



NetBrain[®] Integrated Edition

Public Cloud Support Release Notes

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1. NetBrain Public Cloud Visual Management Summary

As more and more IT workloads are being moved to the public cloud, such as AWS, Azure, and Google Cloud Platform (GCP), operating the public cloud environment becomes challenging for IT specialists. Even if the automation and agility during the provisioning process have been greatly improved, it is not the same for the manageability of the public cloud environment. The main challenges of managing the public cloud consist of the following aspects:

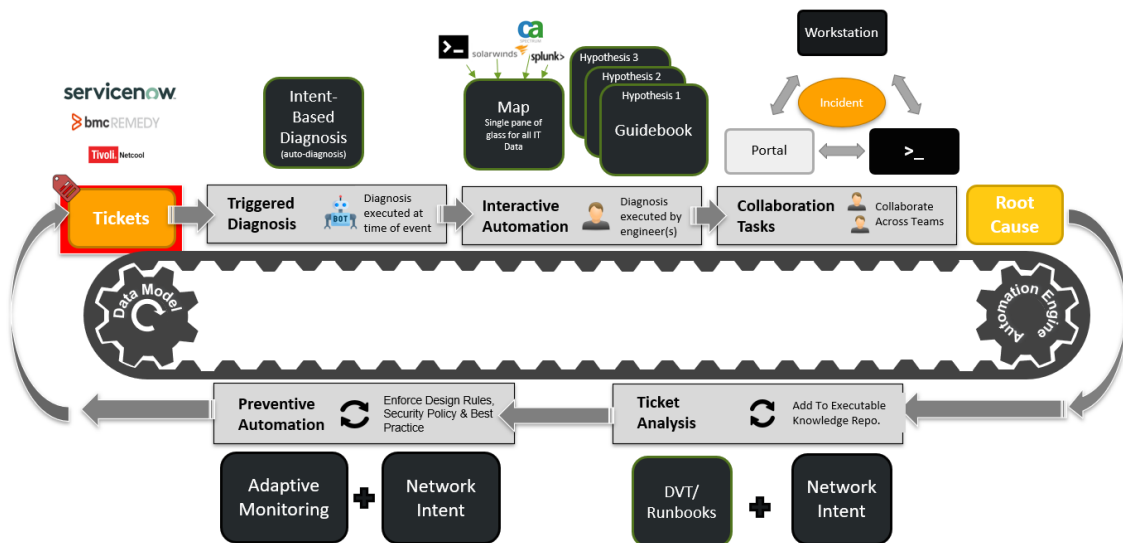
- **Lack of visibility:** agile provision of cloud resources makes visibility difficult using the traditional manual method.
- **A huge number of accounts and subscriptions:** to comply with the security requirements, you may have a huge number of accounts and subscriptions that are used by different teams, managing all resources scattered in all these accounts and subscriptions bring a huge management burden to the team when it comes to the troubleshooting cloud issues.
- **Multi-cloud and hybrid-cloud environments:** East-West Traffic supporting key applications often traverse physical data centers, SDN data centers, and public cloud. You may also have different public cloud providers to prevent vendor lock-in. As a result, many organizations bring multiple public cloud providers into their production use, and you will need to understand different cloud providers' uniqueness.
- **Collaboration within different teams and customers:** The application that traverses through your network may involve multiple teams: network team, security team, cloud team, server team, and application team. When a problem occurs, you may need to involve all the related teams to determine the root cause.

