_method": "Dynamic",
   "name": "eh_automation_vpngw_ip02",
   "resource_group": "eh_automation_rg02"
  }
 ],
```

Table 7 Gateway public IP address variables

VARIABLE	EXPLANATION
ALLOCATION_METHOD	Defines how public IP address is allocated. Either Dynamic or Static
NAME	Name of the public IP address object
RESOURCE_GROUP	Resource group the public IP object is to be associated with

(Create, change, or delete public IP addresses, 2017) (Configure a VNet-to-VNet VPN gateway connection using the Azure portal, 2017)

4.2.7 VPN Gateways

VPN gateways are provisioned in a task named ‘Deploy Azure Azure VPN gateways’ and connected in a task ‘Create connection between VPN gateways’ listed in Appendix 1. Network Tasks. The variables referred to in the task can be found in Appendix 2. Network Variables.

The task iterates the list of dictionaries ‘gateway_subnets’ represented in JSON format below and the variables required for creating a gateway subnet are listed and explained in the table VPN gateway variables. Variables required to create a connection between gateways are listed and explained in table VPN gateway connection variables.

```
"gateway_subnets": [
  {
   "allocation_method": "Dynamic",
   "cidr": "10.15.0.0/24",
   "connected_to_gw": "eh_automation_vpngw02",
   "connection_routingweight": "3",
   "connectionname": "eh_automation_vnet2vnet01",
   "enableBGP": "false",
   "gateway_name": "eh_automation_vpngw01",
   "gatewaytype": "Vpn",
   "location": "eastus",
```

```
  "name": "GatewaySubnet",
  "publicIP": "eh_automation_vpngw_ip01",
  "resource_group": "eh_automation_rg01",
  "rg_of_connected_gw": "eh_automation_rg02",
  "sharedkey": "asdasdasdasd",
  "sku": "Standard",
  "vnet": "eh_automation_vn01",
  "vpntype": "RouteBased"
 },
 {
  "allocation_method": "Dynamic",
  "cidr": "10.15.4.0/24",
  "connected_to_gw": "eh_automation_vpngw01",
  "connection_routingweight": "3",
  "connectionname": "eh_automation_vnet2vnet02",
  "enableBGP": "false",
  "gateway_name": "eh_automation_vpngw02",
  "gatewaytype": "Vpn",
  "location": "westeurope",
  "name": "GatewaySubnet",
  "publicIP": "eh_automation_vpngw_ip02",
  "resource_group": "eh_automation_rg02",
  "rg_of_connected_gw": "eh_automation_rg01",
  "sharedkey": "asdasdasdasd",
  "sku": "Standard",
  "vnet": "eh_automation_vn02",
  "vpntype": "RouteBased"
 }
],
```


Table 8 VPN gateway variables

VARIABLE	EXPLANATION
ALLOCATION_METHOD	Allocation method of the private IP address
ENABLEBGP	Enable Border Gateway Protocol, either 'true' or 'false'
GATEWAY_NAME	Name of the gateway
LOCATION	Location of the gateway. Same as the location of the resource group.
PUBLICIP	Name of the public IP address item to associate with the gateway.
RESOURCE_GROUP	Resource group where the gateway is to be created

SKU	Tier of the gateway
VNET	VNET where the gateway is to be created
VPNTYPE	Type of the VPN
GATEWAYTYPE	Type of the gateway
NAME	Name of the subnet gateway subnet is to be located to

Table 9 VPN gateway connection variables

VARIABLE	EXPLANATION
RESOURCE_GROUP	Resource group where the connection item is to be created
LOCATION	location where the connection item is to be created. Same as the location of the resource group.
CONNECTIONNAME	Name of the connection item
GATEWAY_NAME	Name of the gateway the connection item is associated to
RG_OF_CONNECTED_GW	Resource group of the gateway to be connected
CONNECTED_TO_GW	Name of the gateway to be connected
CONNECTION_ROUTINGWEIGHT	Routing weight of the connection
SHARED_KEY	Pre-shared key of the connection. Must be same on both ends

(Configure a VNet-to-VNet VPN gateway connection using the Azure portal, 2017)

4.2.8 Load balancers and load balancer public IP addresses

Load balancers are provisioned in tasks ‘Deploy public Azure Loadbalancer using Azure Resource Manager Templates’ and ‘Deploy private Azure Loadbalancers using Azure Resource Manager Templates’. The public IP addresses for the Internet facing load balancers are provisioned in the task ‘Create public IP for internet facing (public)

LB's' listed in Appendix 3. Load balancer tasks. The variables referred to in the tasks can be found in Appendix 4. Load balancer variables.

The tasks 'Deploy public Azure Loadbalancer using Azure Resource Manager Templates' and 'Create public IP for internet facing (public) LB's' both iterate 'public_loadbalancers' list of dictionaries.

The task 'Deploy private Azure Loadbalancers using Azure Resource Manager Templates' iterates 'internal_loadbalancers' list of dictionaries. JSON representation of variables used for creating load balancers and public IP address objects below:


```
{
  "internal_loadbalancers": [
    {
      "backendpoolname": "eh_automation_solrlbbepool01",
      "location": "eastus",
      "name": "eh_automation_app01lb01",
      "number_of_failed_probes1": 2,
      "number_of_failed_probes2": 2,
      "port1": 80,
      "port2": 81,
      "privateIPAllocationMethod": "dynamic",
      "probe1name": "eh_automation_port80probe",
      "probe1protocol": "Http",
      "probe2name": "eh_automation_port81probe",
      "probe2protocol": "Http",
      "probeInterval1": 5,
      "probeInterval2": 5,
      "relativedomainname": "ehautomationapplb01",
      "requestpath1": "/",
      "requestpath2": "/",
      "resource_group": "eh_automation_rg01",
      "subnet": "eh_automation_appsn01",
      "virtual_network": "eh_automation_vn01"
    }
  ],
  "public_loadbalancers": [
    {
      "backendpoolname": "eh_automation_ihslbbepool01",
      "location": "eastus",
      "name": "eh_automation_dmz01lb01",
      "number_of_failed_probes1": 2,
      "number_of_failed_probes2": 2,
      "port1": 80,
      "port2": 81,
      "privateIPAllocationMethod": "dynamic",
```

```
    "probe1name": "eh_automation_port80probe",
    "probe1protocol": "Http",
    "probe2name": "eh_automation_port81probe",
    "probe2protocol": "Http",
    "probeInterval1": 5,
    "probeInterval2": 5,
    "public_ip_allocation_method": "Dynamic",
    "public_ip_name": "eh_automation_dmz01lb01_ip01",
    "relativedomainname": "ehautomationdmzlb01",
    "requestpath1": "/",
    "requestpath2": "/",
    "resource_group": "eh_automation_rg01",
    "subnet": "eh_automation_dmzsn01",
    "virtual_network": "eh_automation_vn01"
   },
   {
    "backendpoolname": "eh_automation_ihslbbepool01",
    "location": "westeurope",
    "name": "eh_automation_dmz02lb01",
    "number_of_failed_probes1": 2,
    "number_of_failed_probes2": 2,
    "port1": 80,
    "port2": 81,
    "privateIPAllocationMethod": "dynamic",
    "probe1name": "eh_automation_port80probe",
    "probe1protocol": "Http",
    "probe2name": "eh_automation_port81probe",
    "probe2protocol": "Http",
    "probeInterval1": 5,
    "probeInterval2": 5,
    "public_ip_allocation_method": "Dynamic",
    "public_ip_name": "eh_automation_dmz02lb01_ip01",
    "relativedomainname": "ehautomationdmzlb02",
    "requestpath1": "/",
    "requestpath2": "/",
    "resource_group": "eh_automation_rg02",
    "subnet": "eh_automation_dmzsn02",
    "virtual_network": "eh_automation_vn02"
   }
  ]
 }
```


The variables in ´public_loadbalancers' list of dictionaries that are used for creating the public IP address objects:

Table 10 Load balancer public IP address variables

VARIABLE	EXPLANATION

PUBLIC_IP_NAME	Name of the public IP address object
RESOURCE_GROUP	Resource group the public IP address is to be associated to
PUBLIC_IP_ALLOCATION_METHOD	Allocation method of the public IP address. Either 'Dynamic' or 'Static'
RELATIVEDOMAINNAME	Relative domain name, must be unique within Azure region.

(Create, change, or delete public IP addresses, 2017)

The variables in 'public_loadbalancers' list of dictionaries that are used for creating the Internet facing load balancers are explained in the table Load balancer variables below:

Table 11 Load balancer variables

VARIABLE	EXPLANATION
LOCATION	Azure region where the load balancer is to be provisioned, same as resource group location
RESOURCE_GROUP	Name of the resource group load balancer is to be associated to
NAME	Name of the load balancer
PRIVATEIPALLOCATIONMETHOD	Allocation method of the private IP address. Either 'Dynamic' or 'Static'
PUBLIC_IP_NAME	Name of the public IP address object to be associated with the load balancer
BACKENDPOOLNAME	Name of the load balancer back end pool
PROBE1NAME	Name of the first back end pool probe
PROBE1PROTOCOL	Protocol used for the first back end probe
PORT1	Port used for first back end probe
REQUESTPATH1	Request path for the probe
PROBEINTERVAL1	Interval for the probe requests

NUMBER_OF_FAILED_PROBES1	Number of failed probes after which end point is determined to be down

(Creating an Internet-facing load balancer using the Azure portal, 2017)

Probe2 related variables are also required, but their functionalities are the same as Probe1's and were left out of the table. In this case both probes are monitoring the same web server using different port since the load balancer has only one back end virtual machine. In case of two virtual machines as the back end, probe2 would be configured to monitor the health of the second virtual machine. The variables in required for creating the internal load balancers are the same, with the exception that 'public_ip_name' is not needed.

4.2.9 Virtual Machine Public IP addresses

Public IP addresses for virtual machines are provisioned in the task 'Create public IP for VM's' listed in Appendix 5. Virtual machine tasks. The variables referred to in the task can be found in Appendix 6. Virtual machine variables.

The 'Create public IP for VM's' iterates the 'vm_public_ips' list of dictionaries. The list of dictionaries is represented in JSON format below and the dictionary variables are explained in the table Virtual machine public IP address variables

```
"vm_public_ips": [
 {
  "allocation_method": "Dynamic",
  "name": "eh_automation_rg01ihs01_ip01",
  "resource_group": "eh_automation_rg01"
 },
 {
  "allocation_method": "Dynamic",
  "name": "eh_automation_rg01solr01_ip01",
  "resource_group": "eh_automation_rg01"
 }
],
```

Table 12 Virtual machine public IP address variables

VARIABLE	EXPLANATION
ALLOCATION_METHOD	Defines how public IP address is allocated. Either Dynamic or Static
NAME	Name of the public IP address object

RESOURCE_GROUP	Resource group the public IP object is to be associated with

(Create, change, or delete public IP addresses, 2017)

4.2.10 Virtual Machine Netwok Interface Cards

Network interface cards are provisioned in tasks ‘Create NIC's for VM's’ and ‘Create NIC's for VM's that are associated to LB back end pools’. LB needs to exist first.’ listed in Appendix 5. Virtual machine tasks. The variables referred to in the task can be found in Appendix 6. Virtual machine variables.

