

AZ-700

Design and implement Azure ExpressRoute



AZ-700 Agenda

Module 01: Introduction to Azure Virtual Networks

Module 02: Designing and Implementing Hybrid Networking

VPN \$

Module 03: Designing and Implementing Azure ExpressRoute ←

ER \$\$

Module 04: Load balance non-HTTP(S) traffic in Azure

Module 05: Load balance HTTP(S) traffic in Azure

Module 06: Design and Implement Network Security

Module 07: Design and Implement private access to Azure Services

Module 08: Design and Implement Network Monitoring

Explore Azure ExpressRoute



ExpressRoute Capabilities

Layer 3 connectivity with redundancy

Connectivity to all regions within a geography

Global connectivity with ExpressRoute premium add-on

Across on-premises connectivity with ExpressRoute Global Reach

Bandwidth options – 50 Mbps to 100 Gbps

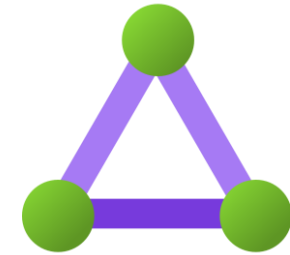
Billing models – Unlimited, metered



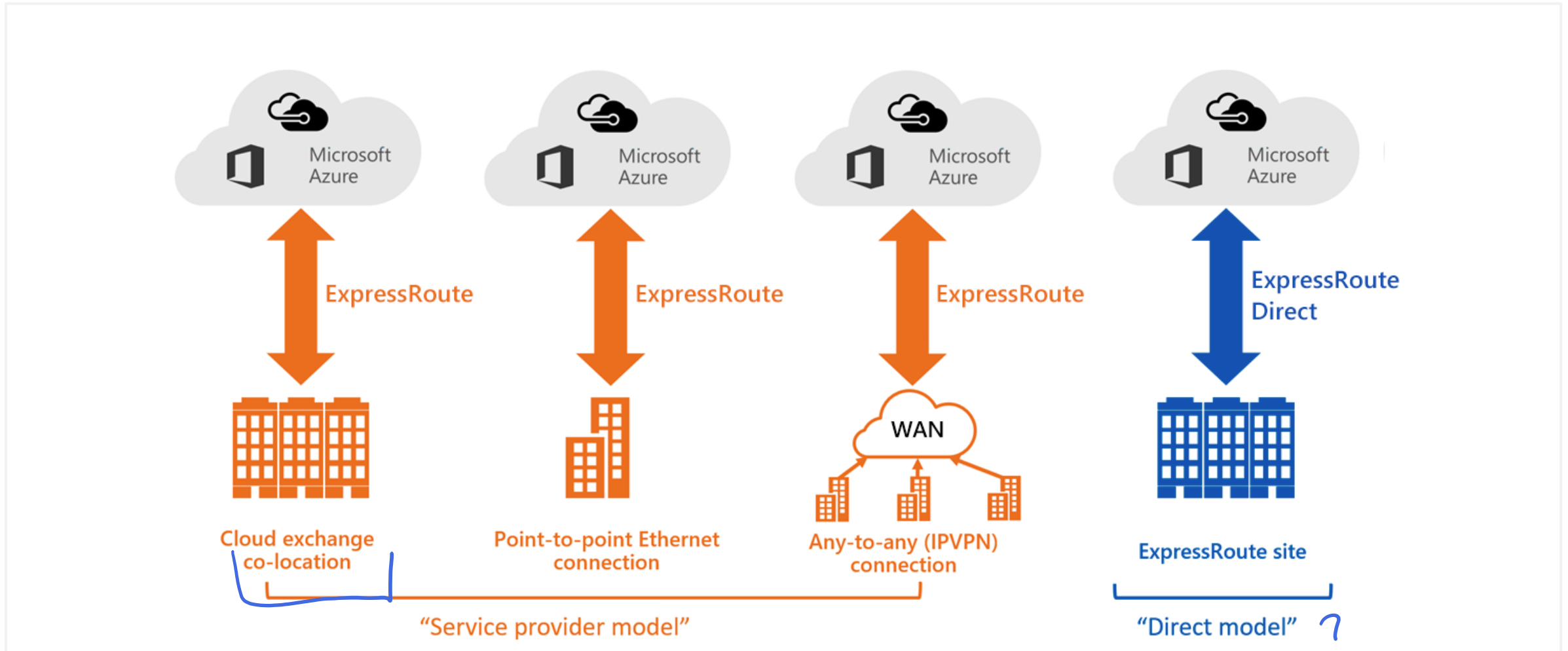
Understand use cases for Azure ExpressRoute

- Faster and Reliable connection to Azure services
- Storage, backup, and Recovery
- Extends Data center capabilities
- Predictable, reliable, and high-throughput connections
- SLA
- Built in redundant circuits
- Border Gateway Protocol (BGP)
- Integrates with existing Multiprotocol Label Switching (MPLS)
- Private connection to Microsoft cloud