The need to have visibility into the public cloud becomes very critical. Therefore, in NetBrain IE v10.0 and v10.1, we have built the support for AWS, Azure, and GCP, and the support consists of the following areas:

- **Auto Discovery:** NetBrain can discover public cloud resources and update the data periodically by leveraging the benchmark function with the auto-discovery function.
- **Review network data and config with dynamic mapping:** as we do for traditional network and SDN networks, we use API to access the public cloud environment and provide the data model to build the map based on the data model. The system can periodically retrieve the data from public cloud providers and update the data model accordingly.
- **Map application dependency across the end-to-end network:** with the ability to build the data model for public cloud, SDN, SD-WAN, and the traditional network, NetBrain can provide you the path analysis function across the entire network. NetBrain can check the routing table/security group/network ACL for all the networking objects along the path and display the checking result details.
- **SPOG access through cloud-native and 3rd party cloud management tools:** NetBrain can use Data View Template (DVT) to display the cloud infrastructure data from the native cloud API, display the cloud monitoring data from the native cloud monitoring, and we can integrate with any of your

cloud monitoring tools, Datadog, Splunk, Dynatrace for example, to overlay the monitoring metrics/logging information on the NetBrain map.

- **Automate Troubleshooting with Runbook:** The support for Runbook Automation is also expanded to the support of the public Cloud. You can build different Runbooks according to your public cloud troubleshooting scenarios and leverage the Automation within NetBrain's entire automation reference workflow.



2. Discover Public Cloud Resources

NetBrain uses either key-based access or role-based access to discover public cloud resources.

The screenshot displays the NetBrain API Server Manager interface. At the top, there are tabs for 'Start Page', 'Discover', and 'API Server Manager'. Below the tabs, it shows 'Total Items: 37' and a '+ Add API Server' button. A table lists various API sources, including ACI MSO, Amazon AWS, and others. Two modal windows are open, both titled 'Edit External API Server'.

Modal 1 (Top):

- Server Name: AWS_Lab_Account_747895045325
- Description: The Lab account that has configured transit VPC
- API Source Type: Amazon AWS
- Access Method: Key-based Access
- Endpoint(Account ID): Key-based Access (selected), Role-based Access
- Access Key ID: AKIA24IQEXTGT3VEWB73
- Secret Access Key: *****
- Front Server: netbrains2924(192.168.29.24)

Modal 2 (Bottom):

- Server Name: 01-GCP Lab
- Description: Discovery for GCP Netbrain Lab
- API Source Type: Google Cloud
- Endpoint (OAuth 2.0 Client ID): 596315864195-hid7fehcapqnerb6nruqj66t3dvst0i9.apps.googleusercontent.com
- Client Secret: *****
- Organization ID: 114793346295
- Front Server: FS_192_168_48_144(192.168.48.144)

Advanced Section (Bottom):

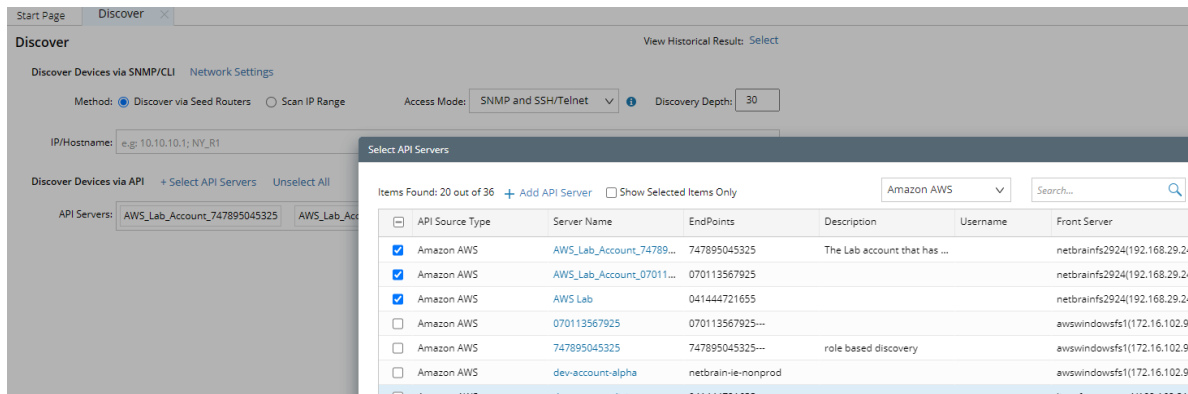
Parameter List: 1 items + Add

Key	Value
Refresh Token	*****

Managed Devices: 399

Buttons: Test, Cancel, OK

You can run the discovery function with the specified accounts to discover the public cloud resources.