The ‘Create NIC's for VM's that are associated to LB back end pools’ iterates ‘vm_be-pool_network_interfaces’ list of dictionaries and the ‘Create NIC's for VM's’ iterates through ‘vm_network_interfaces’ list of dictionaries. JSON representation of the variables can be found below. The dictionary variables are explained in the table Virtual machine NIC variables.

```
"vm_bepool_network_interfaces": [
 {
  "lb_be_pool_name": "eh_automation_ihslbbepool01",
  "loadbalancername": "eh_automation_dmz01lb01",
  "location": "eastus",
  "name": "eh_automation_rg01ihs01_nic01",
  "networksecuritygroup": "eh_automation_dmznsg01",
  "public_ip_address_name": "eh_automation_rg01ihs01_ip01",
  "resource_group": "eh_automation_rg01",
  "subnet_name": "eh_automation_dmzsn01",
  "virtual_network_name": "eh_automation_vn01"
 },
 {
  "lb_be_pool_name": "eh_automation_solrlbbepool01",
  "loadbalancername": "eh_automation_app01lb01",
  "location": "eastus",
  "name": "eh_automation_rg01solr01_nic01",
  "networksecuritygroup": "eh_automation_appnsg01",
  "public_ip_address_name": "eh_automation_rg01solr01_ip01",
  "resource_group": "eh_automation_rg01",
  "subnet_name": "eh_automation_appsn01",
  "virtual_network_name": "eh_automation_vn01"
 }
],
"vm_network_interfaces": [
 {
```

```
    "name": "eh_automation_rg01app01_nic01",
    "public_ip": false,
    "public_ip_address_name": null,
    "resource_group": "eh_automation_rg01",
    "subnet_name": "eh_automation_appsn01",
    "virtual_network_name": "eh_automation_vn01"
   },
   {
    "name": "eh_automation_rg01db01_nic01",
    "public_ip": false,
    "public_ip_address_name": null,
    "resource_group": "eh_automation_rg01",
    "subnet_name": "eh_automation_appsn01",
    "virtual_network_name": "eh_automation_vn01"
   }
  ],
```

Table 13 Virtual machine NIC variables

VARIABLE	EXPLANATION
NAME	Name of the network interface card
PUBLIC_IP	Create public IP address for the NIC, either 'true' or 'false'
PUBLIC_IP_ADDRESS_NAME	Name of the public IP address object to be associated with the NIC
RESOURCE_GROUP	Resource group the public IP address is to be associated with
SUBNET_NAME	Name of the subnet the network interface will be associated with
VIRTUAL_NETWORK_NAME	Name of the virtual network the NIC will be associated with
LB_BE_POOL_NAME	Name of the load balancer back end the NIC is to be associated with
LOADBALANCERNAME	Name of the load balancer the NIC is to be associated with
NETWORKSECURITYGROUP	Network Security group the NIC is to be associated with

(Create, change, or delete network interfaces, 2017)

4.2.11 Create storage account

Storage account is provisioned in the task ‘Create storage account’ listed in Appendix 5. Virtual machine tasks. Storage account creation is not variablized and does not iterate a list of dictionaries like other tasks since only one was deployed. For scalability, it could also be variablized. Storage account is created with parameters explained in table Storage account parameters.

Table 14 Storage account parameters

PARAMETER	EXPLANATION
RESOURCE_GROUP	Resource group the storage account is to be associated with
NAME	Name of the storage account
ACCOUNT_TYPE	Type of the storage account

(About Azure storage accounts, 2017)

4.2.12 Availability Groups

Availability groups are provisioned in a task named ‘Create availability groups’ listed in Appendix 5. Virtual machine tasks. The variables referred to in the task can be found in Appendix 6. Virtual machine variables.

The task ‘Create availability groups’ iterates though a list of dictionaries called ‘availability_groups. JSON representation of the ‘availability_groups’ list of dictionaries provided below. The dictionary variables are explained in the table Availability group variables.

```
"availability_groups": [
 {
  "location": "eastus",
  "name": "eh_automation_rg01ihsag01",
  "platformFaultDomainCount": 2,
  "platformUpdateDomainCount": 2,
  "resource_group": "eh_automation_rg01",
  "use_managed_disks": "Classic"
 },
 {
  "location": "eastus",
  "name": "eh_automation_rg01appag01",
  "platformFaultDomainCount": 2,
```

```
  "platformUpdateDomainCount": 2,
  "resource_group": "eh_automation_rg01",
  "use_managed_disks": "Classic"
 },
 {
  "location": "eastus",
  "name": "eh_automation_rg01solrag01",
  "platformFaultDomainCount": 2,
  "platformUpdateDomainCount": 2,
  "resource_group": "eh_automation_rg01",
  "use_managed_disks": "Classic"
 },
 {
  "location": "eastus",
  "name": "eh_automation_rg01dbag01",
  "platformFaultDomainCount": 2,
  "platformUpdateDomainCount": 2,
  "resource_group": "eh_automation_rg01",
  "use_managed_disks": "Classic"
 }
],
```


Table 15 Availability group variables

VARIABLE	EXPLANATION
LOCATION	Location of the availability group. Same as the location of the resource group.
NAME	Name of the availability group.
PLAFORMFAULTDOMAINCOUNT	Number of fault domains in the availability group
PLATFORMUPDATEDOMAINCOUNT	Number of update domains in the availability group
RESOURCE_GROUP	Resource group the availability group is associated with
USE_MANAGED_DISKS	Defines if the VMs in the availability set have managed disks

(Increase VM availability by creating an Azure availability set, 2017)

4.2.13 Virtual Machines

Virtual machines are provisioned in the task ‘’ listed in Appendix 5. Virtual machine tasks. The variables referred to in the task can be found in Appendix 6. Virtual machine variables.

Each type of virtual machine is separated into a list of dictionaries of their own. The task iterates all of the list of dictionaries. JSON representation of the lists of dictionaries below and the dictionary variables are explained in the table Virtual machine variables.


```
"vm_db2": [
 {
  "admin_password": "x1LJRewq0EA4BnOMyc2b",
  "admin_username": "rootti",
  "availabilityset": "eh_automation_rg01dbag01",
  "location": "eastus",
  "name": "ehautomationrg01db01",
  "network_interface_names": "eh_automation_rg01db01_nic01",
  "operatingsystem": "CentOS",
  "osversion": "7.2",
  "publisher": "OpenLogic",
  "resource_group": "eh_automation_rg01",
  "short_hostname": "ehautomationrg01db01",
  "storage_account_name": "ehautomationstdstg01",
  "storage_blob_name": "eh-automation-db01-vdisk.vhd",
  "storage_container_name": "eh-automation-rg01-vdisksc-01",
  "version": "latest",
  "vm_size": "Standard_DS1_v2"
 }
],
"vm_ihs": [
 {
  "admin_password": "x1LJRewq0EA4BnOMyc2b",
  "admin_username": "rootti",
  "availabilityset": "eh_automation_rg01ihsag01",
  "location": "eastus",
  "name": "ehautomationrg01ihs01",
  "network_interface_names": "eh_automation_rg01ihs01_nic01",
  "operatingsystem": "CentOS",
  "osversion": "7.2",
  "publisher": "OpenLogic",
  "resource_group": "eh_automation_rg01",
  "short_hostname": "ehautomationrg01ihs01",
  "storage_account_name": "ehautomationstdstg01",
  "storage_blob_name": "eh-automation-ihs01-vdisk.vhd",
```

```
    "storage_container_name": "eh-automation-rg01-vdisksc-01",
    "version": "latest",
    "vm_size": "Standard_DS1_v2"
   }
  ],
 "vm_solr": [
   {
    "admin_password": "x1LJRewq0EA4BnOMyc2b",
    "admin_username": "rootti",
    "availabilityset": "eh_automation_rg01solrag01",
    "location": "eastus",
    "name": "ehautomationrg01solr01",
    "network_interface_names": "eh_automation_rg01solr01_nic01",
    "operatingsystem": "CentOS",
    "osversion": "7.2",
    "publisher": "OpenLogic",
    "resource_group": "eh_automation_rg01",
    "short_hostname": "ehautomationrg01solr01",
    "storage_account_name": "ehautomationstdstg01",
    "storage_blob_name": "eh-automation-solr01-vdisk.vhd",
    "storage_container_name": "eh-automation-rg01-vdisksc-01",
    "version": "latest",
    "vm_size": "Standard_DS1_v2"
   }
  ]
 }
 "vm_app": [
   {
    "admin_password": "x1LJRewq0EA4BnOMyc2b",
    "admin_username": "rootti",
    "availabilityset": "eh_automation_rg01appag01",
    "location": "eastus",
    "name": "ehautomationrg01app01",
    "network_interface_names": "eh_automation_rg01app01_nic01",
    "operatingsystem": "CentOS",
    "osversion": "7.2",
    "publisher": "OpenLogic",
    "resource_group": "eh_automation_rg01",
    "short_hostname": "ehautomationrg01app01",
    "storage_account_name": "ehautomationstdstg01",
    "storage_blob_name": "eh-automation-app01-vdisk.vhd",
    "storage_container_name": "eh-automation-rg01-vdisksc-01",
    "version": "latest",
    "vm_size": "Standard_DS1_v2"
   }
  ],
```

Table 16 Virtual machine variables

VARIABLE	EXPLANATION
ADMIN_PASSWORD	Password for the admin user
ADMIN_USERNAME	Username of the admin user
AVAILABILITYSET	Availability set the VM will belong to
LOCATION	Location of the VM, same as location of the resource group
NAME	Name of the VM
NETWORK_INTERFACE_NAMES	Name of the NIC to be associated with the VM
OPERATINGSYSTEM	Operating system of the VM
OSVERSION	Operation system version of the VM
PUBLISHER	Publisher of the VM image
RESOURCE_GROUP	Resource group the VM is to be associated with
SHORT_HOSTNAME	Hostname of the VM
STORAGE_ACCOUNT_NAME	Name of the storage account
STORAGE_BLOB_NAME	Name of the storage blob, will be created if it does not exist
STORAGE_CONTAINER_NAME	Name of the storage container, will be created if it does not exist
VERSION	Version of the OS
VM_SIZE	Size of the VM

(Create and Manage Windows VMs with the Azure PowerShell module, 2017)

4.2.14 Traffic Managers

Traffic managers are provisioned in a task ‘Deploy Azure Traffic Manager’ listed in Appendix 7. Traffic Managers. The variables referred to in the task can be found in Appendix 8. Traffic Manager variables.