Leased Line
not encrypted



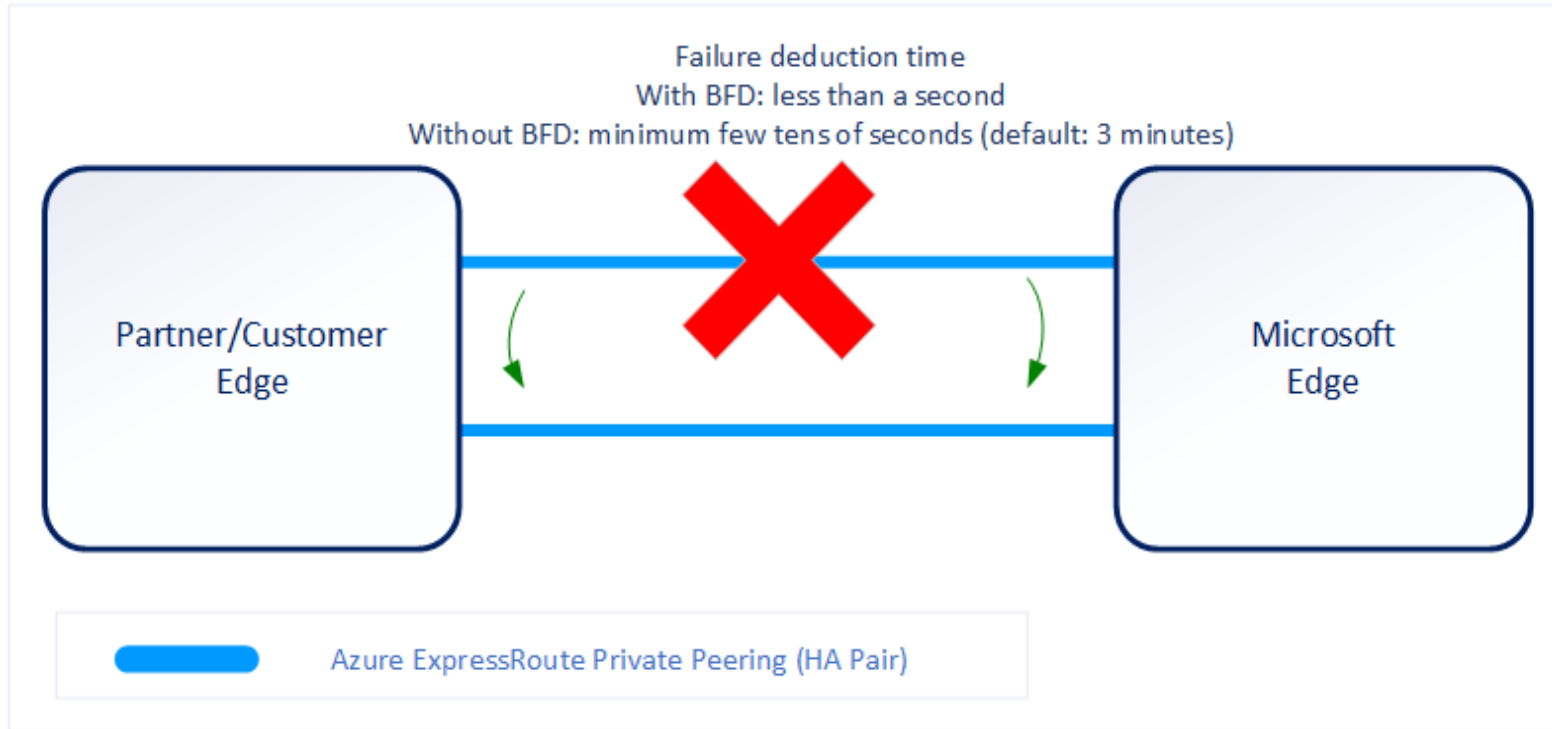
ExpressRoute connectivity models



Design considerations for ExpressRoute deployments

ExpressRoute using a Service Provider	ExpressRoute Direct
Uses service providers to enable fast onboarding and connectivity into existing infrastructure	Requires 100 Gbps/10 Gbps infrastructure and full management of all layers
Integrates with hundreds of providers including Ethernet and MPLS	Direct/Dedicated capacity for regulated industries and massive data ingestion
Circuits SKUs from 50 Mbps to 10 Gbps	Customer may select a combination of the following circuit SKUs on 100-Gbps ExpressRoute Direct: (5 Gbps, 10 Gbps, 40 Gbps, 100 Gbps) Customer may select a combination of the following circuit SKUs on 10-Gbps ExpressRoute Direct: (1 Gbps, 2 Gbps, 5 Gbps, 10 Gbps)
Optimized for single tenant	Optimized for single tenant with multiple business units and multiple work environments

Bidirectional Forwarding Detection (BFD) with ExpressRoute Private Peering



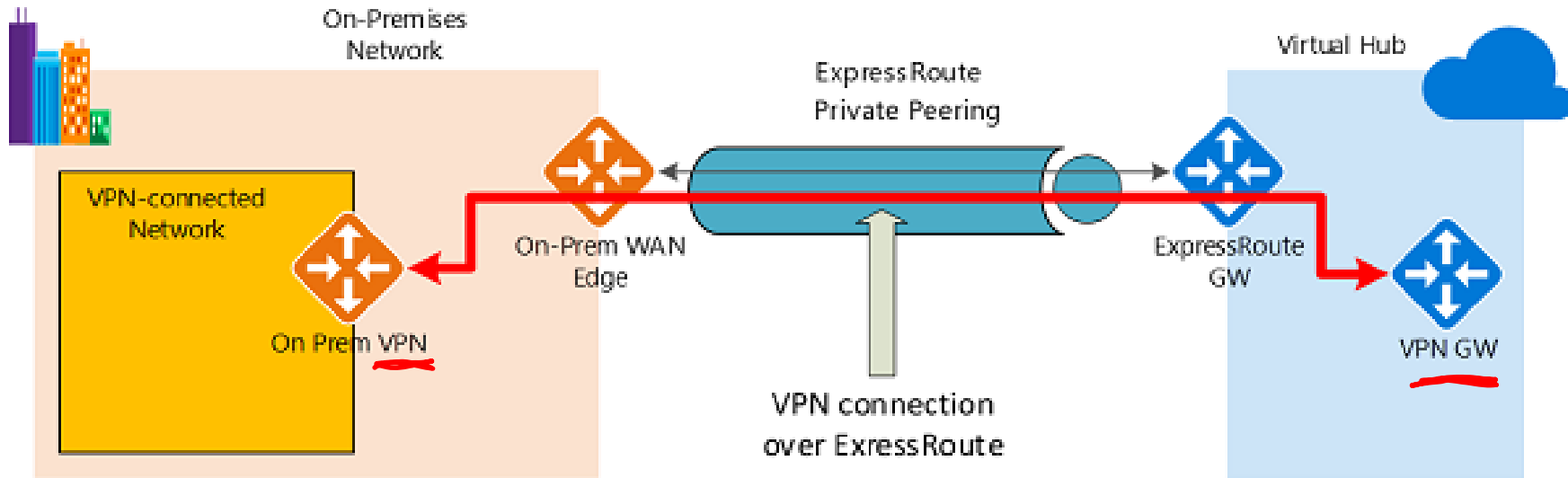
BFD is configured by default

You only need to configure BFD on both your primary and secondary devices

You configure the BFD on the interface and then link it to the BGP session.

Configure encryption over ExpressRoute

RSA
Quantum Computing

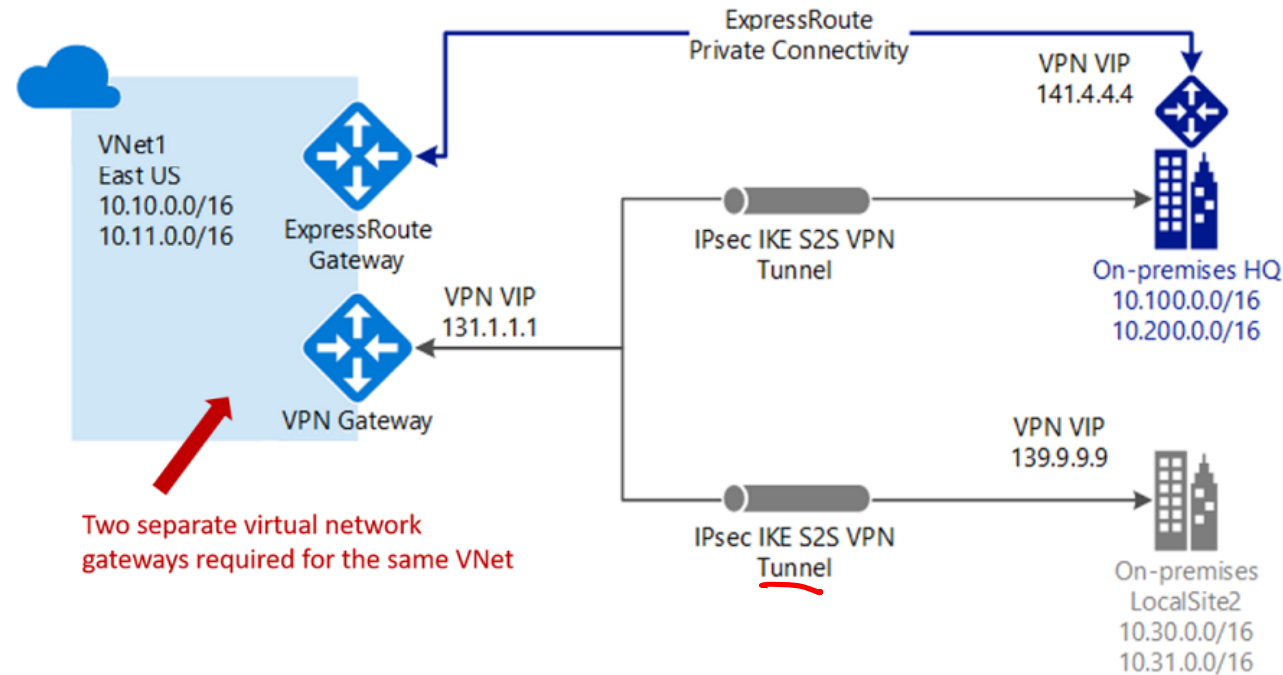


Establish ExpressRoute connectivity with an ExpressRoute circuit and private peering

Establish the VPN connectivity over ExpressRoute

Routing between the on-premises networks and Azure over both the ExpressRoute and VPN paths

