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GÉANT & Microsoft ExpressRoute Request and Configuration manual

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Abstract
Future programmable networks must be highly agile and dynamic allowing end-users to control their traffic. While providing on-demand connectivity, they must also be scalable and elastic. For these purposes, the zero touch provisioning concept needs to be extended to a multi-domain network level where the process of automation can be based primarily on NFV.

Document Revision History

Version	Date	Description of change	Person
0.01	2016-07-01	Very first draft based on SURFnet's version 0.98 – will need to check and change a lot more details…	Migiel de Vos
0.02	2016-08-09	Input from first tests with direct MS ExpressRoute via GÉANT	Migiel de Vos
0.03	2016-08-19	Review by Gerben van Malenstein	Migiel de Vos
0.04	2016-08-06	Minor changes, still very drafty	Migiel de Vos

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1 Introduction

GÉANT provides the opportunity to deliver direct connectivity from institutions via the NRENs and GÉANT to Microsoft. Microsoft calls this ExpressRoute; a service that can be delivered on top of point-to-point Layer2 connectivity.

A Microsoft ExpressRoute lets an institution extend their on-premises network into the Microsoft cloud platform, Microsoft Azure, over a dedicated connection. ExpressRoute connections bypass the public internet and enable the institution to use institutional IP address space for the infrastructure hosted at Microsoft. ExpressRoutes are carried over private L2 connections on top of which the institution sets up IP connectivity between the on-premises network and the network hosted at Microsoft. External BGP is used as the routing protocol.

This manual can be (adjusted and) handed over to institutions to setup their ExpressRoute via their NREN to Microsoft. The picture below shows schematically, how connectivity is provided between the institution and Microsoft.

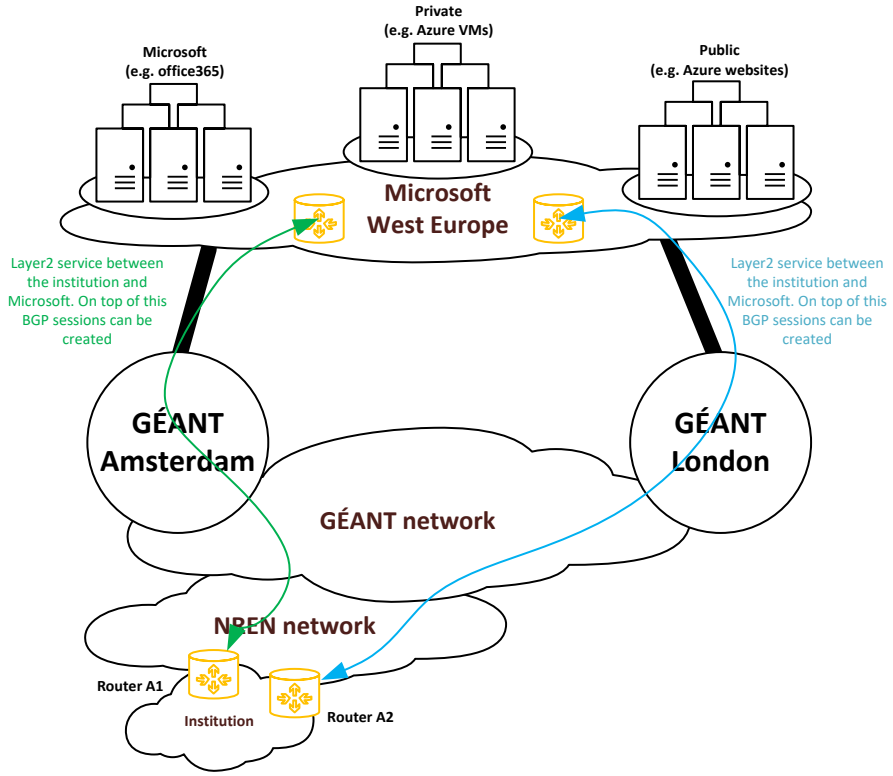


Figure 1: schematic overview of an ExpressRoute connection via GÉANT

Microsoft ExpressRoute has direct connectivity (via NetherLight) to GÉANT in Amsterdam and direct connectivity (via NetherLight) to GÉANT in London. Via these connections redundant services can be provided to all NRENs and their connected institutions in Europe.