The task iterates through ‘traffic managers’ list of dictionaries. One of the dictionary object contains another list of dictionaries called ‘endpoints’, which contains all con-

figuration for Traffic Manager end points. JSON representation of the variables below. Traffic manager related variables are explained in the table Traffic manager variables and endpoint related variables in Traffic manager endpoint variables.

```
{
  "trafficmanagers": [
   {
    "endpoints": [
     {
      "name": "eh_automation_tm01_ep01",
      "properties": {
       "endpointLocation": "East Us",
       "endpointStatus": "Enabled",
       "priority": "1",
       "target": "ehautomationdmzlb01.eastus.cloudapp.azure.com",
       "targetResourceId": "/subscriptions/b84a78c3-bc63-4953-99ec-
184700b37905/resourceGroups/eh_automation_rg01/providers/Mi-
crosoft.Network/publicIPAddresses/eh_automation_dmz01lb01_ip01",
       "weight": "1"
      },
      "type": "Microsoft.Network/trafficManagerProfiles/azureEndpoints"
     },
     {
      "name": "eh_automation_tm01_ep02",
      "properties": {
       "endpointLocation": "West Europe",
       "endpointStatus": "Enabled",
       "priority": "2",
       "target": "ehautomationdmzlb02.westeurope.cloudapp.azure.com",
       "targetResourceId": "/subscriptions/b84a78c3-bc63-4953-99ec-
184700b37905/resourceGroups/eh_automation_rg02/providers/Mi-
crosoft.Network/publicIPAddresses/eh_automation_dmz02lb01_ip01",
       "weight": "1"
      },
      "type": "Microsoft.Network/trafficManagerProfiles/azureEndpoints"
     }
    ],
    "location": "eastus",
    "name": "eh-automation-tm01",
    "port": "80",
    "requestpath": "/",
    "resource_group": "eh_automation_rg01",
    "trafficroutingmethod": "Priority",
    "ttl": "300",
    "virtual_network": "eh_automation_vn01"
   }
  ]
}
```

Table 17 Traffic manager variables

VARIABLE	EXPLANATION
RESOURCE_GROUP	Resource group the Traffic Manager is to be associated with
LOCATION	Location of the Traffic Manager
NAME	Name of the Traffic Manager
TRAFFICROUTINGMETHOD	Traffic Routing Method
TTL	Time to live for the DNS record
PORT	TCP port to monitor
REQUESTPATH	Request path to monitor
ENDPOINTS	List of dictionaries containing configuration for endpoints

(Create a Traffic Manager profile, 2017)

Table 18 Traffic manager endpoint variables

VARIABLE	EXPLANATION
NAME	Name of the endpoint object
TYPE	Type of the endpoint
ENDPOINTSTATUS	Status of the endpoint
TARGETRESOURCEID	Resource ID of the endpoint public IP-address
TARGET	FQDN of the endpoint
WEIGHT	Weight value of the end point
PRIORITY	Priority of the end point. Lowest value is the preferred end point
ENDPOINTLOCATION	Location of the end point in specific format

(Traffic Manager endpoint monitoring, 2017) (Create a Traffic Manager profile, 2017)

5 Verification

The screenshots in this chapter are taken from Azure Portal after the automation tasks have been run. The tasks and variables for deploying the resources have been described in the previous chapter. The test organization name used in the thesis has

been blacked out from the screenshots. The resource groups have been successfully provisioned in the figure Resource Groups below.

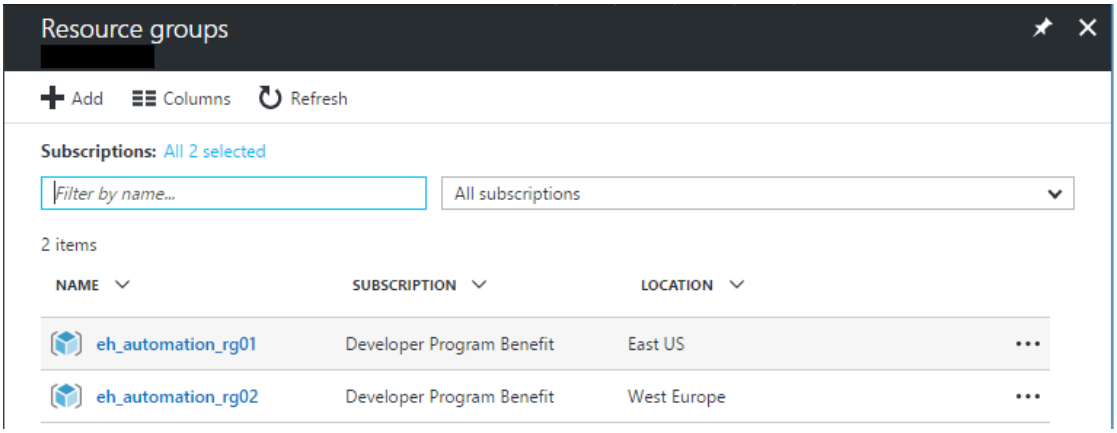


Figure 4 Resource Groups

Virtual networks and subnets have been successfully provisioned as specified in the figures Virtual Networks, VNET 01 Subnets and VNET 02 Subnets below.

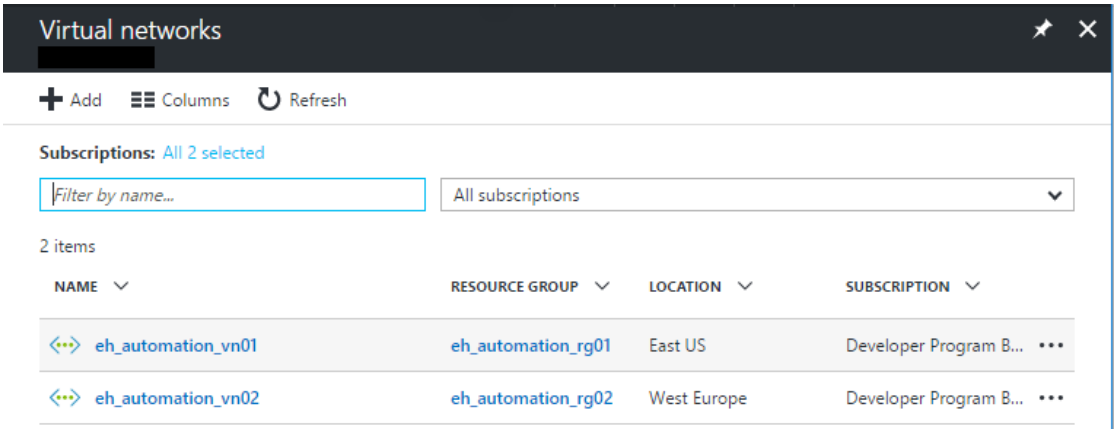


Figure 5 Virtual Networks

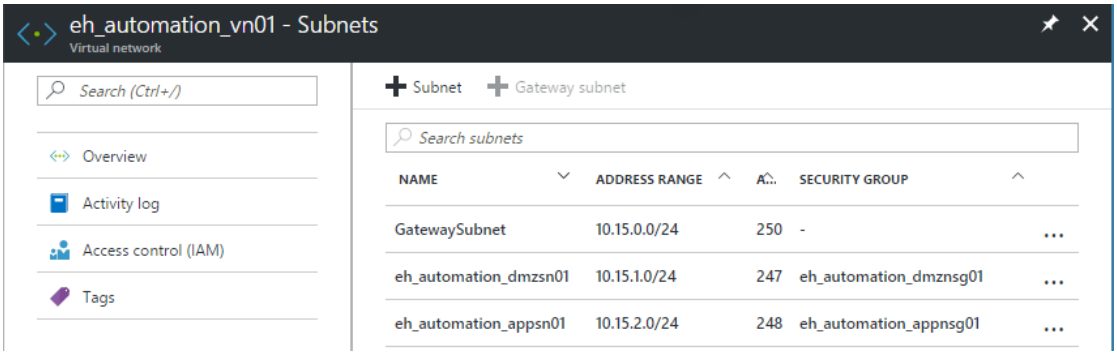


Figure 6 VNET 01 Subnets

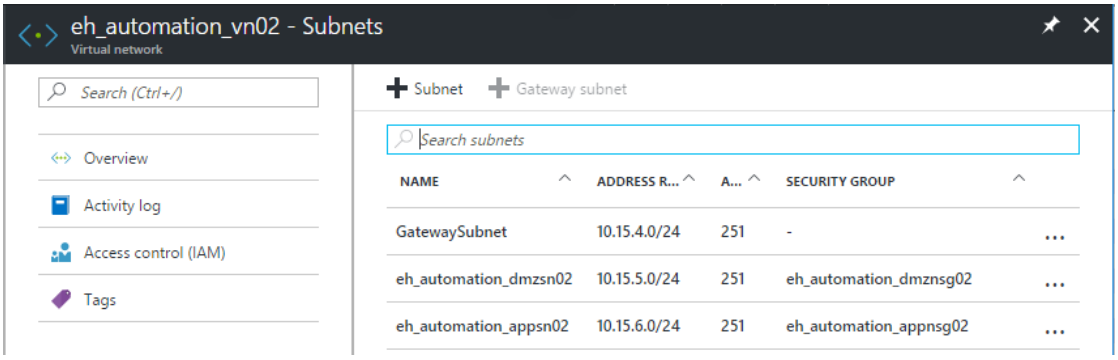


Figure 7 VNET 02 Subnets

The Network Security Groups and all the rules they contain have been successfully provisioned in the figures Network Security Groups, DMZ 01 Network Security Group, DMZ 02 Network Security Group, APP 01 Network Security Group and APP 02 Network Security Group below.