Coexisting Site-to-Site and ExpressRoute



Use S2S VPN as a
secure failover path
for ExpressRoute

Use S2S VPNs to connect to
sites that are not connected
with ExpressRoute

Notice two VNet
gateways for the
same virtual network

Design an ExpressRoute deployment

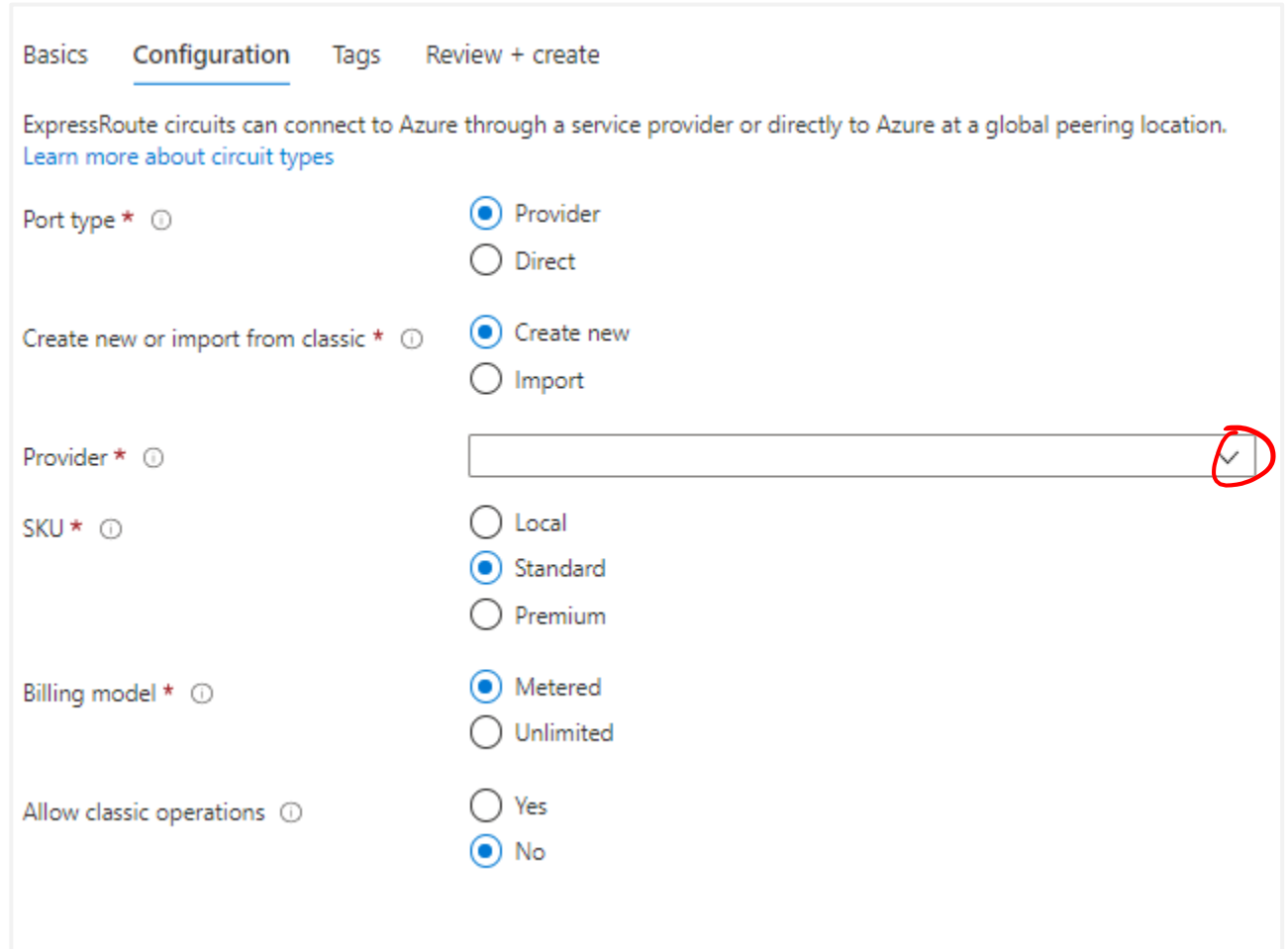


ExpressRoute SKUs

Local (if available) - provides free egress data transfer and gives you access to only 1-2 Azure regions in the same area as your circuit

Standard SKU - gives you access to all Azure regions in a geopolitical area

Premium SKU - provides support for more than 4K routes, ability to connect to more than 10 virtual networks, and global connectivity



The screenshot shows the 'Configuration' tab of the Azure ExpressRoute portal. It includes tabs for 'Basics', 'Configuration', 'Tags', and 'Review + create'. A descriptive text states: 'ExpressRoute circuits can connect to Azure through a service provider or directly to Azure at a global peering location. [Learn more about circuit types](#)'. The configuration options are as follows:

- Port type ***: ☒ Provider, ☐ Direct
- Create new or import from classic ***: ☒ Create new, ☐ Import
- Provider ***: A text input field with a dropdown arrow on the right, which is circled in red and contains a checkmark.
- SKU ***: ☐ Local, ☒ Standard, ☐ Premium
- Billing model ***: ☒ Metered, ☐ Unlimited
- Allow classic operations**: ☐ Yes, ☒ No

Choose a peering location



Choose the right ExpressRoute Circuit and billing model

Choose Metered or unlimited data plan

Choose Bandwidth

You can increase gateway size but not decrease without service outage

Pricing varies by region and zone

Unlimited data. Billing is based on a monthly fee; all inbound and outbound data transfer is included free of charge.

Metered data. Billing is based on a monthly fee; all inbound data transfer is free of charge. Outbound data transfer is charged per GB of data transfer. Data transfer rates vary by region.

ExpressRoute premium add-on.
ExpressRoute premium is an add-on to the ExpressRoute circuit.

Exercise – Configure an ExpressRoute Gateway



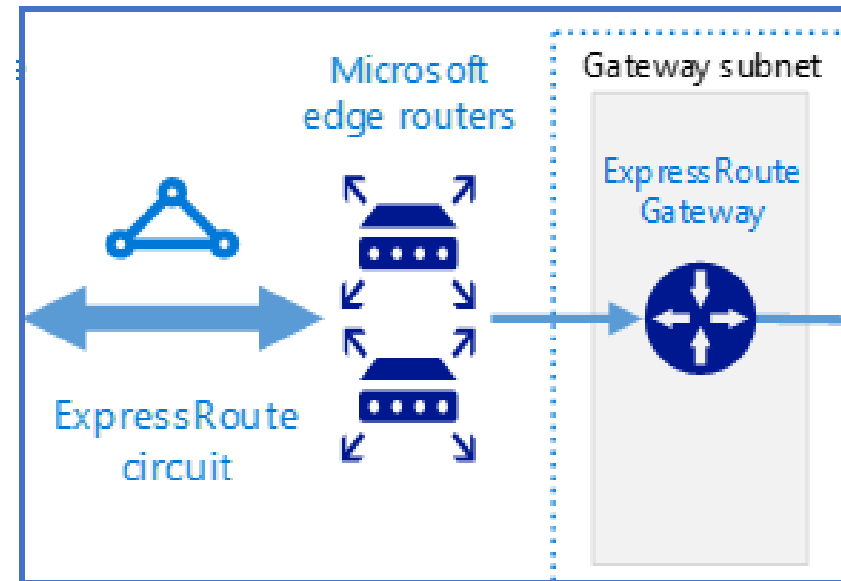
Exercise - Configure an ExpressRoute Gateway



In this exercise, you learn how to:

Task 1: Create the VNet and gateway subnet

Task 2: Create the virtual network gateway



Exercise – Provision an ExpressRoute circuit



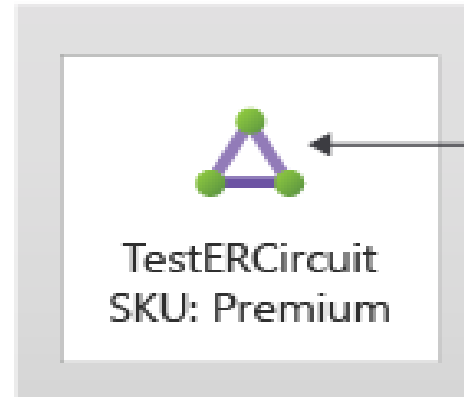
Exercise



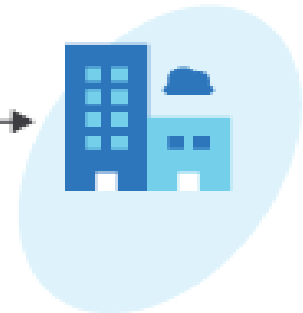
In this exercise, you learn how to:

- Task 1: Create and provision an ExpressRoute circuit
- Task 2: Retrieve your Service key
- Task 3: Deprovisioning an ExpressRoute circuit

ExpressRouteResourceGroup
(West US 2)



Equinix
(Seattle)



Configure peering for an ExpressRoute deployment



Learning Objectives - Peering for an ExpressRoute

- Configure Private peering
- Configure Microsoft peering
- Choose between private peering only, Microsoft peering only, or both
- Route filters
- Learning Recap

Configure Private peering



A pair of subnets that are not part of any address space reserved for virtual networks. One subnet will be used for the primary link, while the other will be used for the secondary link

A valid on-prem VLAN ID to establish this peering on

AS number for peering

Advertise the routes from your on-premises Edge router to Azure via BGP

Optional - An MD5 hash if you choose to use one

 Private peering  ...

ASH-Cust15-ER

Peer ASN * ⓘ
 ✓

Subnets
☒ Both
☐ IPv4
☐ IPv6

IPv4 Primary subnet * ⓘ
 ✓

IPv4 Secondary subnet * ⓘ
 ✓

☒ Enable IPv4 Peering ⓘ

IPv6 Primary subnet * ⓘ
 ✓

IPv6 Secondary subnet * ⓘ
 ✓

☒ Enable IPv6 Peering ⓘ

VLAN ID * ⓘ
 ✓

Shared key

Add Global Reach

Global Reach name	ExpressRoute Circuit name ⓘ	IPv4 Subnet ⓘ	IPv6 Subnet ⓘ
<div></div>			

Save

Cancel

Configure Microsoft peering

A pair of subnets owned by you and registered in an RIR/IRR. One subnet will be used for the primary link, while the other will be used for the secondary link.




A valid on-prem VLAN ID to establish this peering on


AS number for peering


Advertised prefixes: You provide a list of all prefixes you plan to advertise over the BGP session



Routing Registry Name



[Home](#) > [ExpressRoute circuits](#) > [TestERCircuit](#) >



 **Microsoft peering**  
TestERCircuit



 To receive route advertisements on Microsoft peering, attach route filters to the circuit after creating Microsoft Peering. [Learn More.](#)



☒ Enable Peering 



Peer ASN * 
 

IPv4 Primary subnet * 
 



IPv4 Secondary subnet * 
 

VLAN ID * 
 

Customer ASN 
 

Routing registry name 
 

Shared key

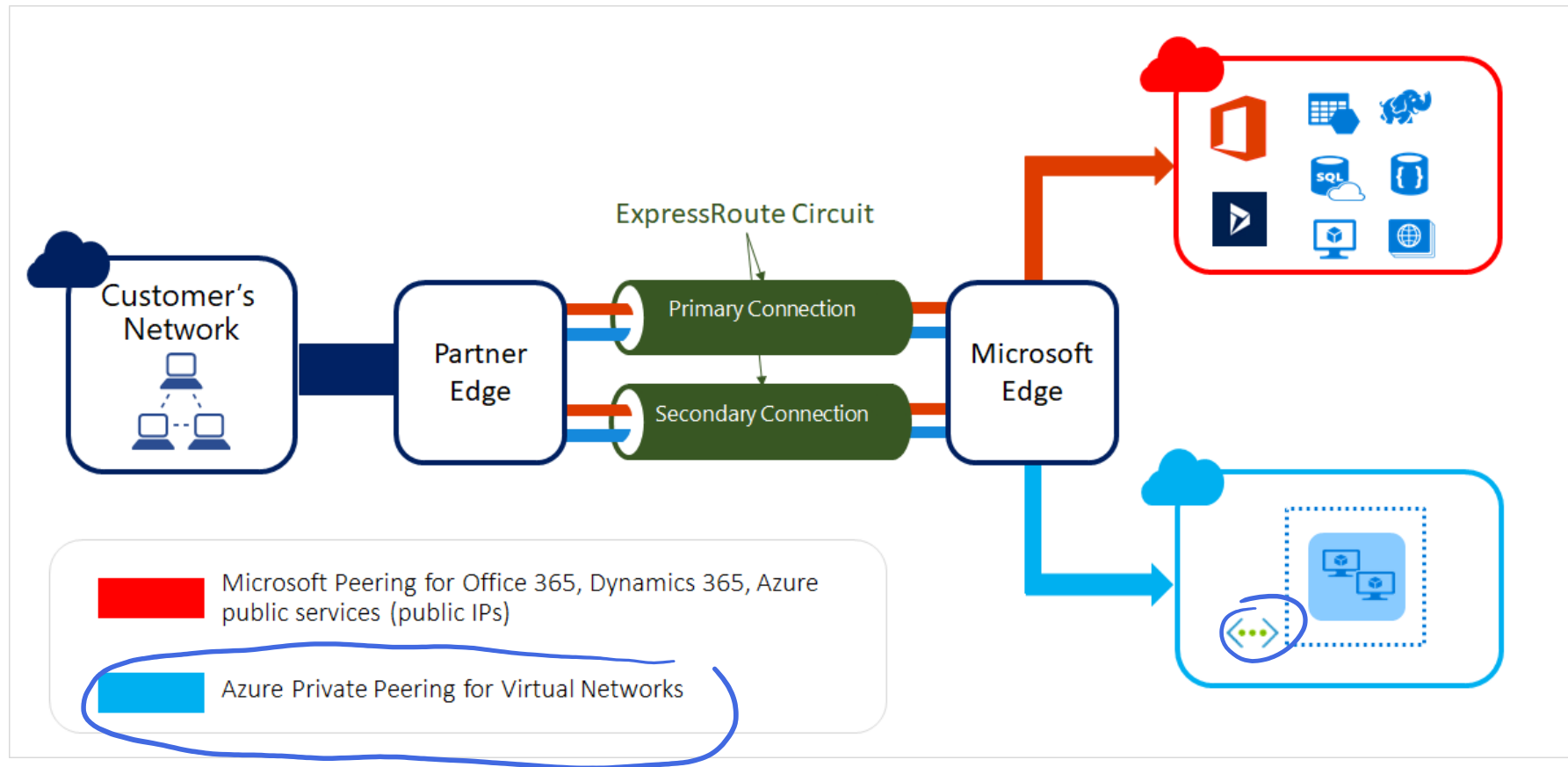
Advertised public prefixes * 
 

Status: Validation Needed

Save

Cancel

Choose between private peering only, Microsoft peering only, or both



Route filters

Create route filter

Basics Tags Review + create

Route filters help you filter the traffic going through your ExpressRoute. Essentially a white list of all the BGP community values, a route filter lets you identify services you want to consume through your ExpressRoute circuit's Microsoft peering. Once a route filter resource is defined and attached to an ExpressRoute circuit, all prefixes that map to the BGP community values are advertised to your network. [Learn more about route filters](#)

Project details

Subscription * ① Azure Subscription

Resource group * ① ExpressRouteResourceGroup

[Create new](#)

Instance details

Name * MyRouteFilter

Region * (US) West US 2

i Route filter must be created in the same location as the ExpressRoutes it will be associated with.