Benchmark tasks can be set up to retrieve the public cloud resources periodically. The discovered objects are displayed in the Network Tree.

2.1. AWS Network Tree

AWS network tree is a hierarchical view, Account > Region > VPC > Subnet. The networking objects are listed based on their hierarchy. For example,

- Transit gateway is listed under regions as transit gateway is a regional service that resides within a certain region.
- AWS direct connect gateways are logical components that can interconnect VGW and TGW from different regions listed under the account.
- AWS direct connect router is a physical device that resides in certain direct connect locations listed under the region.

Network

Category

AWS

View

Network Centric ViewL...

Find...

- Region: us-east-1(6)
 - Region: us-east-2(6)
 - DX Gateways
 - Region: ap-northeast-1(6)
 - Region: ca-central-1(7)
 - Region: us-east-1(17)
 - Region: us-east-2(11)
 - Transit Gateways(1)
 - VPC: SharedFrom070113567925 Test | 172.29.0.0/16(2)
 - VPC: VPC1-TestPeerConnection | 10.30.0.0/16(9)
 - VPC: spoke-vpc-2 | 172.26.2.0/24(12)
 - VPC: spoke-vpc-3 | 172.26.3.0/24(12)
 - VPC: transit-vpc | 172.26.0.0/24(10)
 - CSR1000V: ip-172-26-0-114(1)
 - CSR1000V: ip-172-26-0-13(1)
 - VPC Router: transit-vpc
 - Subnet: transit-private-a | 172.26.0.128/26
 - Subnet: transit-private-b | 172.26.0.192/26
 - Subnet: transit-public-a | 172.26.0.0/26 (1)
 - EC2: awsAWS-Support Test | 172.26.0.46
 - Subnet: transit-public-b | 172.26.0.64/26 (1)
 - IGW: transit-igw
 - VGW: BGP-Transit-NB-VGW
 - Gateway VPC Endpoint: vpce-00bbc0fbb428e87eb
 - VPC: vpc-00a3b35e314056695 | 172.26.1.0/24(15)
 - VPC: vpc-0c2701148082b113a | 172.27.0.0/16(1)

EC2: awsAWS-Support Test | 172.26.0.46

Context Maps

Device Details

EC2: awsAWS-Support Test | 172.26.0.46_L3 Topology

Context Action: None

Last updated by Eddy at 12/17/2020, 12:16:37 AM

From the **Device Details** pane, you can view the details for each object, and the hyperlink will take you to the AWS console directly.

Property

Interfaces

Name:	awsAWS-Support Test(i-00f7ccd3f1bcf96ca)
Instance ID:	i-00f7ccd3f1bcf96ca
AMI ID:	ami-0d5d9d301c853a04a
Instance Type:	t2.micro
Launch Time:	2020-12-16 12:00:34+00:00
Owner:	747895045325
Availability Zone:	us-east-2a
Platform:	linux/Unix
Private DNS:	ip-172-26-0-46.us-east-2.compute.internal
Private IP:	172.26.0.46
Public DNS (IPv4):	
Security Groups:	sg-00808211878a9b791
Source/dest. check:	true
Instance state:	running
Subnet ID:	subnet-01fb350af825a53f5
VPC ID:	vpc-08248fb7d26b2feca
Tags:	
Name:	awsAWS-Support Test