The default for delivering ExpressRoute connectivity is by providing two double tagged services (IEEE 802.1ad) between Microsoft and the institution. In this case the outer tag with its payload will be transparently transported between the institution and Microsoft. This means that the NREN, GÉANT and NetherLight will only care about transporting packets between the institution and Microsoft based on the outer tag. Both Microsoft and the institution will handle the inner and outer tags, including the payload for both services (primary and secondary). By default, the primary and secondary VLAN tags are identical. Microsoft recommends to use two customer devices to terminate each of the services.

There are many other solutions available for providing ExpressRoutes to customers. Examples are:

- Accepting the double VLAN tagged from Microsoft as is (described above)
- Stripping the outer tag facing the institution, so that only the inner tag(s) remain
- Retagging VLAN tag(s) such that both services can be terminated on the same institution port/device
- Creating a VRF per ExpressRoute/institution

These options are not discussed in this manual.

This technical manual describes how a system and/or network manager from an institution and/or NREN can request and setup the Microsoft ExpressRoute services via their NREN and GÉANT.

2 Preconditions

To be able to request and setup an ExpressRoute connection via GÉANT institutions should consider the following conditions and requirements:

- You must have a valid Microsoft account with an active Azure subscription
- You must have connectivity to an NREN that is connected to GÉANT
- You need a device that is capable of handling double tagged VLANs (IEEE 802.1ad)[1]
- You must have a router that runs BGP

[1] Other options are possible, but not discussed in the manual

3 Requesting an ExpressRoute via GÉANT

Microsoft and the NREN require the necessary information for setting up the ExpressRoute service. Most information comes from numbering plans and background information of the institution itself, other information such as the Microsoft s-key follows from the application process.

As a guideline for delivering the service we adhere to the following schedule:

	Responsible party	Exp. time
Check availability at your local NREN (optional but recommended)	Institution	1 week
This first check is performed to see whether the preconditions are met to quickly set up the connection. If the conditions are met, the Microsoft s-key can be requested.		
Request s-key at Microsoft *	Institution	1 hour
Fill the application form and send it to your NREN	Institution	1 hour
Determine request and configure end-to-end service	NREN (and GÉANT)	1 week
Configure layer3 connectivity with Microsoft	Institution	1 day
Test connectivity with the Azure platform	Institution	1 day

* note that Microsoft starts billing for the ExpressRoute connectivity as soon as you receive the s-key

The first check at your NREN can be used to speed up the next steps in the procedure. It is wise to use this first check, such that your NREN is able to verify if your institution is ready to request an ExpressRoute. Please send an email to your contact at the NREN with the following information:

- Port name(s)/number(s) where the ExpressRoute service should be delivered
- Preferred bandwidth to Azure

The NREN will confirm whether your institution is ready to start-up the next phase, which is requesting a so-called “S-key” at Microsoft.

The application for requesting an ExpressRoute can be done by using the table/form on the next page. This table contains some fields that are required by GÉANT, Microsoft and your NREN. Only the red fields need to be filled.

Table 1, required information for requesting an ExpressRoute

Azure ExpressRoute GÉANT information:	
NREN Details	
NREN name	
Customer Contact Details	
Customer name	
Technical/Operations Contact name	
Technical contact e-mail	
Technical contact phone number	
GÉANT Service Provider	
Azure	Amsterdam [1]
AWS Account ID or Azure S-Key	xxxxxxxx-xxxx-xxxx-xxxx-xxxxxxxxxxxx
Requested ExpressRoute bandwidth (Gbps)	
Type of service	Redundant
Customer port details	
Primary port details	
Secondary port details (only in case of two ports)	

Please forward this table with the required details to your NREN. The NREN will ask GÉANT to configure the service from ExpressRoute to your NREN, such that the NREN is able to complete the part towards the institution.

After the above is completed, the institution can setup VLAN and BGP configuration and test the connectivity to Azure.