[Review + create](#)

[< Previous](#)

[Next : Tags >](#)

[Download a template for automation](#)

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Manage rule

MyRouteFilter

[Save](#) [Discard](#)

Rule name * Rule1

Allowed service communities *

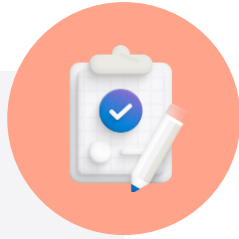
2 selected

- ☒ Select all
- ☐ Exchange (12076:5010)
- ☒ Other Office 365 Services (12076:510)
- ☒ SharePoint Online (12076:5020)
- ☐ Skype For Business (12076:5030)
- ☐ CRM Online (12076:5040)
- ☐ Azure Active Directory (12076:5060)
- ☐ Azure Australia Central (12076:5103)
- ☐ Azure Australia Central 2 (12076:510)
- ☐ Azure Australia East (12076:51015)
- ☐ Azure Australia Southeast (12076:51)
- ☐ Azure Brazil South (12076:51014)
- ☐ Azure Canada Central (12076:51020)
- ☐ Azure Canada East (12076:51021)
- ☐ Azure Central India (12076:51017)
- ☐ Azure Central US (12076:51009)
- ☐ Azure Central US EUAP (12076:5100)
- ☐ Azure East Asia (12076:51010)
- ☐ Azure East US (12076:51004)
- ☐ Azure East US 2 (12076:51005)

Create route filter and create route filter rules

Attach the route filter to an ExpressRoute circuit

Learning Recap – Peering ExpressRoute



Check your
knowledge
questions and
additional
study

[Azure ExpressRoute: Circuits and peering | Microsoft Docs](#)

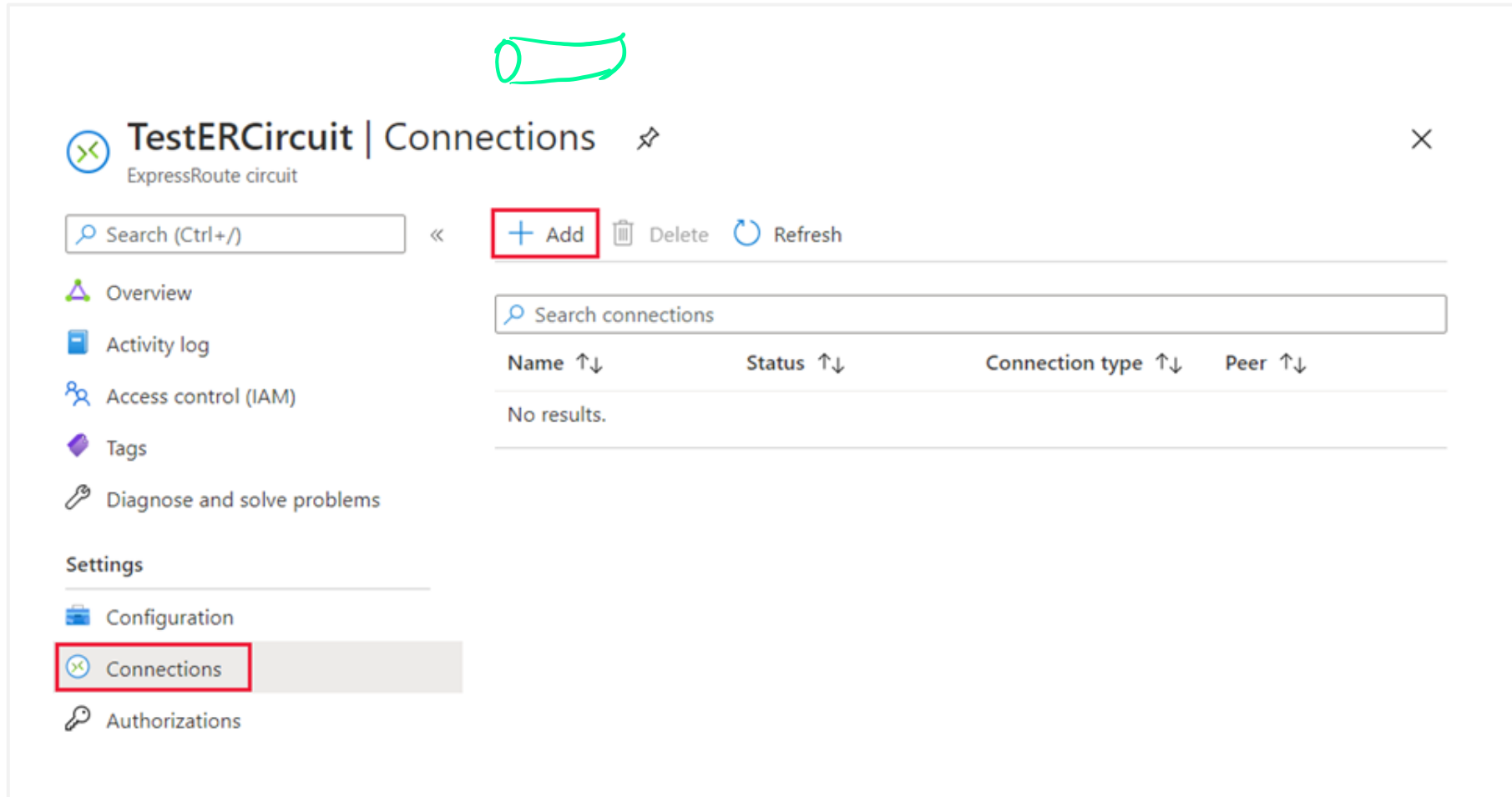
Connect an ExpressRoute circuit to a VNet



Learning Objectives - Connect an ExpressRoute Circuit to a VNet

- Connect virtual network to an ExpressRoute circuit
- Learning Recap

Connect virtual network to an ExpressRoute circuit



The screenshot shows the 'TestERCircuit | Connections' page in the Azure portal. The page title is 'TestERCircuit | Connections' with a sub-header 'ExpressRoute circuit'. The left sidebar contains navigation links: Overview, Activity log, Access control (IAM), Tags, Diagnose and solve problems, Settings, Configuration, Connections (highlighted with a red rectangle), and Authorizations. The main content area has a search bar 'Search (Ctrl+ /)' and a toolbar with '+ Add' (highlighted with a red rectangle), 'Delete', and 'Refresh'. Below the toolbar is a search bar 'Search connections' and a table with columns: Name ↑↓, Status ↑↓, Connection type ↑↓, and Peer ↑↓. The table currently displays 'No results.'.

Connect virtual network to an ExpressRoute circuit – continued

Create connection

Basics

Settings

Tags

Review + create

Create a secure connection to your virtual network by using VPN Gateway or ExpressRoute. [Learn more about VPN Gateway](#)
[Learn more about ExpressRoute](#)

Project details

Subscription

Azure Subscription

Resource group

ExpressRouteResourceGroup

Create new

Instance details

Connection type

ExpressRoute

Name

ER-VNet-Connection

Region

(US) West US 2

Review + create

< Previous

Next : Settings >

Download a template for automation

Create connection

Basics

Settings

Tags

Review + create

Virtual network gateway

To use a virtual network with a connection, it must be associated to a virtual network gateway.