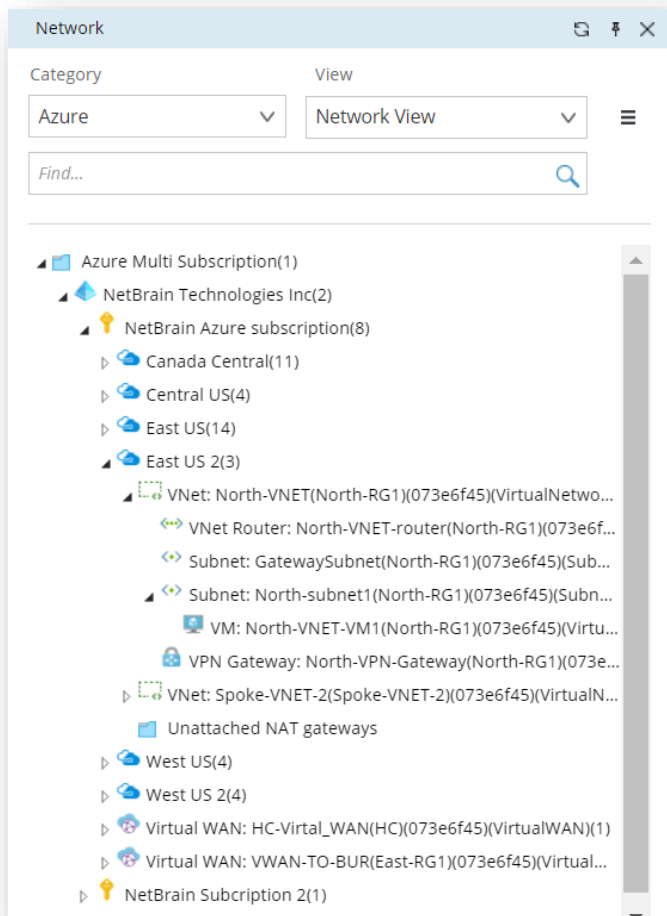
2.2. Azure Network Tree

Below is an example of a hieratical view for the Azure resources:

- Level 0: Tenant
 - Level 1: Subscription
 - Level 2: Region
 - Level 3: VNet
 - Level 4: Virtual Network Distributed Router
 - Level 4 : Subnet
 - Level 5: Virtual machines
 - Level 4: VPN Gateway
 - Level 4: Express Route Gateway
 - Level 4: Application Gateway
 - Level 4: Azure Load Balancer (Internal)
 - Level 4: NAT Gateway
 - Level 4: Azure Firewall
 - Level 3: MSEE
 - Level 3: Azure Load Balancer (Public)
 - Level 3: Unassigned NAT Gateway
 - Level 2: Virtual WAN
 - level 3: Virtual WAN Hub
 - level 4: VPN Gateway for vHub
 - level 4: Express Route Gateway for vHub
 - level 4: Azure Firewall

The networking objects are listed based on their hierarchy. For example,

- The virtual network as a parent node includes a sub-node virtual network distributed router and subnet. The virtual network distributed router is a NetBrain conceptual component to simulate a virtual network as a network object to build a relationship with other resources that belong to this virtual network. The virtual machine is listed under the subnet that belongs to this virtual network.
- The VPN gateway, ExpressRoute gateway, application gateway, Azure load balancer (internal), NAT gateway, Azure firewall are listed under the virtual network to which they belong.
- If the NAT gateway does not belong to any virtual network, it will be listed under the region as an unassigned NAT gateway.



You can view the details for each object from the details pane, and the hyperlink will take you to the Azure console.