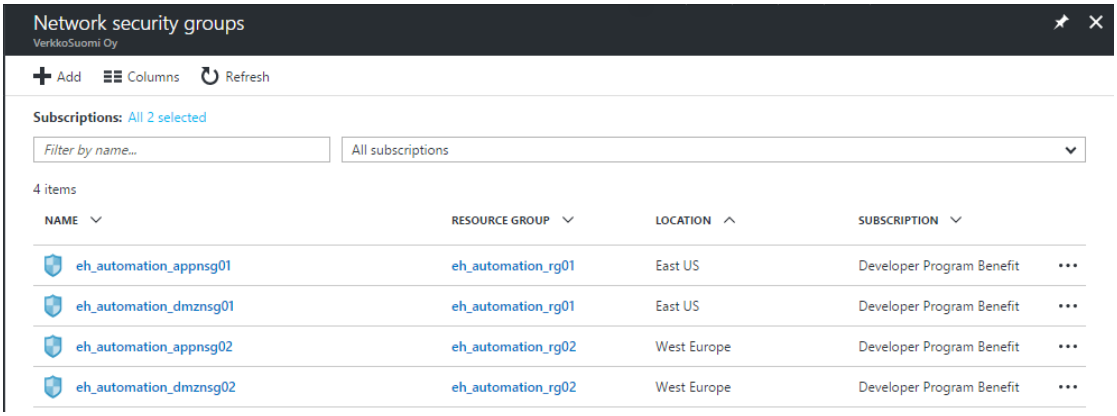


Figure 8 Network Security Groups

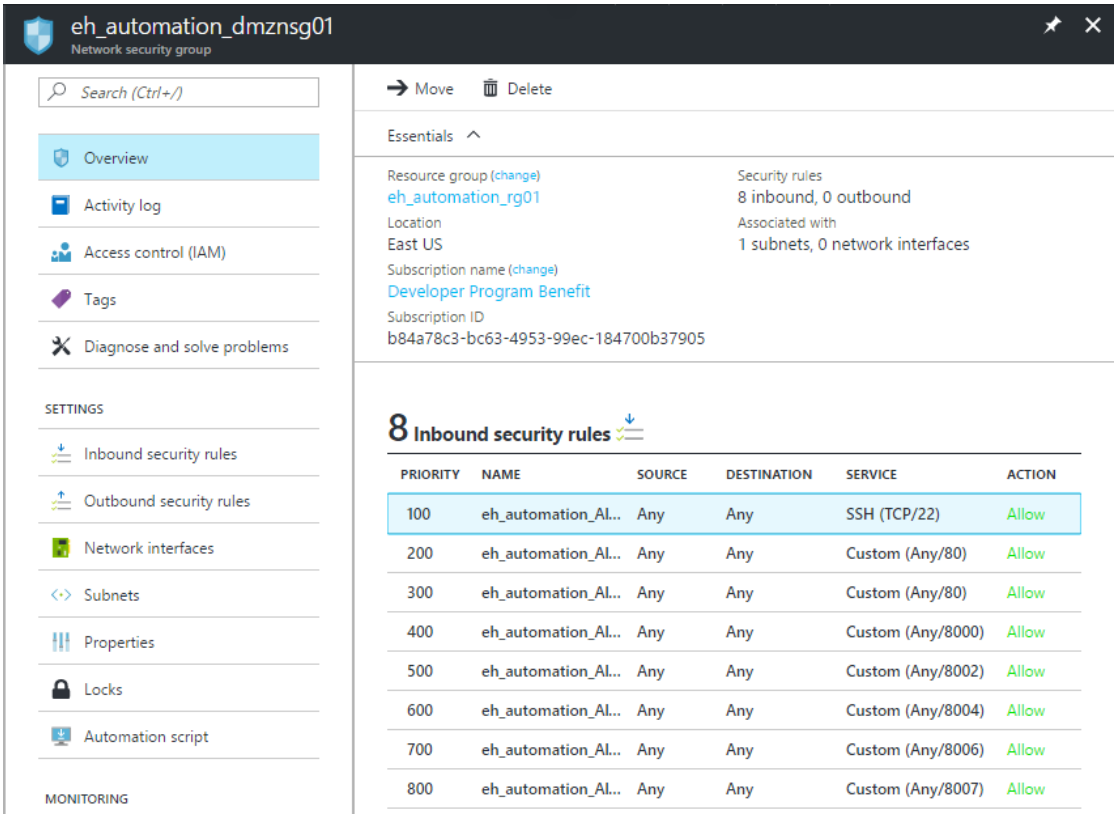


Figure 9 DMZ 01 Network Security Group

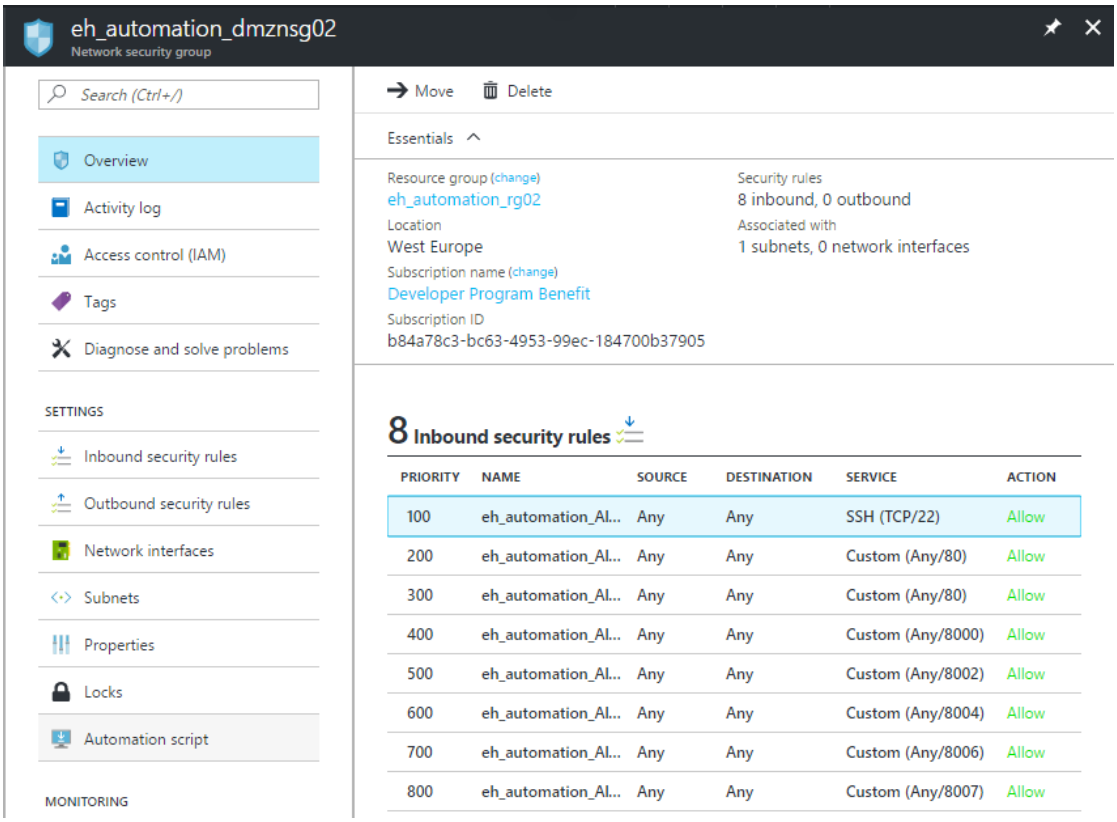
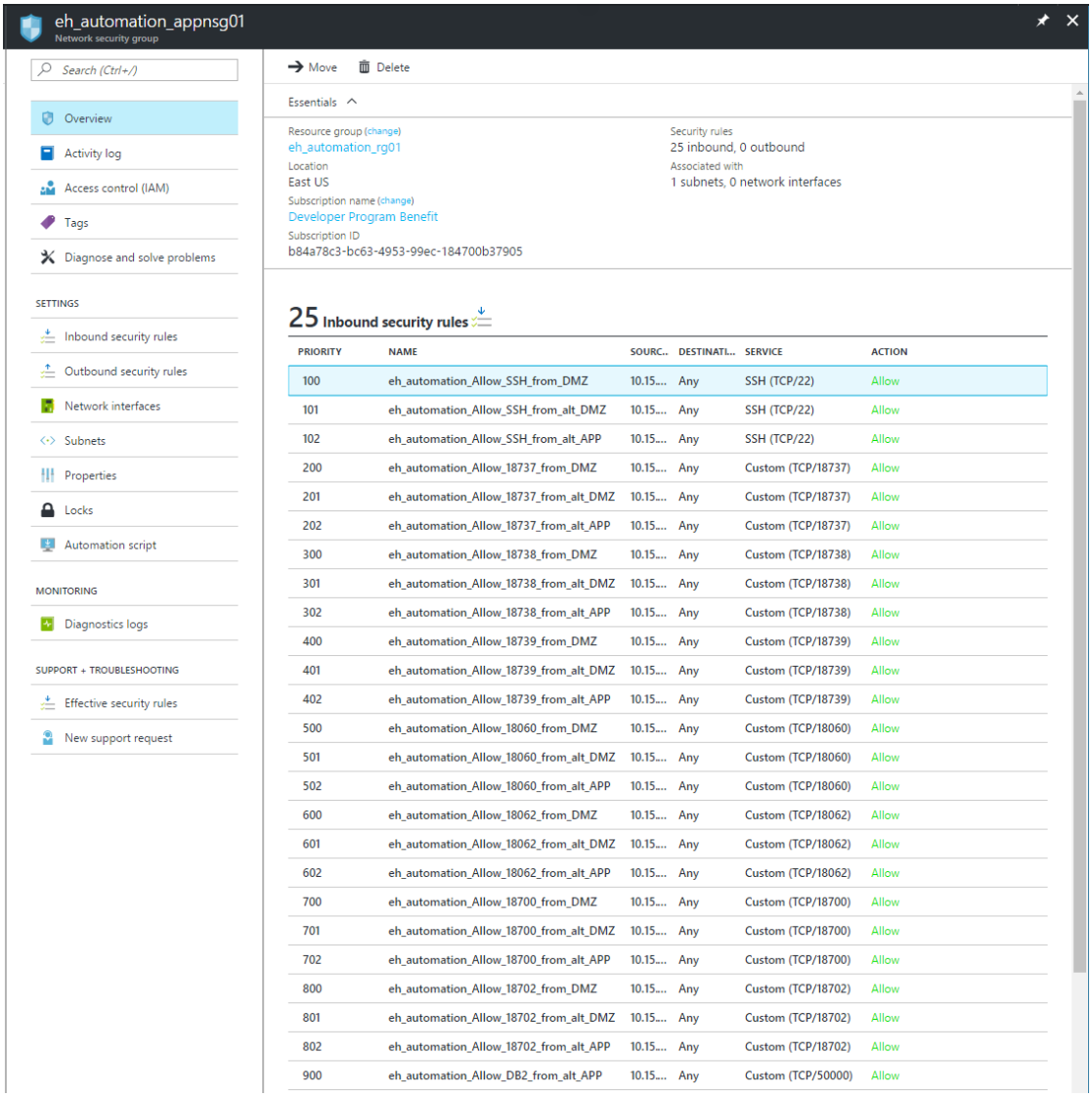
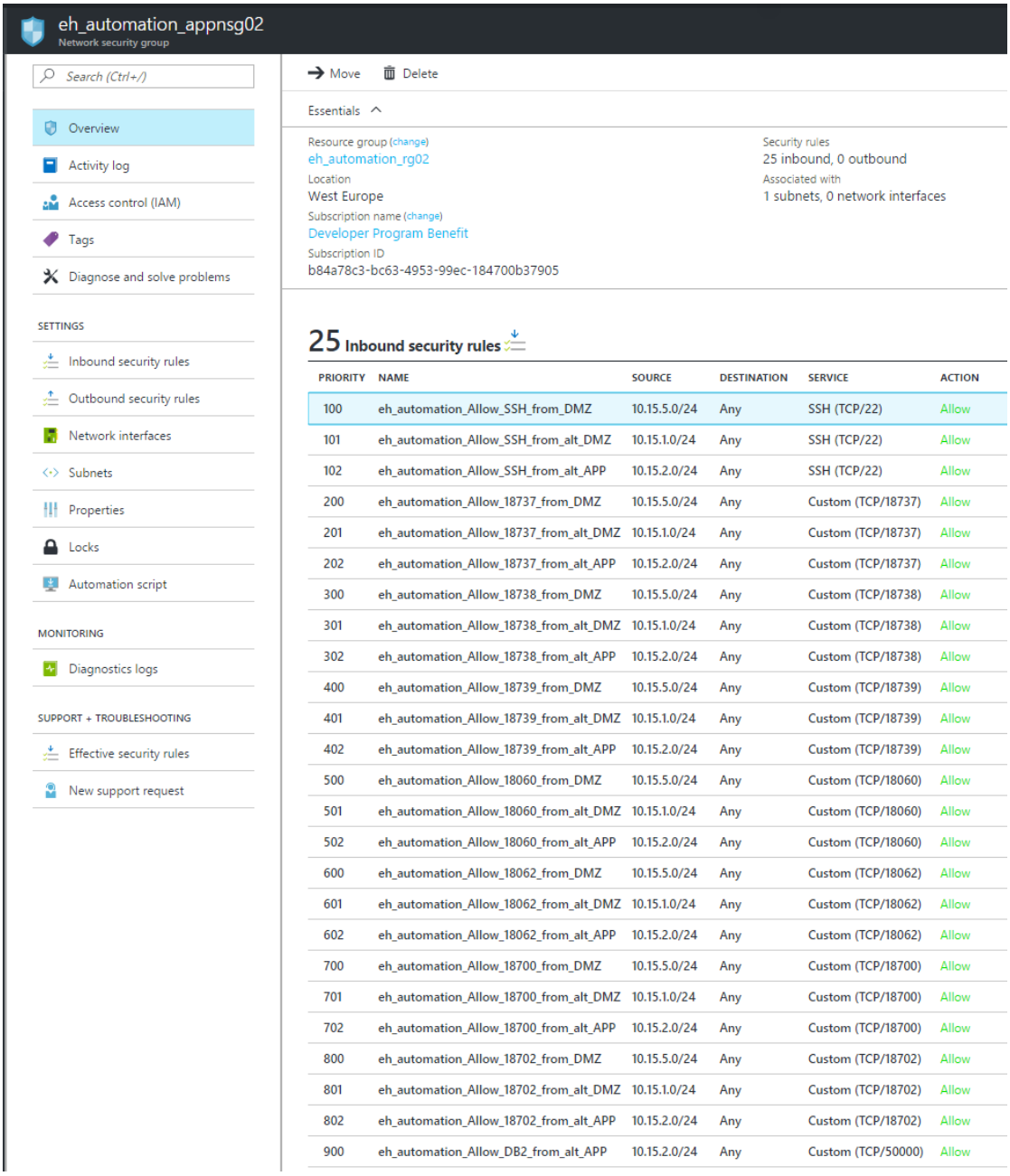


Figure 10 DMZ 02 Network Security Group



PRIORITY	NAME	SOURC..	DESTINATI...	SERVICE	ACTION
100	eh_automation_Allow_SSH_from_DMZ	10.15....	Any	SSH (TCP/22)	Allow
101	eh_automation_Allow_SSH_from_alt_DMZ	10.15....	Any	SSH (TCP/22)	Allow
102	eh_automation_Allow_SSH_from_alt_APP	10.15....	Any	SSH (TCP/22)	Allow
200	eh_automation_Allow_18737_from_DMZ	10.15....	Any	Custom (TCP/18737)	Allow
201	eh_automation_Allow_18737_from_alt_DMZ	10.15....	Any	Custom (TCP/18737)	Allow
202	eh_automation_Allow_18737_from_alt_APP	10.15....	Any	Custom (TCP/18737)	Allow
300	eh_automation_Allow_18738_from_DMZ	10.15....	Any	Custom (TCP/18738)	Allow
301	eh_automation_Allow_18738_from_alt_DMZ	10.15....	Any	Custom (TCP/18738)	Allow
302	eh_automation_Allow_18738_from_alt_APP	10.15....	Any	Custom (TCP/18738)	Allow
400	eh_automation_Allow_18739_from_DMZ	10.15....	Any	Custom (TCP/18739)	Allow
401	eh_automation_Allow_18739_from_alt_DMZ	10.15....	Any	Custom (TCP/18739)	Allow
402	eh_automation_Allow_18739_from_alt_APP	10.15....	Any	Custom (TCP/18739)	Allow
500	eh_automation_Allow_18060_from_DMZ	10.15....	Any	Custom (TCP/18060)	Allow
501	eh_automation_Allow_18060_from_alt_DMZ	10.15....	Any	Custom (TCP/18060)	Allow
502	eh_automation_Allow_18060_from_alt_APP	10.15....	Any	Custom (TCP/18060)	Allow
600	eh_automation_Allow_18062_from_DMZ	10.15....	Any	Custom (TCP/18062)	Allow
601	eh_automation_Allow_18062_from_alt_DMZ	10.15....	Any	Custom (TCP/18062)	Allow
602	eh_automation_Allow_18062_from_alt_APP	10.15....	Any	Custom (TCP/18062)	Allow
700	eh_automation_Allow_18700_from_DMZ	10.15....	Any	Custom (TCP/18700)	Allow
701	eh_automation_Allow_18700_from_alt_DMZ	10.15....	Any	Custom (TCP/18700)	Allow
702	eh_automation_Allow_18700_from_alt_APP	10.15....	Any	Custom (TCP/18700)	Allow
800	eh_automation_Allow_18702_from_DMZ	10.15....	Any	Custom (TCP/18702)	Allow
801	eh_automation_Allow_18702_from_alt_DMZ	10.15....	Any	Custom (TCP/18702)	Allow
802	eh_automation_Allow_18702_from_alt_APP	10.15....	Any	Custom (TCP/18702)	Allow
900	eh_automation_Allow_DB2_from_alt_APP	10.15....	Any	Custom (TCP/50000)	Allow

Figure 11 APP 01 Network Security Group



PRIORITY	NAME	SOURCE	DESTINATION	SERVICE	ACTION
100	eh_automation_Allow_SSH_from_DMZ	10.15.5.0/24	Any	SSH (TCP/22)	Allow