Virtual network gateway

ERGW

ExpressRoute circuit

TestERCircuit

Redeem authorization

Routing weight

0

Review + create

< Previous

Next : Tags >

Download a template for automation

Verify connection

<>

TestERCircuit | Connections

ExpressRoute circuit

Search (Ctrl+/)

<<

+ Add

🗑️ Delete

🔄 Refresh

Overview

Activity log

Access control (IAM)

Tags

Diagnose and solve problems

Settings

Configuration

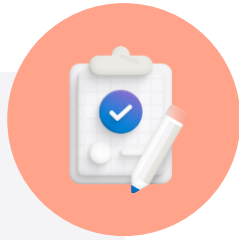
Connections

Authorizations

Search connections

Name ↑↓	Status ↑↓	Connection type ↑↓	Peer ↑↓
ER-VNet-Connection	Succeeded	ExpressRoute	ERGW

Learning Recap – Connect an ExpressRoute Circuit to a VNet



Check your
knowledge
questions and
additional
study

[Azure ExpressRoute: Circuit configuration workflow | Microsoft Docs](#)

Connect geographically dispersed networks with ExpressRoute Global Reach



Learning Objectives - ExpressRoute Global Reach

- Use Cross-region connectivity to link multiple ExpressRoutes
- Choose when to use ExpressRoute Global Reach
- Configure ExpressRoute Global Reach
- Learning Recap

Use Cross-region connectivity to link multiple ExpressRoutes

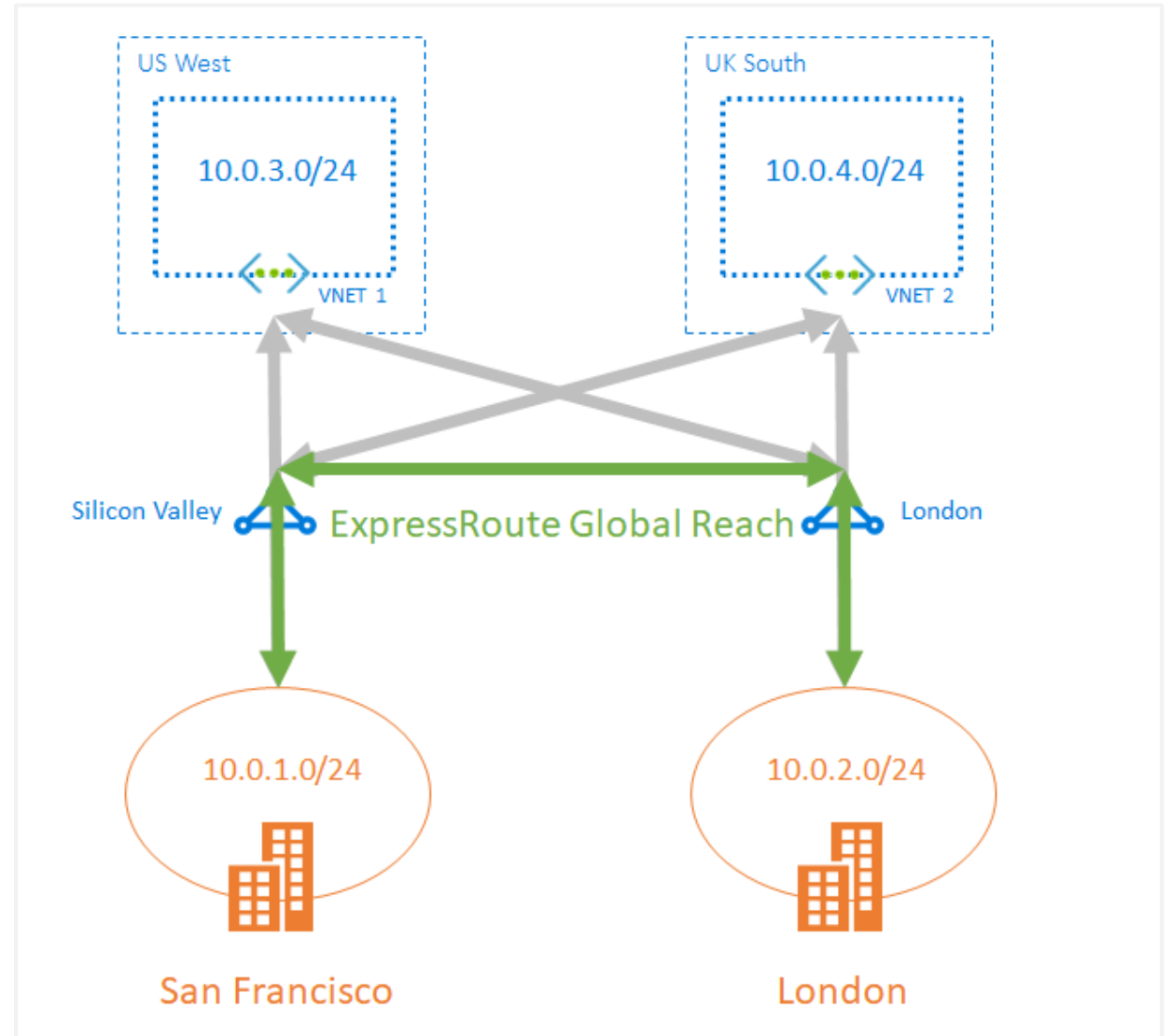
Connectivity to all regions within a geopolitical region

Global connectivity with ExpressRoute Premium

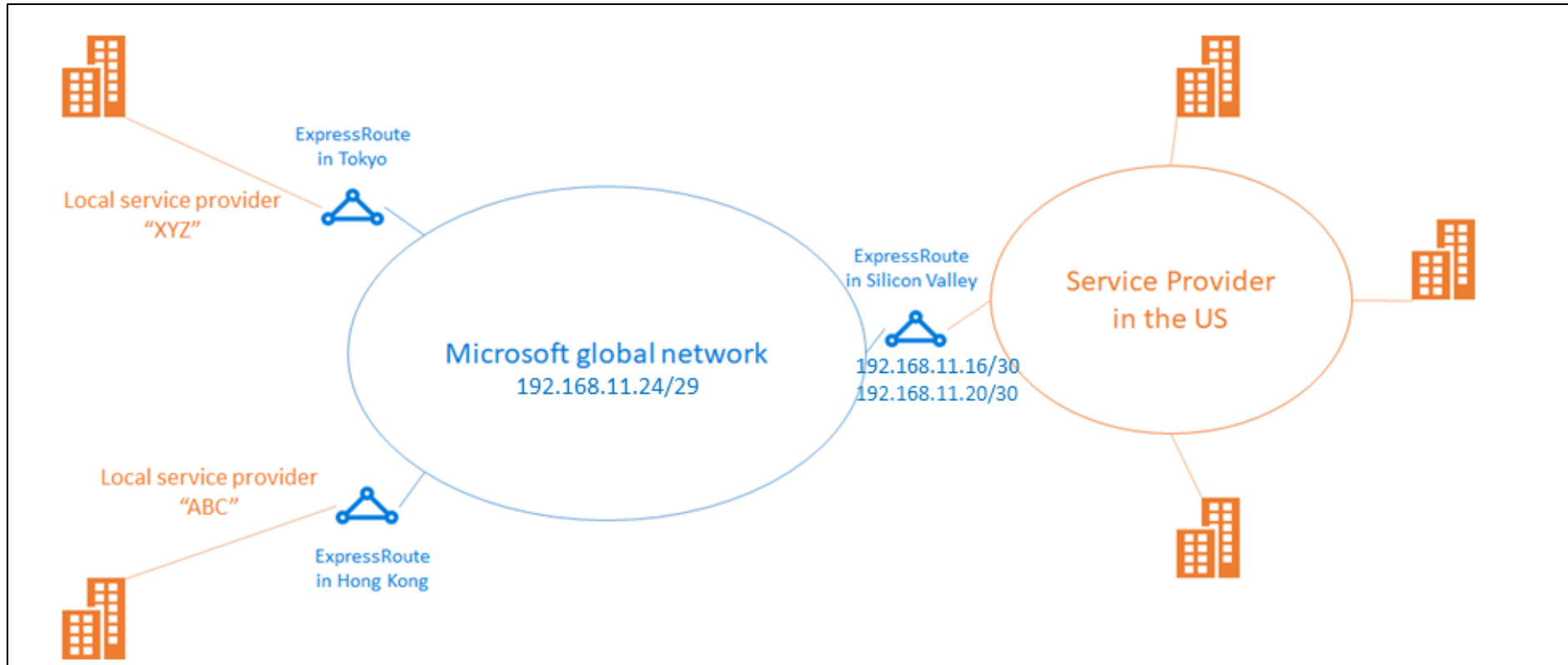
Local connectivity with ExpressRoute Local