Appendix A Examples

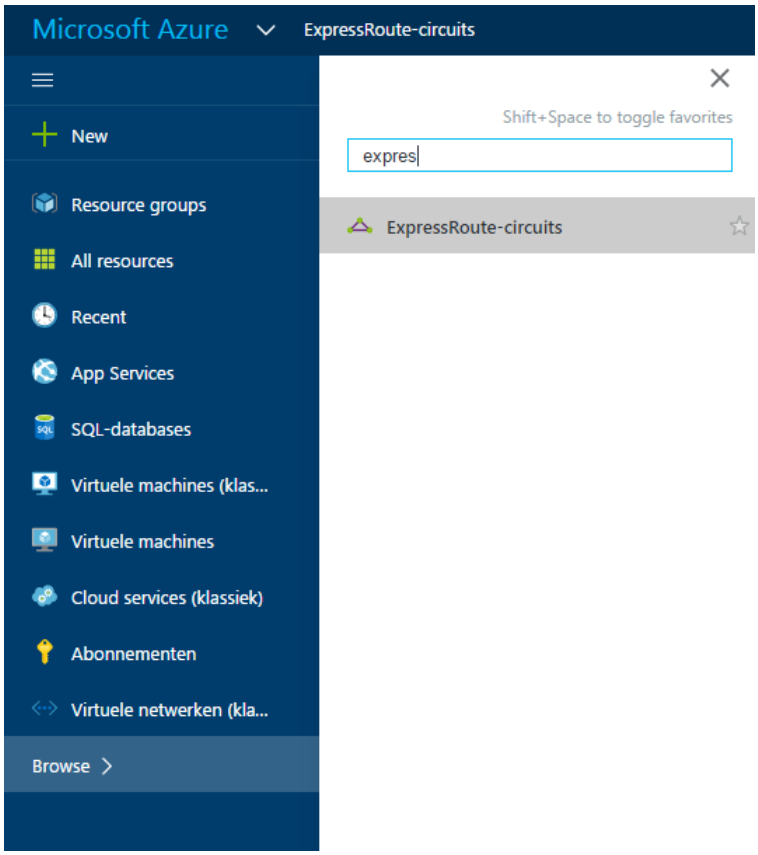
A.1 Requesting ExpressRoute via the Microsoft Portal

To be able to request an s-key you'll need:

- A Microsoft account with an active Azure subscription

A.1.1 Opening the Microsoft Portal to request an ExpressRoute circuit

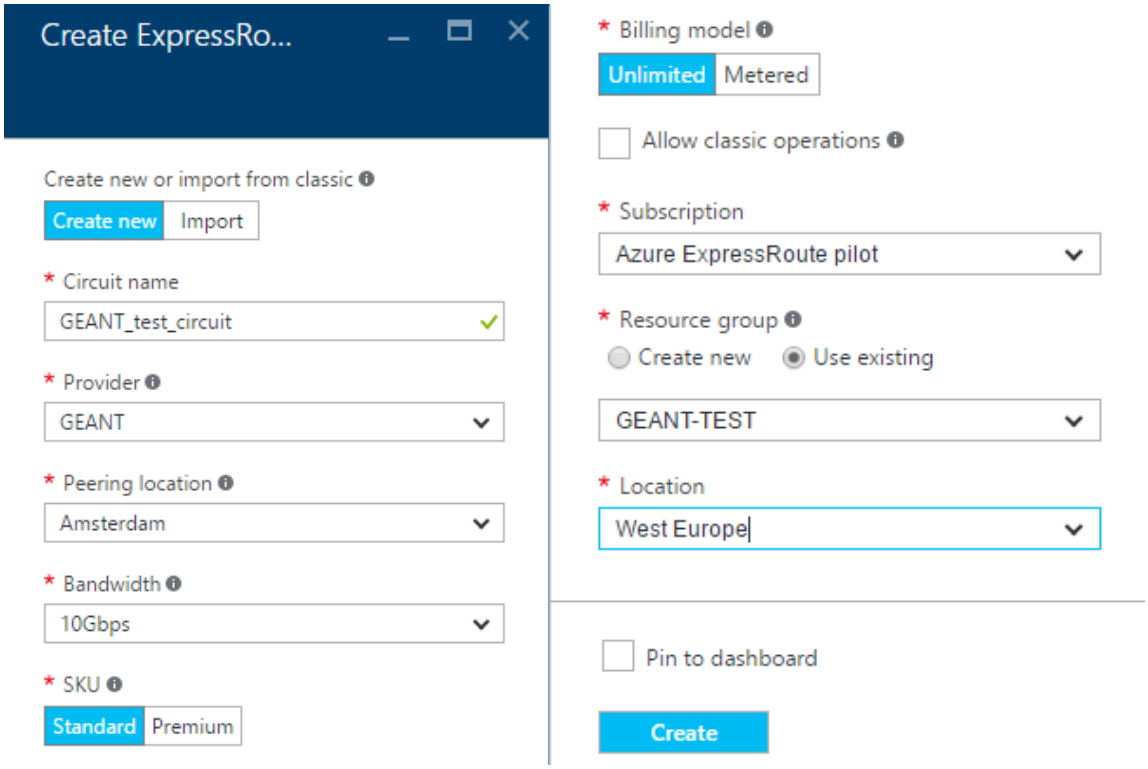
Use your favorite browser to go to **https://portal.azure.com/** and login with your Microsoft Account with Azure subscription. Once logged in click "Browse >", search for "ExpressRoute-circuits" and click on it.