101	eh_automation_Allow_SSH_from_alt_DMZ	10.15.1.0/24	Any	SSH (TCP/22)	Allow
102	eh_automation_Allow_SSH_from_alt_APP	10.15.2.0/24	Any	SSH (TCP/22)	Allow
200	eh_automation_Allow_18737_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18737)	Allow
201	eh_automation_Allow_18737_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18737)	Allow
202	eh_automation_Allow_18737_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18737)	Allow
300	eh_automation_Allow_18738_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18738)	Allow
301	eh_automation_Allow_18738_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18738)	Allow
302	eh_automation_Allow_18738_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18738)	Allow
400	eh_automation_Allow_18739_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18739)	Allow
401	eh_automation_Allow_18739_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18739)	Allow
402	eh_automation_Allow_18739_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18739)	Allow
500	eh_automation_Allow_18060_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18060)	Allow
501	eh_automation_Allow_18060_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18060)	Allow
502	eh_automation_Allow_18060_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18060)	Allow
600	eh_automation_Allow_18062_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18062)	Allow
601	eh_automation_Allow_18062_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18062)	Allow
602	eh_automation_Allow_18062_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18062)	Allow
700	eh_automation_Allow_18700_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18700)	Allow
701	eh_automation_Allow_18700_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18700)	Allow
702	eh_automation_Allow_18700_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18700)	Allow
800	eh_automation_Allow_18702_from_DMZ	10.15.5.0/24	Any	Custom (TCP/18702)	Allow
801	eh_automation_Allow_18702_from_alt_DMZ	10.15.1.0/24	Any	Custom (TCP/18702)	Allow
802	eh_automation_Allow_18702_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/18702)	Allow
900	eh_automation_Allow_DB2_from_alt_APP	10.15.2.0/24	Any	Custom (TCP/50000)	Allow

Figure 12 APP 02 Network Security Group

The VPN gateways and the connections between them have been successfully provisioned in the figures VPN Gateways, VPN Gateway 01 Configuration, VPN Gateway 01 Connections, VPN Gateway 02 Configuration and VPN Gateway 02 Connections below.