Across on-premises connectivity with ExpressRoute Global Reach

ExpressRoute Direct





ExpressRoute Global Reach



Designed to complement your service provider's WAN implementation and connect your branch offices across the world

You can link ExpressRoute circuits together to make a private network between your on-premises networks

Configure ExpressRoute Global Reach

Private peering 

TestERCircuit

☒ Enable Peering ⓘ

Peer ASN * ⓘ

IPv4 Primary subnet * ⓘ

IPv4 Secondary subnet * ⓘ

VLAN ID * ⓘ


Shared key

Add Global Reach

Global Reach name	ExpressRoute Circuit name ⓘ	Global Reach subnet ⓘ
<input type="text"/>		

Save

Cancel

Add Global Reach 

TestERCircuit

Global Reach name *

☐ Redeem authorization ⓘ

ExpressRoute circuit * ⓘ

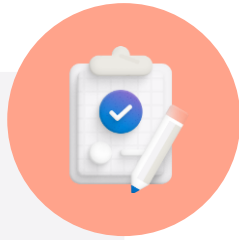
TestERCircuit2
resourceGroup: ExpressRouteResourceGroup2, location: eastus

Global Reach subnet * ⓘ

Add

Cancel

Learning Recap – ExpressRoute Global Reach



Check your
knowledge
questions and
additional
study

[Azure ExpressRoute: Connect to Microsoft Cloud
using Global Reach | Microsoft Docs](#)

Improve data path performance between networks with ExpressRoute FastPath



Learning Objectives - ExpressRoute FastPath

- ExpressRoute FastPath
- Configure ExpressRoute FastPath
- Learning Recap

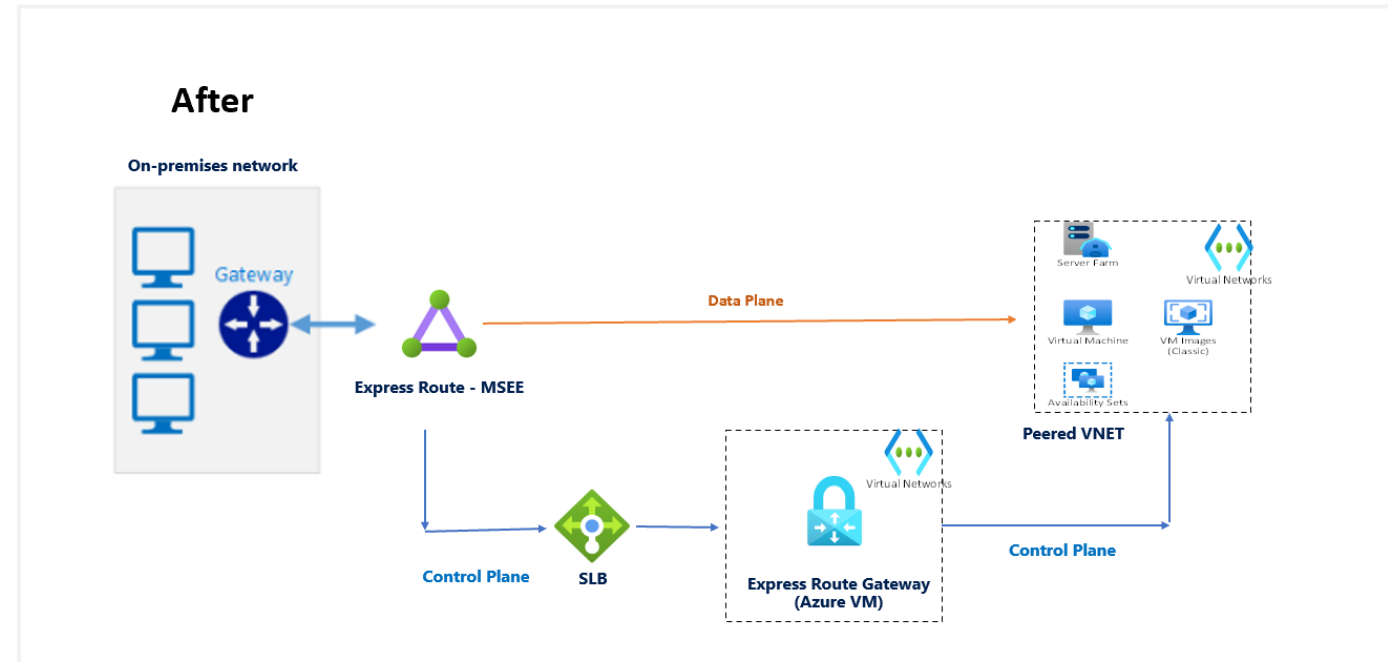
ExpressRoute FastPath

FastPath is designed to improve the data path performance between your on-premises network and your virtual network

When enabled, FastPath sends network traffic directly to virtual machines in the virtual network, bypassing the gateway.

FastPath improves data path performance such as packets per second and connections per second between your on-premises network and your virtual network.


You can enable ExpressRoute FastPath if your virtual network gateway is Ultra Performance or ErGw3AZ




Configure ExpressRoute FastPath

Updating an existing connection to enable FastPath

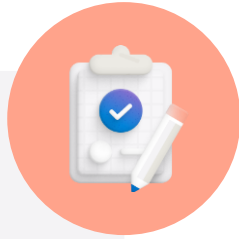
Azure PowerShell

 Copy

 Open Cloudshell

```
$connection = Get-AzVirtualNetworkGatewayConnection -Name "MyConnection" -ResourceGroupName "MyRG"
$connection.ExpressRouteGatewayBypass = $True
Set-AzVirtualNetworkGatewayConnection -VirtualNetworkGatewayConnection $connection
```

Learning Recap – ExpressRoute FastPath



Check your
knowledge
questions and
additional
study

[About Azure ExpressRoute FastPath | Microsoft Docs](#)

Troubleshoot ExpressRoute connection issues



Learning Objectives - Troubleshoot ExpressRoute Connection

- Verify circuit provisioning and state through the Azure portal
- Validate Peering Configuration
- Validate Address Resolution Protocol (ARP)
- Troubleshooting network performance
- Learning Recap

Verify circuit provisioning and state

Get-AzExpressRouteCircuit -ResourceGroupName
"USWest-ER-Demo-RG" -Name "ER-Demo-Ckt-SV"

```
Name : ER-Demo-Ckt-SV
ResourceGroupName : USWest-ER-Demo-RG
Location : westus
Id : /subscriptions/*****/resourceGroups/
USWest-ER-Demo-RG/providers/*****/expressRouteCircuits/ ER-Demo-Ckt-SV
Etag : W/"#####"
ProvisioningState : Succeeded
Sku : {
  "Name": "Standard_UnlimitedData",
  "Tier": "Standard",
  "Family": "UnlimitedData"
}
CircuitProvisioningState : Enabled
ServiceProviderProvisioningState : Provisioned
ServiceProviderNotes :
ServiceProviderProperties : {
  "ServiceProviderName": "****",
  "PeeringLocation": "*****",
  "BandwidthInMbps": 200
}
ServiceKey : *****
Peerings : []
Authorizations : []
```

The screenshot shows the Azure portal interface for an ExpressRoute circuit. The top header displays the circuit name 'ER-Demo-Ckt-SV' and its type 'ExpressRoute circuit'. Below this, there are 'Settings' and 'Delete' buttons. The 'Essentials' section provides a summary of the circuit's configuration:

Resource group	Provider
USWest-ER-Demo-RG	Equinix
Circuit status	Provider status
Enabled	Provisioned
Location	Peering location
West US	Silicon Valley
Subscription name	Bandwidth
ExpressRoute-Demo	200 Mbps
Subscription ID	Service key

Below the Essentials section, there is a 'Peerings' section with a table showing the status of various peering connections:

TYPE	STATUS	PRIMARY SUBNET	SECONDARY SUBNET
Azure private	Disabled	-	-
Azure public	Disabled	-	-
Microsoft	Disabled	-	-

The 'Circuit status' and 'Provider status' are highlighted with a red box, indicating that the circuit is 'Enabled' and 'Provisioned'.