A.1.2 Requesting an S-Key

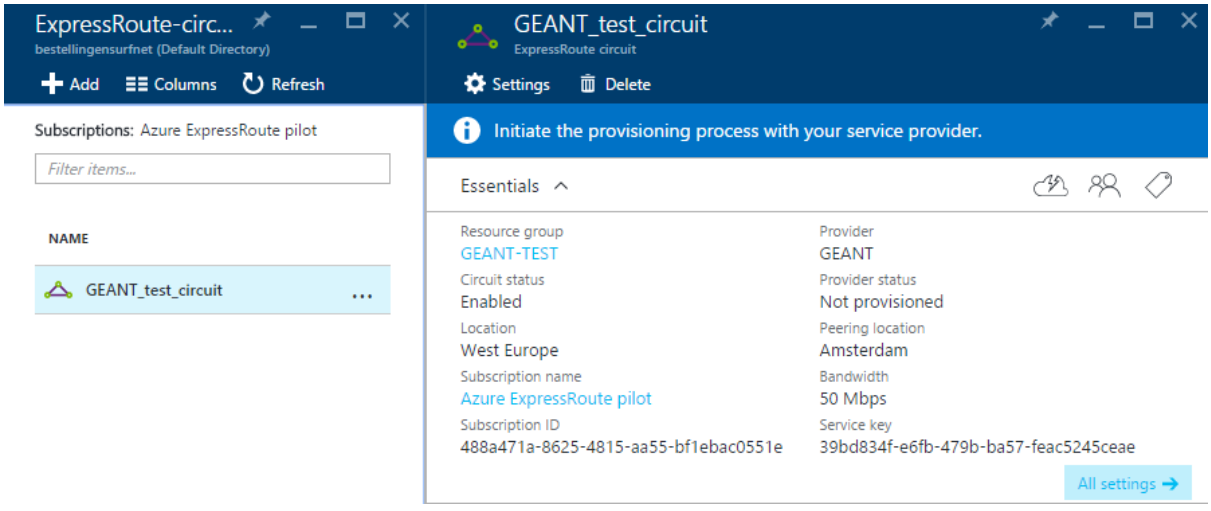
Click on “Add” to request an S-Key.

Enter the details as shown in the picture and modify values to your own needs.



Please note that the peering location will be Amsterdam, but GÉANT will provision the service via Amsterdam and London to other locations in Europe. This is done to create resiliency for the ExpressRoute services.

When you are ready click on “Create”. Please note that Microsoft starts billing from this moment. In the next screen you’ll find the Service Key. Using this key you should be able to fill the application for requesting an ExpressRoute and send this to your NREN.