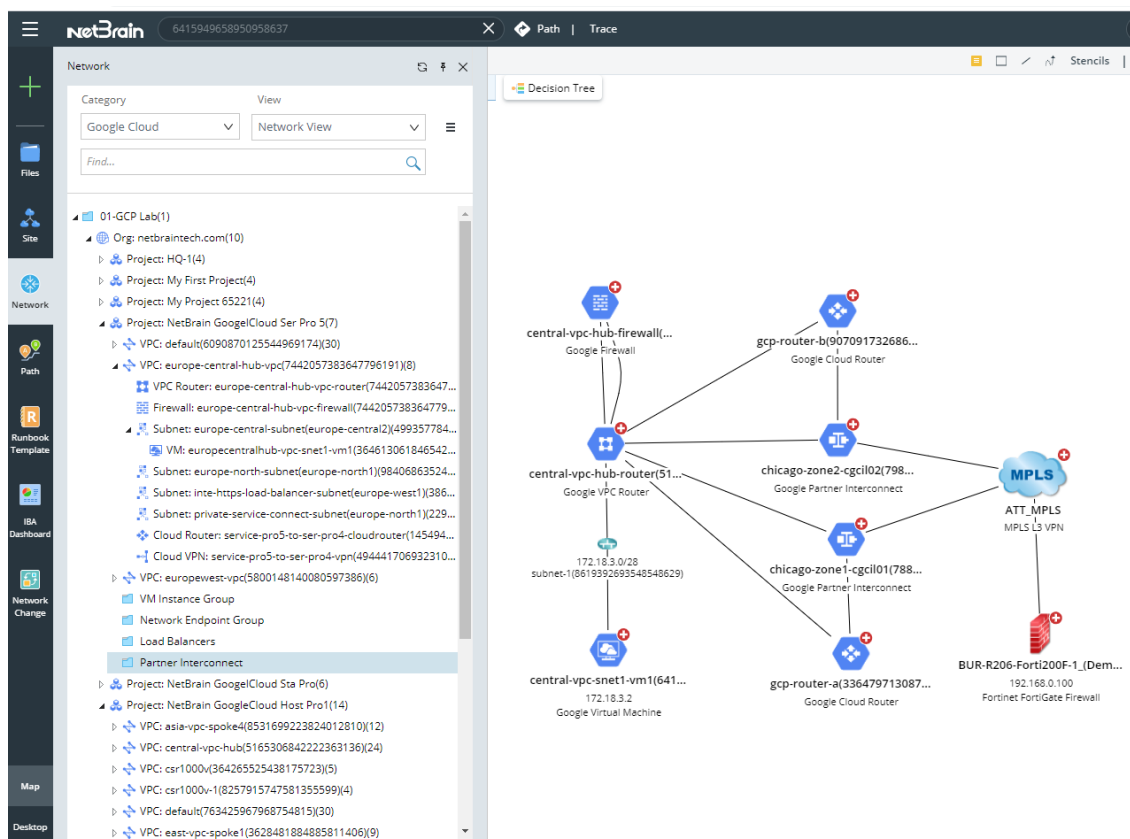
2.3. GCP Network Tree

GCP network tree is a hieratical view, Organization > Folder > Project > VPC Network. Through this tree, you have access to all accounts in a single view.

- Level 1: Google Organization
 - Level 2: Google Folder
 - Level 2/1: Google Folder
 - Level 2/2: Google Folder
 -
 - Level 2/2/.../n: Google Folder
 - Level 3: Google Project
 - Level 4: Google VPC Network
 - Level 5: Google VPC Router
 - Level 5: Google Subnet
 - Level 6: Google VM instance 1 (Folder)
 - Level 6: Google VM instance 2 (Folder)
 - Level 5: Google Cloud Router
 - Level 5: Google VPN Gateway
 - Level 5: Google Cloud NAT
 - Level 5: Google Firewall
 - Level 5: Google Network Virtual Appliance (NVA)
 - Level 6: Google VM instance
 - Level 4: Google VM Instance Group (Folder)
 - Level 4: Google Network Endpoint Group (Folder)
 - Level 4: Google Load Balancer (Folder)
 - Level 4: Google Partner Interconnect (Folder)
 - Level 4: Google Dedicated Interconnect (Folder)