Reset a failed circuit

```
Connect-AzAccount
Get-AzSubscription
Select-AzSubscription -SubscriptionName "Replace_with_your_subscription_name"
$ckt = Get-AzExpressRouteCircuit -Name "ExpressRouteARMCircuit" -ResourceGroupName
"ExpressRouteResourceGroup"

Set-AzExpressRouteCircuit -ExpressRouteCircuit $ckt
```

The circuit should now be healthy. Open a support ticket with Microsoft support if the circuit is still in a failed state.

Validate Peering Configuration

The screenshot displays the Azure portal interface for an ExpressRoute circuit. The left-hand navigation pane is visible, with the 'Overview' tab selected and highlighted by a red rectangle. The main content area shows the circuit's details and a table of its peering configurations.

ExpressRoute circuit details:

- Resource group: [Demo-RG](#) (change)
- Circuit status: **Enabled**
- Location: **East US**
- Subscription: [ExpressRoute-Lab](#) (change)
- Subscription ID: **#####-####-####-#####**
- Tags: [Click here to add tags](#) (change)
- Provider: **Equinix**
- Provider status: **Provisioned**
- Peering location: **Washington DC**
- Bandwidth: **50 Mbps**
- Service key: **#####-####-####-#####**

Peering configurations table:

Type	Status	Primary subnet	Secondary subnet	Last modified by	
Azure private	Provisioned	192.168.20.16/30	192.168.20.20/30	Customer	...
Azure public	Not provisioned	-	-	-	...
Microsoft	Not provisioned	-	-	-	...

Validate ARP

Address Resolution Protocol (ARP):

- layer 2 protocol defined in RFC 826.
- Used to map the Ethernet address (MAC address) with an ip address.

Title of ARP table error messages:

- On-premises MAC address show incomplete
- Microsoft entry in the ARP table

The ARP table provides a mapping of the IP address and MAC address for a particular peering. The ARP table for an ExpressRoute circuit peering provides the following information for each interface (primary and secondary):

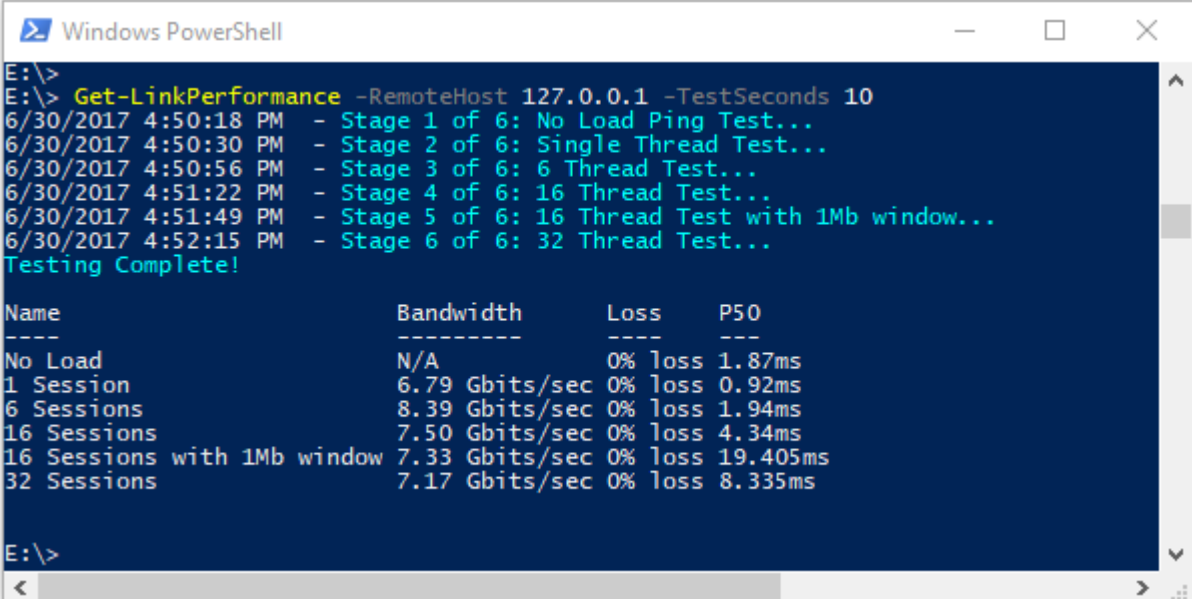
- Mapping of on-premises router interface ip address to the MAC address
- Mapping of ExpressRoute router interface ip address to the MAC address
- Age of the mapping ARP tables can help validate layer 2 configuration and troubleshooting basic layer 2 connectivity issues.

Troubleshooting network performance

Most network issues can be analyzed and isolated with Azure Network Watcher or PowerShell and CLI

To help with troubleshooting, the Azure Connectivity Toolkit (AzureCT) was developed to put some of these tools in an easy package.

These tools and methods are wrapped into a PowerShell module (AzureCT) that you can install and use

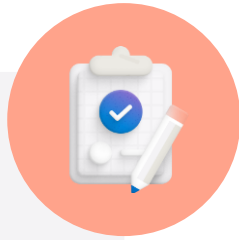


```
E:\>
E:\> Get-LinkPerformance -RemoteHost 127.0.0.1 -TestSeconds 10
6/30/2017 4:50:18 PM - Stage 1 of 6: No Load Ping Test...
6/30/2017 4:50:30 PM - Stage 2 of 6: Single Thread Test...
6/30/2017 4:50:56 PM - Stage 3 of 6: 6 Thread Test...
6/30/2017 4:51:22 PM - Stage 4 of 6: 16 Thread Test...
6/30/2017 4:51:49 PM - Stage 5 of 6: 16 Thread Test with 1Mb window...
6/30/2017 4:52:15 PM - Stage 6 of 6: 32 Thread Test...
Testing Complete!

Name                               Bandwidth      Loss      P50
----                               -
No Load                           N/A            0% loss   1.87ms
1 Session                          6.79 Gbits/sec 0% loss   0.92ms
6 Sessions                         8.39 Gbits/sec 0% loss   1.94ms
16 Sessions                        7.50 Gbits/sec 0% loss   4.34ms
16 Sessions with 1Mb window        7.33 Gbits/sec 0% loss   19.405ms
32 Sessions                        7.17 Gbits/sec 0% loss   8.335ms

E:\>
```

Learning Recap – Troubleshoot ExpressRoute Connection Issues



Check your
knowledge
questions and
additional
study

[Azure ExpressRoute: Verify Connectivity – Troubleshooting Guide | Microsoft Docs](#)

[Troubleshoot network link performance: Azure | Microsoft Docs](#)

[Reset a failed circuit – ExpressRoute: PowerShell: Azure | Microsoft Docs](#)

End of presentation