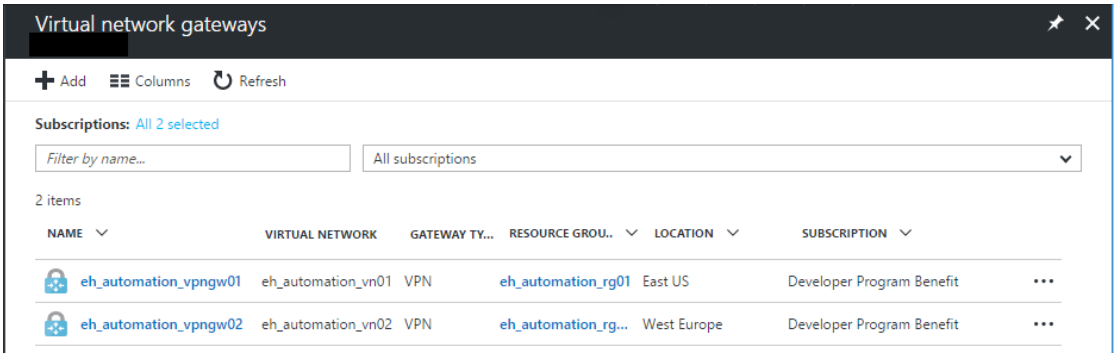


Figure 13 VPN Gateways

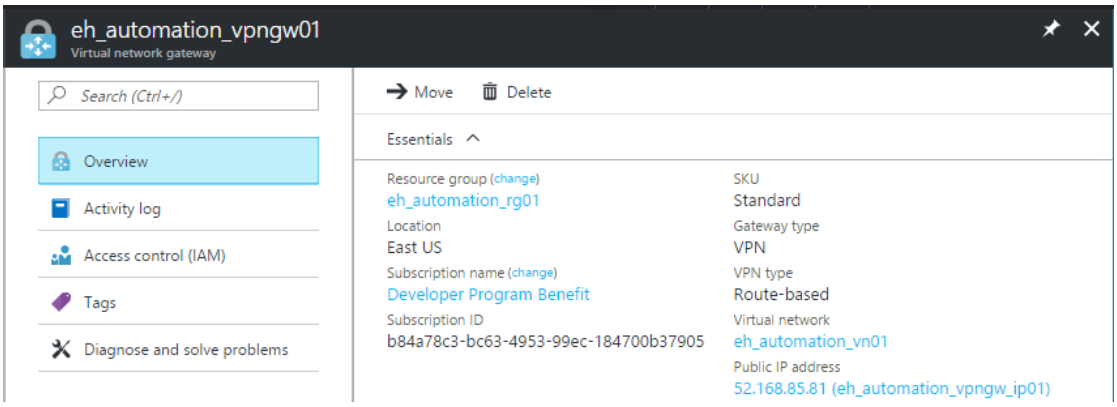


Figure 14 VPN Gateway 01 Configuration

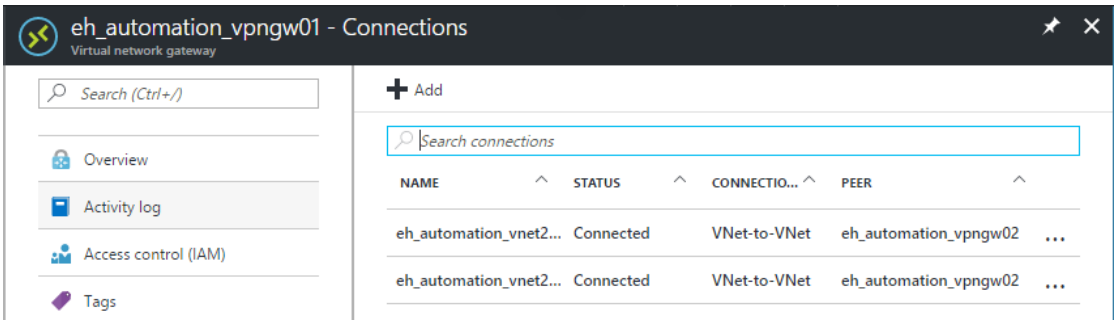


Figure 15 VPN Gateway 01 Connections

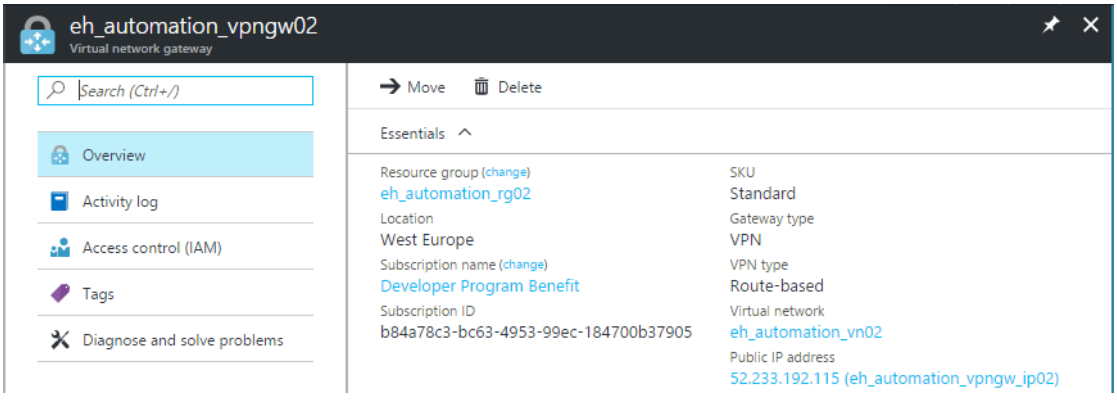


Figure 16 VPN Gateway 02 Configuration

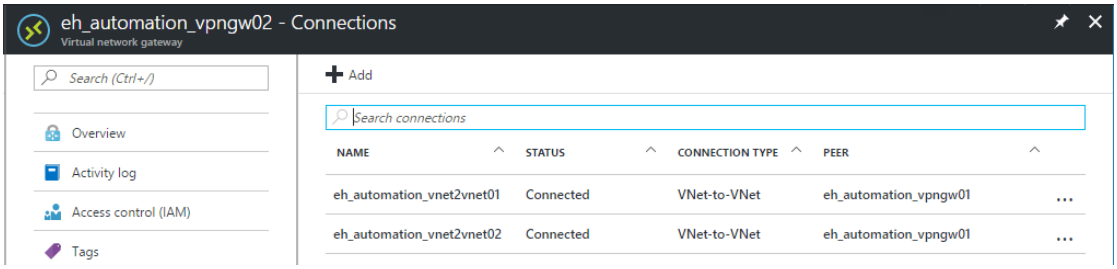


Figure 17 VPN Gateway 02 Connections

The availability groups have been successfully provisioned in the figure Availability Sets below.

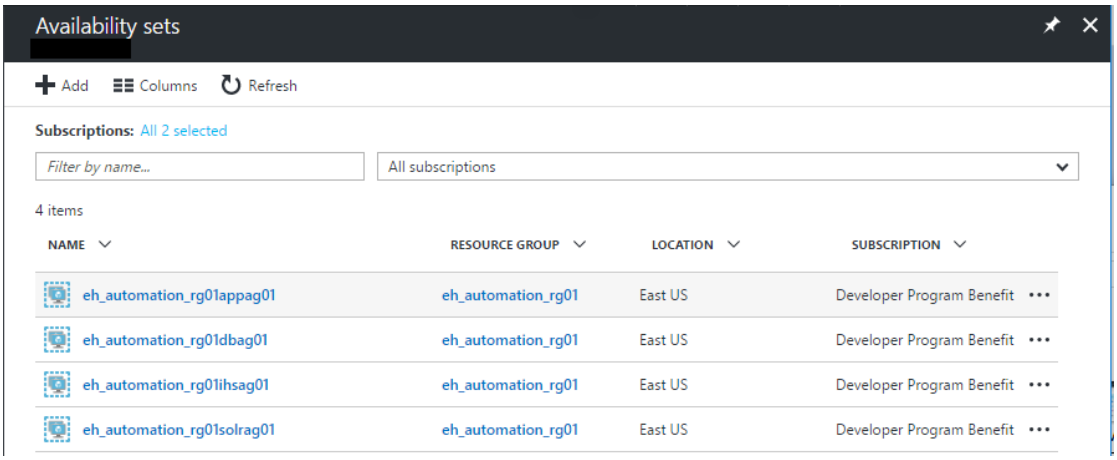


Figure 18 Availability Sets

The Network Interface Cards have been provisioned successfully as specified in the figures Network Interface Cards, IHS01 Network Interface Card, WAS01 Network Interface Card, SOLR01 Network Interface Card and DB01 Network Interface Card below.

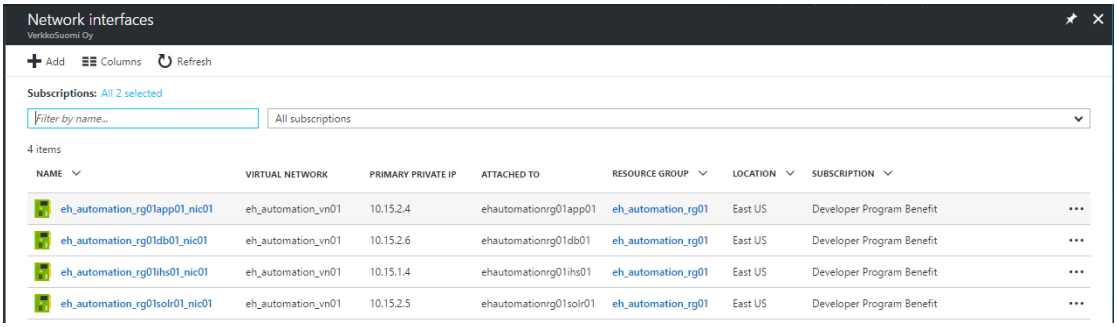


Figure 19 Network Interface Cards

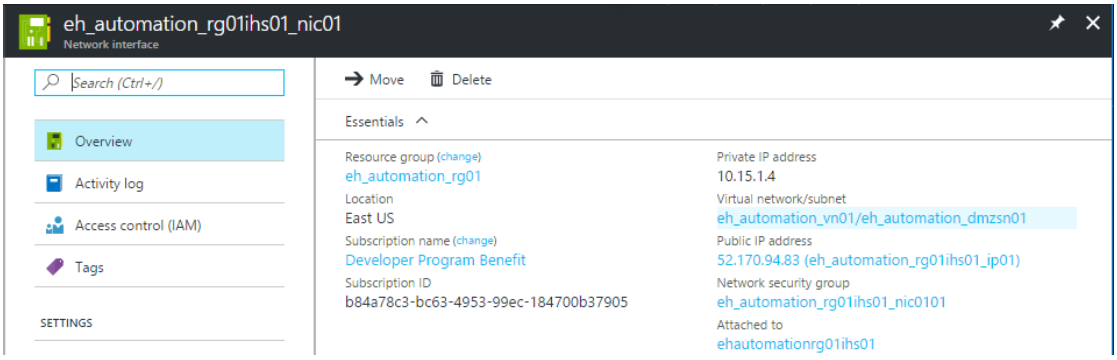


Figure 20 IHS01 Network Interface Card

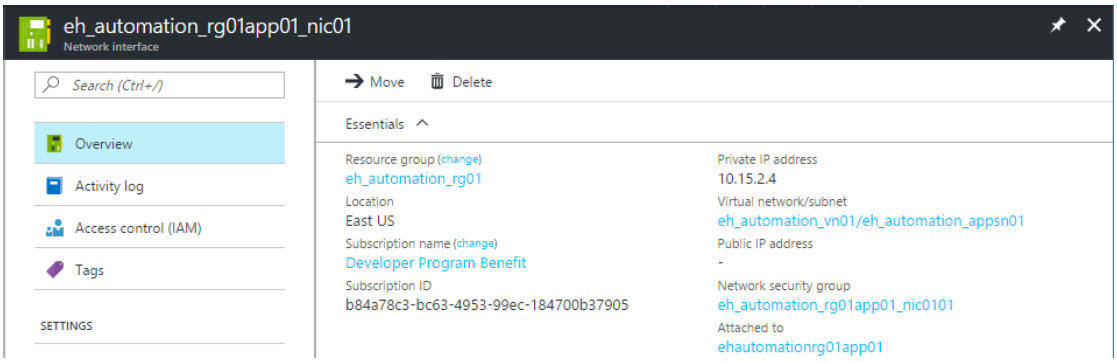


Figure 21 WAS01 Network Interface Card

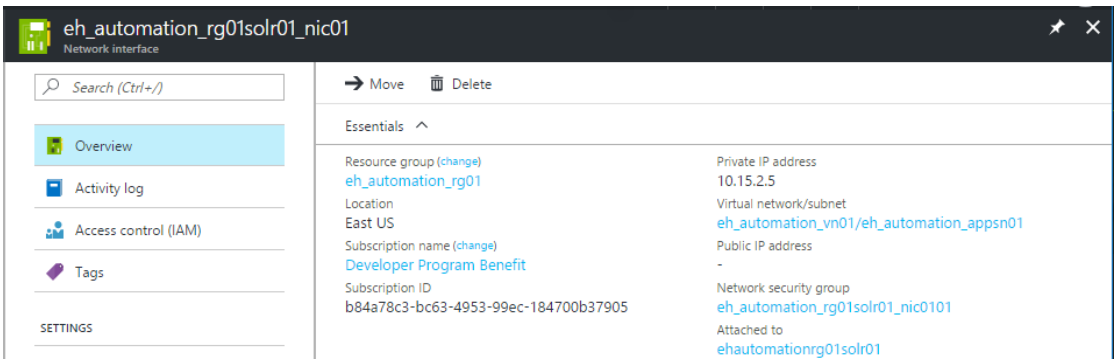


Figure 22 SOLR01 Network Interface Card

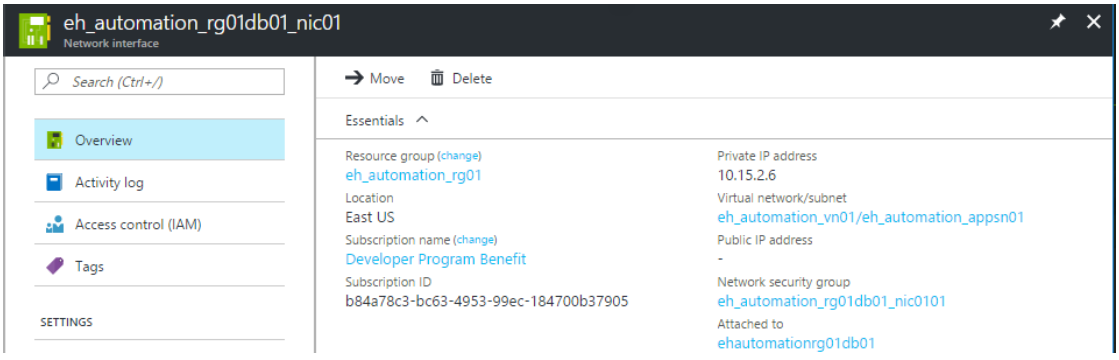


Figure 23 DB01 Network Interface Card

The public IP addresses have been successfully provisioned as specified in the figure Public IP addresses below.