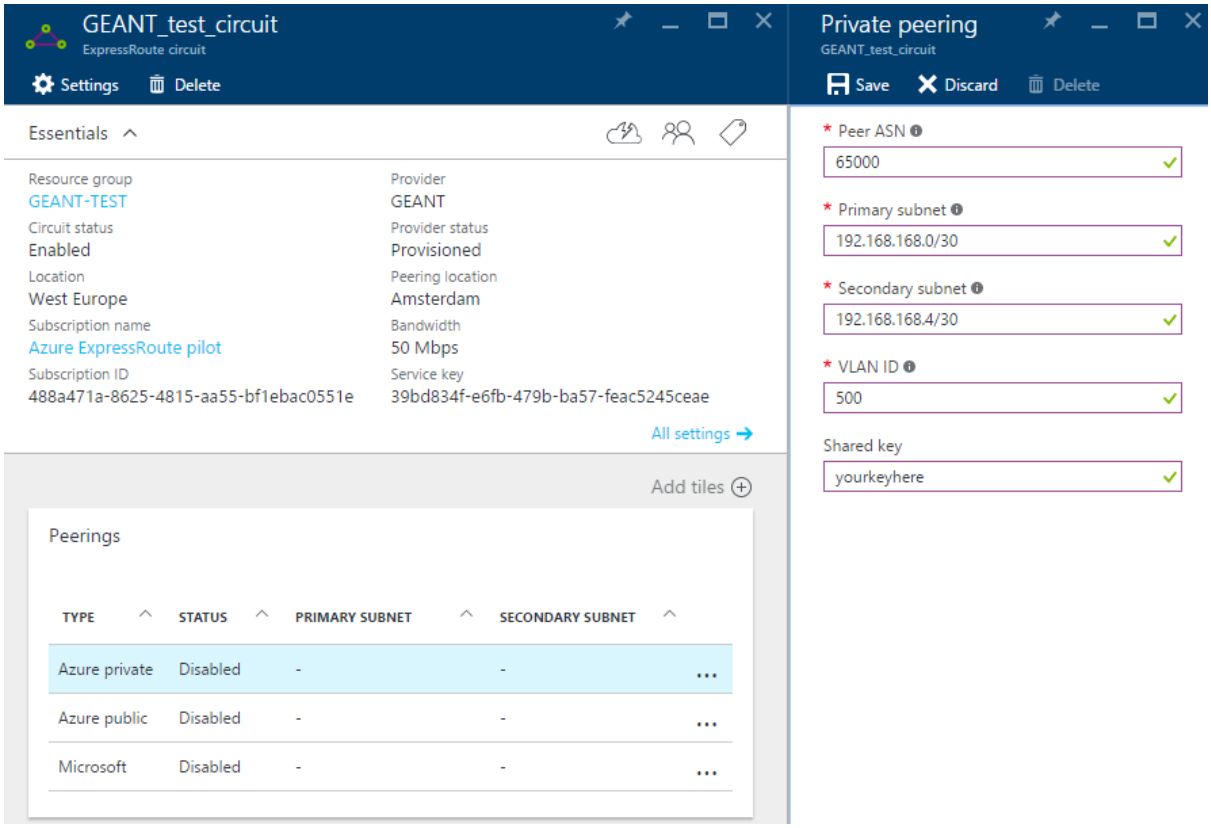
A.2 Configuring an ExpressRoute peering

In order to start using ExpressRoute, at least two BGP peerings need to be configured, one per geographical path. Microsoft offers three types of peering services:

- Azure private: Azure compute services, namely virtual machines (IaaS) and cloud services (PaaS), that are deployed within a virtual network can be connected through the private peering domain. The private peering domain is considered to be a trusted extension of your own core network into Microsoft Azure.
- Azure public: services such as Azure Storage, SQL databases and Websites are offered on public IP addresses. You can privately connect to services hosted on public IP addresses, including VIPs of your cloud services, through the public peering routing domain.
- Microsoft; connectivity to all other Microsoft online services (such as Office 365 services) will be through private peering.

A.2.1 Configuring an ExpressRoute peering in the Azure portal

In the Azure portal click on the peering for which you'd like to enter the settings. Note that the VLAN ID entered here is the inner tag used for this peering.



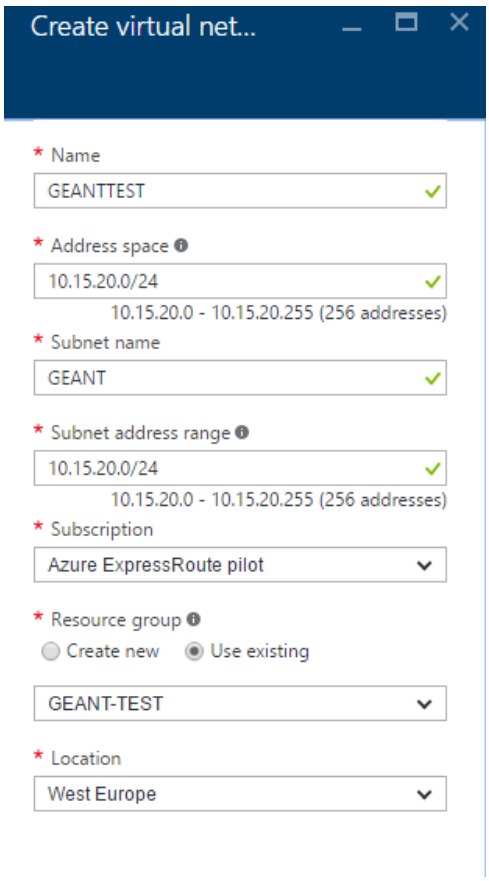
Click "save" when you're finished.