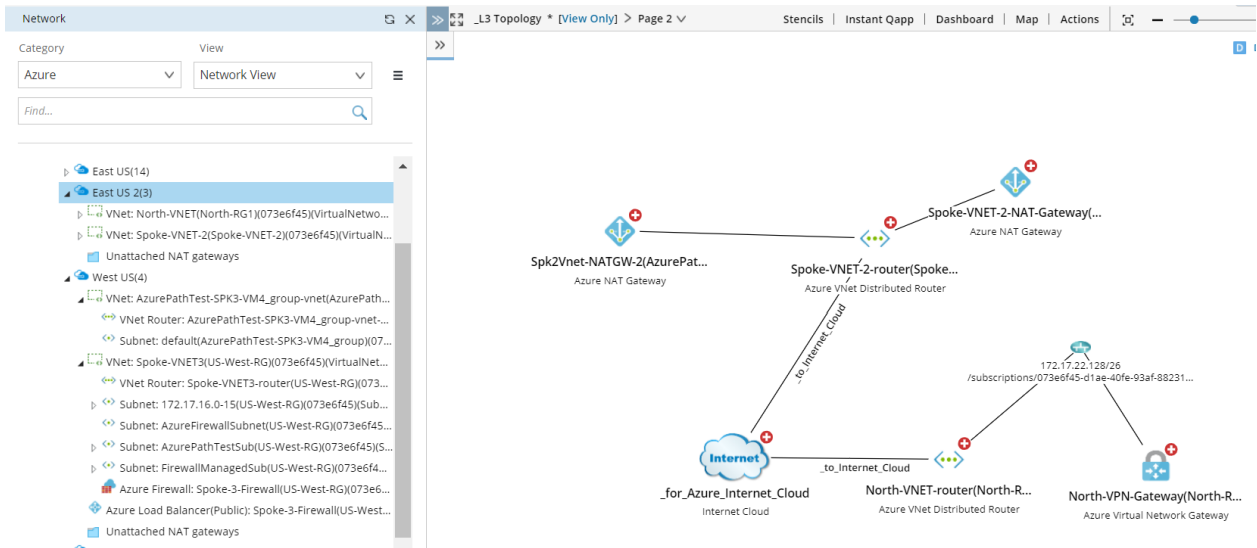
The network objects are listed based on their hierarchy, for example,

- The subnet is listed under the associated VPC Network.
- VM Instance is listed under the connected Subnet.
- Load Balancer is a logic object connected with different VPC networks in multiple regions under the project.
- Interconnect is not associated with a specific VPC Network, so it is under the project.