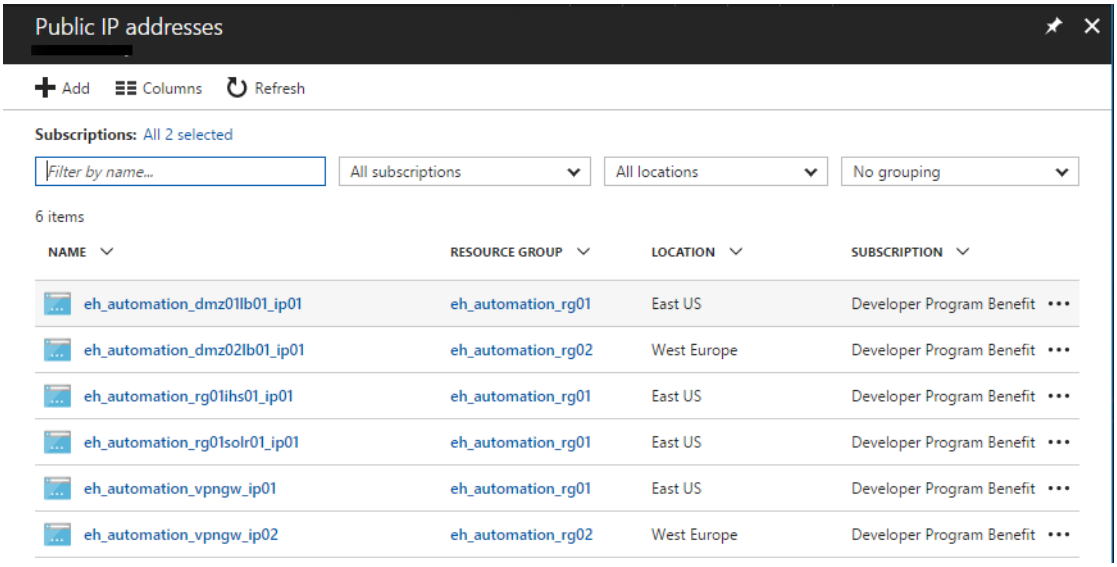


Figure 24 Public IP addresses

The load balancers have been provisioned as specified in the figures Load balancers, DMZ01 Load Balancer 01, DMZ 02 Load Balancer 01, APP01 Load Balancer 01 below.

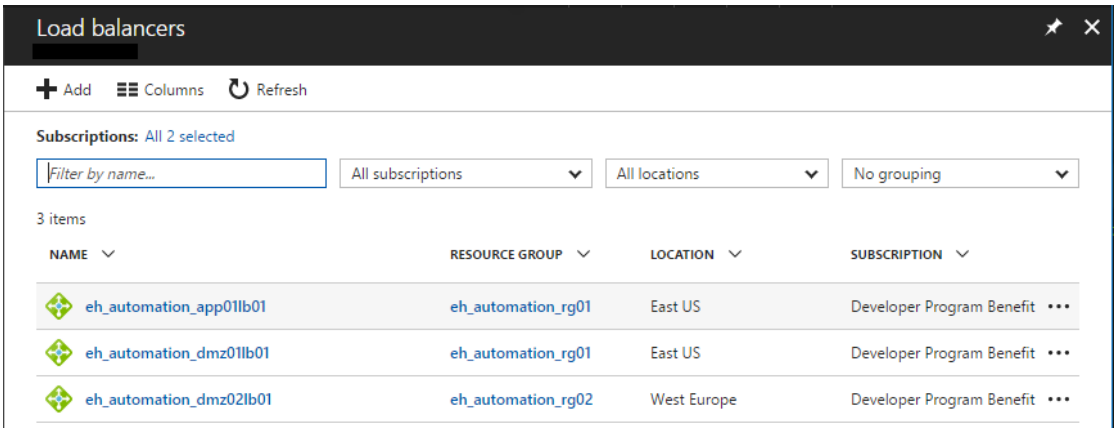


Figure 25 Load balancers

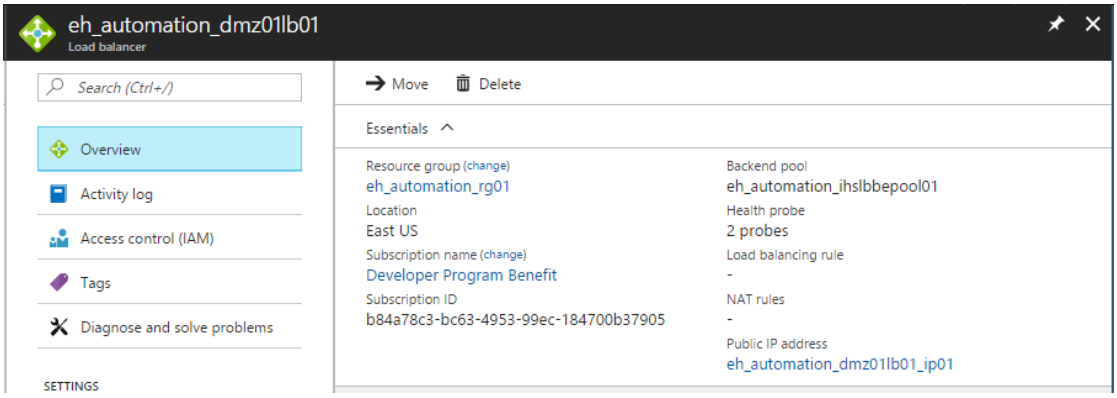


Figure 26 DMZ01 Load Balancer 01

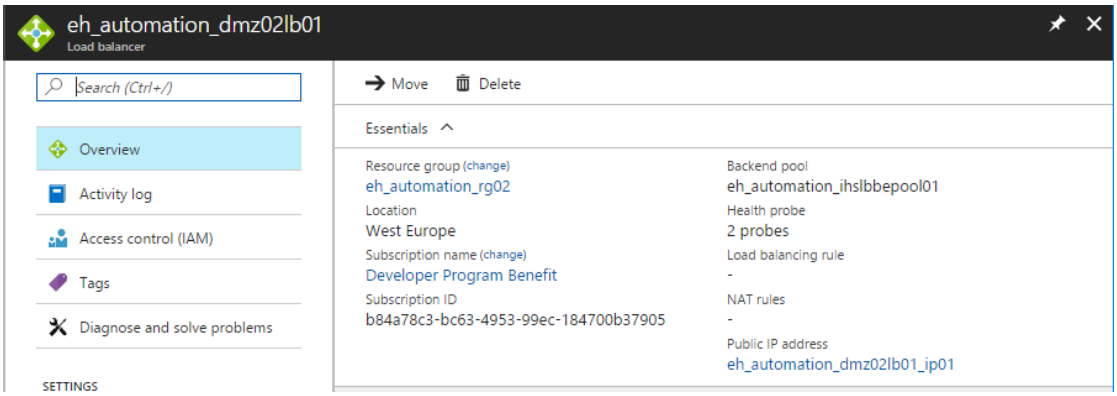


Figure 27 DMZ 02 Load Balancer 01

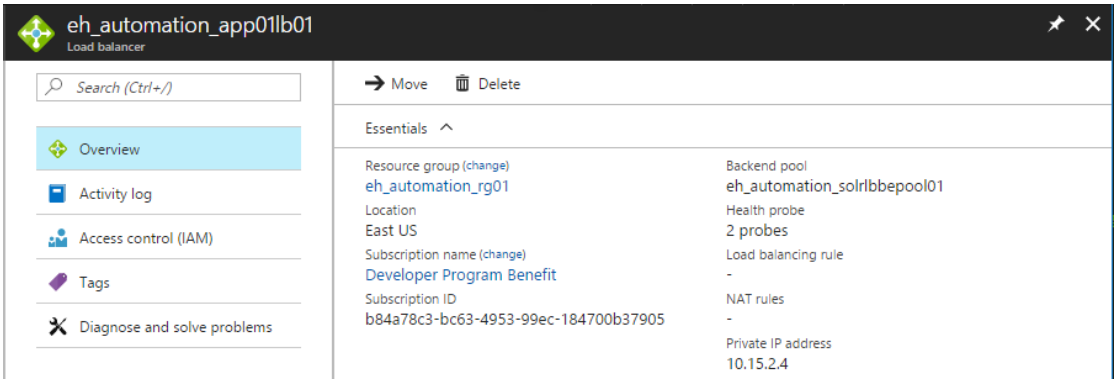


Figure 28 APP01 Load Balancer 01

Traffic managers have been provisioned as specified in the figures Traffic Managers, Traffic Manager 01 below.