A.3 Configuring a Virtual Network with Gateway

A virtual network can be used as a network for your virtual machines. This network can be announced via the ExpressRoute peering to your local premises.

A.3.1 Configuring a Virtual Network via the Azure portal

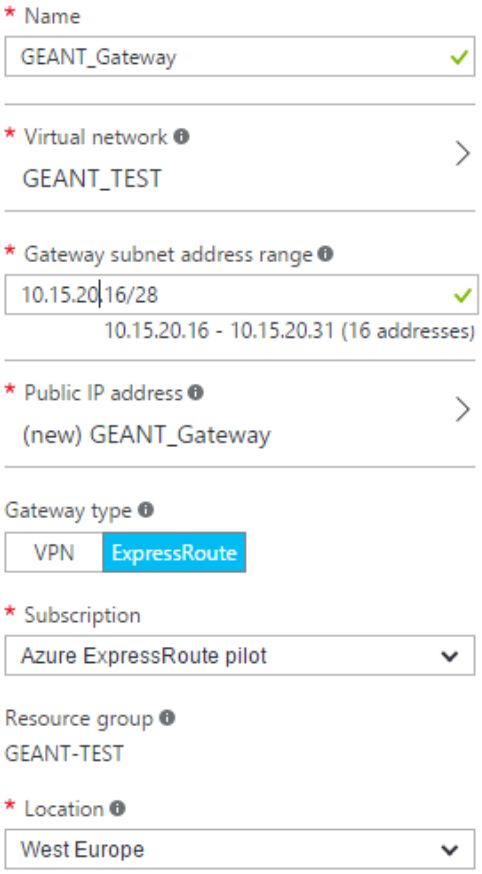
In the portal click on “Browse >” and search for “Virtual Networks” and click on it. To add a virtual network click on “Add”.



Enter the necessary details and click on “Create”.

A.3.2 Configuring a Virtual Network Gateway via the Azure portal

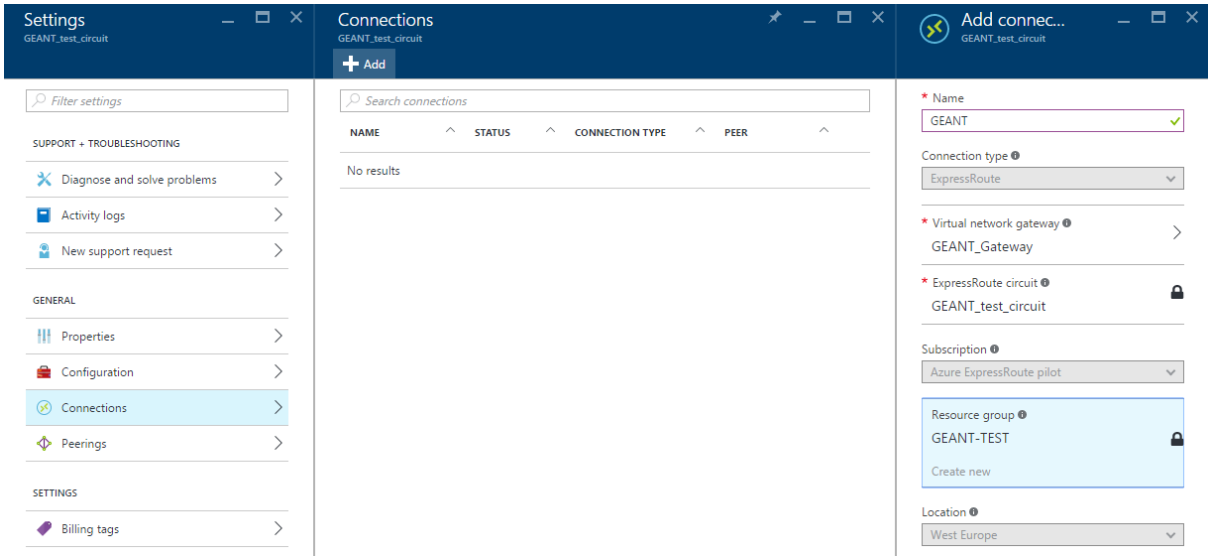
In the portal click on “Browse >” and search for “Virtual network gateways” and click on it. To add a virtual network gateway click on “Add”.