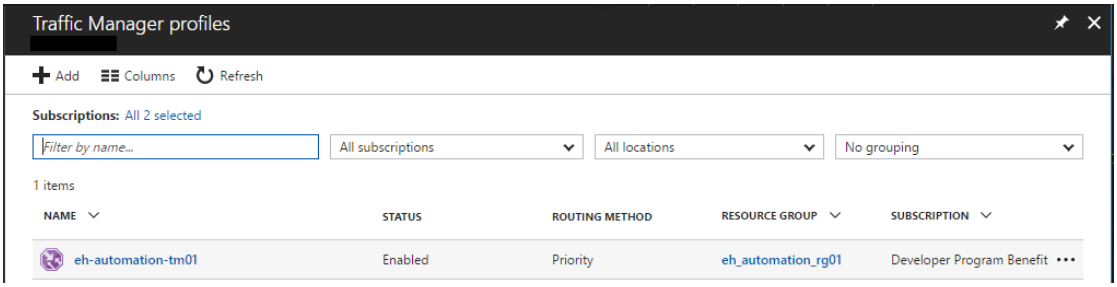


Figure 29 Traffic Managers

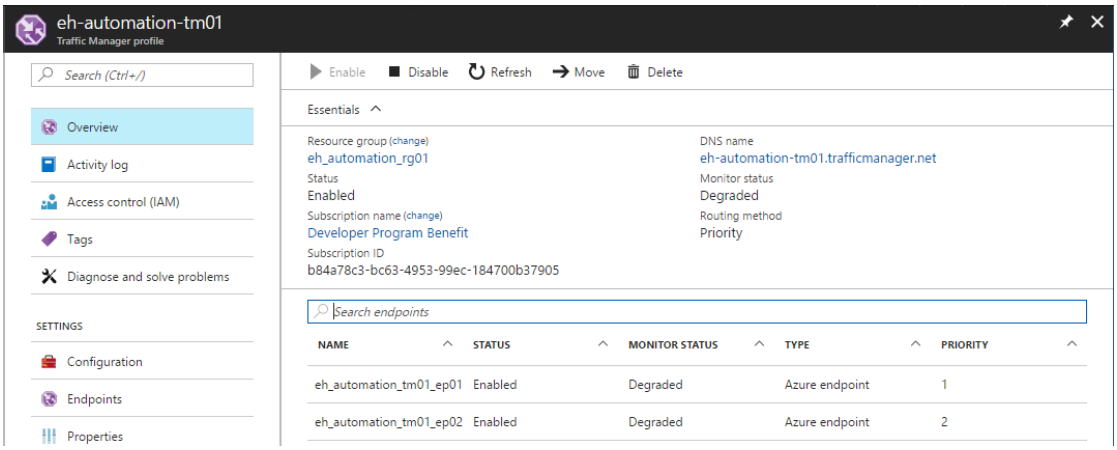


Figure 30 Traffic Manager 01

The logic of the Network Security Group rules was verified working using SSH to connect to the virtual machines. The IP addresses in the figures below do not necessarily match the IP addresses in the previous screen shots since the IP addresses are dynamic and the following tests were performed on a later time.

Figure SSH connection to IHS demonstrates a SSH connection to the IHS server from the Internet. The connection is successful, as the rules allow TCP port 22 connections to DMZ subnet from everywhere. This could be further restricted so that SSH connections are allowed only from certain IP address ranges.

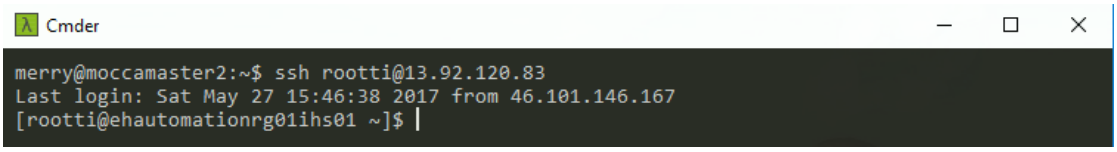


Figure 31 SSH connection to IHS

SSH connection from IHS to private IP address of the SOLR server is also successful as seen on the figure SSH connection to SOLR from IHS, because TCP port 22 is allowed from DMZ subnet to APP subnet.

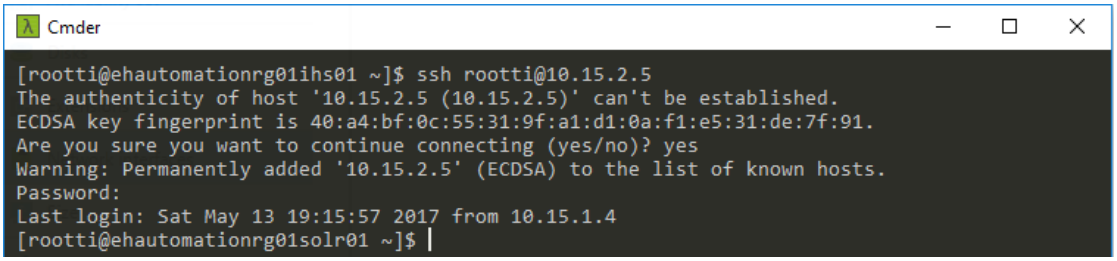


Figure 32 SSH Connection to SOLR from IHS

SSH connection from the Internet to the public IP address of the SOLR server fails as expected as seen on the figure SSH connection to SOLR from the Internet. The rules do not allow TCP port 22 to APP subnet directly from the Internet.

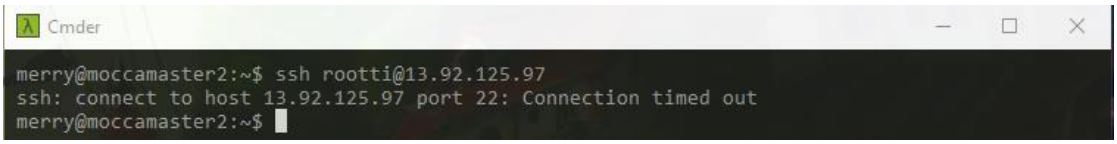


Figure 33 SSH connection to SOLR from the Internet

To verify VPN gateway connections and related Network Security Group rules were working as intended, another Linux based virtual machine was manually deployed to the eh_automation_rg02 resource group. The figure SSH between VNETs displays that the SSH connection is successful between APP01 (10.15.2.0/24) and APP02 (10.15.6.0/24) subnets which reside in different Virtual Networks.

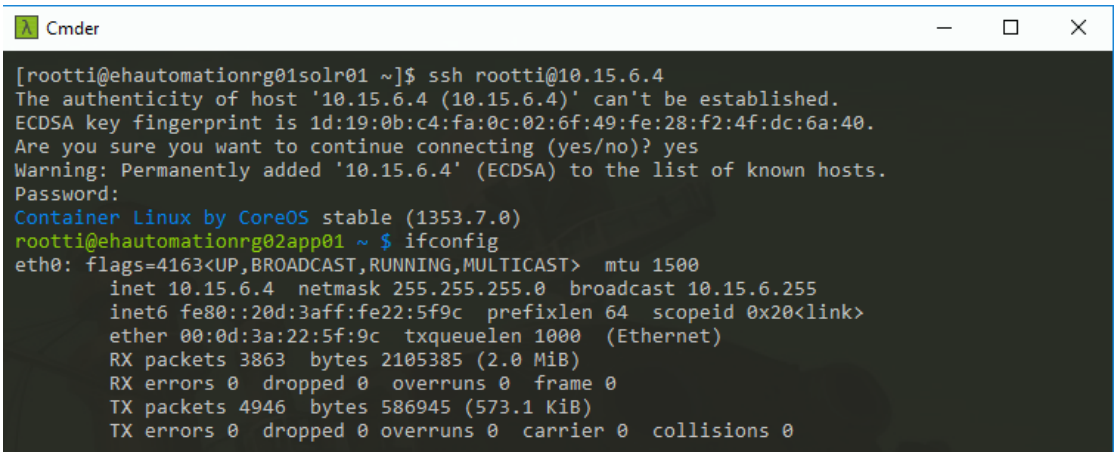


Figure 34 SSH between VNETs

6 Conclusions

Automation of the Microsoft Azure server and network infrastructure using the chosen automation tool proved to be much more time consuming than assumed at

first and for this reason, IBM WebSphere Commerce software stack installation and configuration was left out of the scope of the thesis. For this reason, a lot of the testing could not be done, since the load balancers and traffic managers did not have back end services to monitor. Once the IBM WebSphere Commerce software stack will be installed and configured at a later time, the traffic manager and load balancer configuration will need to be verified working and might need some tuning. This should mainly be a matter of only changing some configuration parameters however.

Biggest factor for the work load was that not all of the Microsoft Azure's IaaS components could be provisioned by using the ready modules of the automation tool or some modules which could be used to provision different Azure components were missing important parameters and the modules could not be utilized for provisioning the component in question. Many of the components therefore had to be provisioned by using Azure Resource Manager templates extracted from Microsoft Azure Portal by formatting them in automation tool compatible format, removing the unecessary parts of the templates and turning some of the template parameters into variables for easier scaling when used with the automation tool.

Some aspects of the automation solution could be refactored to allow easier horizontal scaling and make some aspects more consistent with the rest of the solution, for example storage groups could have their own list of dictionaries and gateway connections could be turned into list of dictionaries so that more than two gateways configured to connect to each other be specified should the need arise. When creating virtual machines for IBM WebSphere Commerce, additional data disks should be planned and attached to the VMs as per customer needs.

Potentially, when utilizing the Microsoft Azure cloud, the server and network infrastructure is possible to be provisioned in matter of hours versus days/weeks and the automation solution makes it easier to create environments that resemble each other more closely, thus eliminating surprises in the release process. Further automating the solution to include software installation and configuration could be beneficial since it would allow flexibility to increase capacity in case for example customer knows there is going to be a significant increase of users in the web store due to a marketing campaign.

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