Enter the necessary details and click on “Create”. Provisioning a virtual network gateway may take up to 45 minutes.

A.3.3 Attach Virtual Network with gateway to ExpressRoute

Go back to your ExpressRoute and in the settings menu click on “Connections”. Then click on “Add”, fill the required details and click on “OK”.



A.4 Local network configuration

A.4.1 Ethernet layer (L2)

Cisco Router A1	Juniper Router A1
#configure terminal (config)#vlan <customer vlan tag A1> (config-vlan)# name Azure (config-vlan)# state active (config-vlan)# no shutdown (config)#interface <interface A1> (config-if) #switchport trunk encapsulation dot1q (config-if)#switchport trunk allowed vlan <customer vlan tag A1> (config-if)#switchport mode trunk (config-if)#switchport nonegotiate (config-if)#no cdp enable (config-if)#no vtp (config-if)#spanning-tree portfast trunk (config-if)#spanning-tree bpdufilter enable	set interfaces <interface A> vlan-tagging set interfaces <interface A> unit <unit-id A1> vlan-id <customer vlan tag A1>

Cisco Router A2	Juniper Router A2
#configure terminal (config)#vlan <customer vlan tag A2> (config-vlan)# name Azure (config-vlan)# state active (config-vlan)# no shutdown (config)#interface <interface A2> (config-if) #switchport trunk encapsulation dot1q (config-if)#switchport trunk allowed vlan <customer vlan tag A2> (config-if)#switchport mode trunk (config-if)#switchport nonegotiate (config-if)#no cdp enable (config-if)#no vtp (config-if)#spanning-tree portfast trunk (config-if)#spanning-tree bpdufilter enable	set interfaces <interface A2> vlan-tagging set interfaces <interface A2> unit <unit-id A2> vlan-id <customer vlan tag A2>

A.4.2 IP layer (L3)

For each VLAN (inner tag) an IPv4 interface needs to be configured.

Cisco Router A1	Juniper Router A1
#configure terminal (config)#interface vlan <customer vlan tag A1> (config-if)#ip address <BGP Peer address customer A1> <subnetmask> (config-if)#no shutdown	set interfaces <interface A1> unit <unit-id A1> family inet address <BGP Peer address customer A1>
Cisco Router A2	**Juniper Router A2**
#configure terminal (config)#interface vlan <customer vlan tag A2> (config-if)#ip address <BGP Peer address customer A2> <subnetmask> (config-if)#no shutdown	set interfaces <interface A2> unit <unit-id A2> family inet address <BGP Peer address customer A2>

It should be possible to ping the Microsoft addresses on the other side.

Cisco	Juniper
#ping <Microsoft IP Address B1> #ping <Microsoft IP Address B2>	ping <Microsoft IP Address B1> ping <Microsoft IP Address B2>

A.5 BGP configuration

Microsoft uses the routing protocol BGP to advertise and receive network prefixes configured in the Azure cloud and institution environment respectively. Therefor an institution should setup BGP sessions with Microsoft. The necessary details required to setup an peering with Microsoft Azure via ExpressRoute are provided by Microsoft in the portal in the “ExpressRoute circuit” menu. These details are provided by the institution, see section A.2.1.

A.5.1 Configuring the BGP peering

Cisco Router A1	Juniper Router A1
#configure terminal (config)#router bgp <Customer AS> (config-router)#network a.b.c.d !eigen IP-apace, classful (config-router)#neighbor <BGP Peer address TC A1> remote-as 15830	set protocols bgp group azure-private type external set protocols bgp group azure-private neighbor <BGP Peer address TC B1> description "Azure A1" set protocols bgp group azure-private neighbor <BGP Peer address TC B1> peer-as 15830
Cisco Router A2	**Juniper Router A2**
#configure terminal (config)#router bgp <Customer AS> (config-router)#network a.b.c.d !eigen IP-apace, classful (config-router)#neighbor <BGP Peer address TC B2> remote-as 15830	set protocols bgp group azure-private type external set protocols bgp group azure-private neighbor <BGP Peer address TC B2> description "Azure A2" set protocols bgp group azure-private neighbor <BGP Peer address TC B2> peer-as 15830

Check if the BGP sessions are UP.

Cisco	Juniper
#show bgp summary	show bgp summary

Check which routes are being distributed from Microsoft to you. You can configure these networks in the Azure portal or via the Azure APIs.

Cisco	Juniper
#show ip bgp neighbor <BGP Peer address TC A1> routes #show ip bgp neighbor <BGP Peer address TC A2> routes	show route receive-protocol bgp < BGP Peer address TC B1> show route receive-protocol bgp < BGP Peer address TC B2>

A.5.2 Configuring the local preference and metric

For example to prefer the connection on router A1 above the connection of router A2.

Cisco Router A1	**Juniper Router A1**
#configure terminal (config)#router bgp <Customer AS> (config-router)#bgp default local-preference 100***)** (config-router)#neighbor <BGP Peer address TC A1> remote-as weight 500***)**	set policy-options policy-statement azure-A1-in then local-preference 100 set protocols bgp group azure-private neighbor <Microsoft IP Address B1> import azure-A1-in
	Juniper Router A2 set policy-options policy-statement azure-A2-in then local-preference 200 set protocols bgp group azure-private neighbor <Microsoft IP Address B2> import azure-A2-in

Ask Microsoft to do the same.

Juniper Router A1

```
set policy-options policy-statement
azure-A-out then metric 10

set protocols bgp group azure-
private neighbor <Microsoft IP
Address B1> export azure-A-out
```

Cisco Router A2

```
#configure terminal
(config)#route-map localonly permit
10

(config-route-map)#match as-path 10

(config-route-map)#set as-path
prepend <Customer AS> <Customer AS>

(config-route-map)#exit
(config-ip)#exit

(config)# router bgp <Customer AS>
(config-router)#neighbor <Microsoft
IP address B2> route-map localonly
out
```

Juniper Router A2

```
set policy-options policy-statement
azure-B-out then metric 20

set protocols bgp group azure-
private neighbor <Microsoft IP
Address B2> export azure-B-out
```

A.5.3 Prefix list

To filter incoming prefixes.

Cisco Router A1	**Juniper Router A1**
#configure terminal (config)#ip prefix-list azure-in seq 5 permit <a.b.0.0/z> (config)#router bgp <Customer AS> (config-router)#neighbor <Microsoft IP address B1> prefix-list azure-in in	set policy-options prefix-list azure-in <ip range/mask> set protocols bgp group azure-private neighbor <BGP Peer address TC B1> import azure-in
Cisco Router A2	**Juniper Router A2**
#configure terminal (config)#ip prefix-list azure-in seq 5 permit <a.b.0.0/z> (config)#router bgp <Customer AS> (config-router)#neighbor <Microsoft IP address B2> prefix-list azure-in in	set policy-options prefix-list azure-in <ip range/mask> set protocols bgp group azure-private neighbor <BGP Peer address TC B2> import azure-in

To filter outgoing prefixes.

Cisco Router A1	**Juniper Router A1**
#configure terminal (config)#ip as-path access-list 10 permit ^$ (config-ip)#route-map azure-out permit 10 (config-route-map)#match as-path 10 (config-router)#neighbor <Microsoft IP address B1> route-map azure-out out	set policy-options prefix-list azure-out <ip range/mask> set protocols bgp group azure-private neighbor <BGP Peer address TC B1> export azure-out
Cisco Router A2	**Juniper Router A2**
#configure terminal (config)#ip as-path access-list 10 permit ^$ (config-ip)#route-map azure-out permit 10 (config-router)#neighbor <Microsoft IP address B2> route-map azure-out out	set policy-options prefix-list azure-out <ip range/mask> set protocols bgp group azure-private neighbor <BGP Peer address TC B2> export azure-out