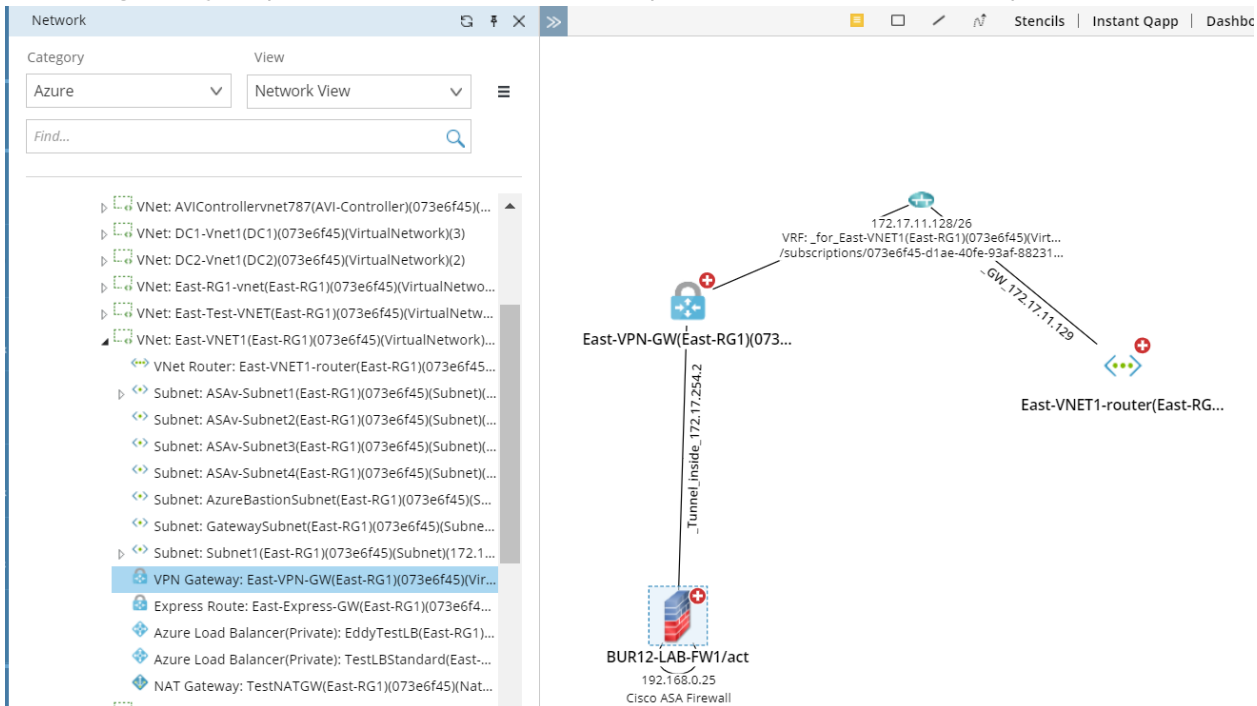


You can click an object from the network tree to view its detailed info, and the hyperlink will bring you to the GCP page for this object.

central-vpc-snet1-natvm(3...
172.18.3.6
Google Virtual Machine

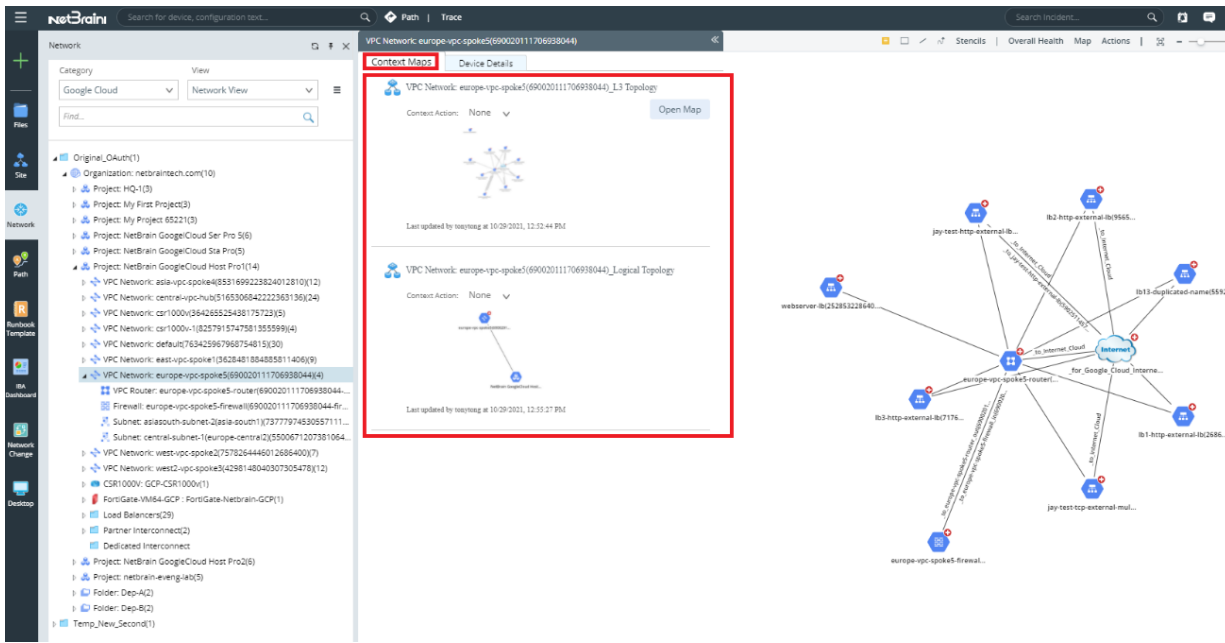


The VPN gateway map demonstrates the relationship between Azure and the on-premise network.

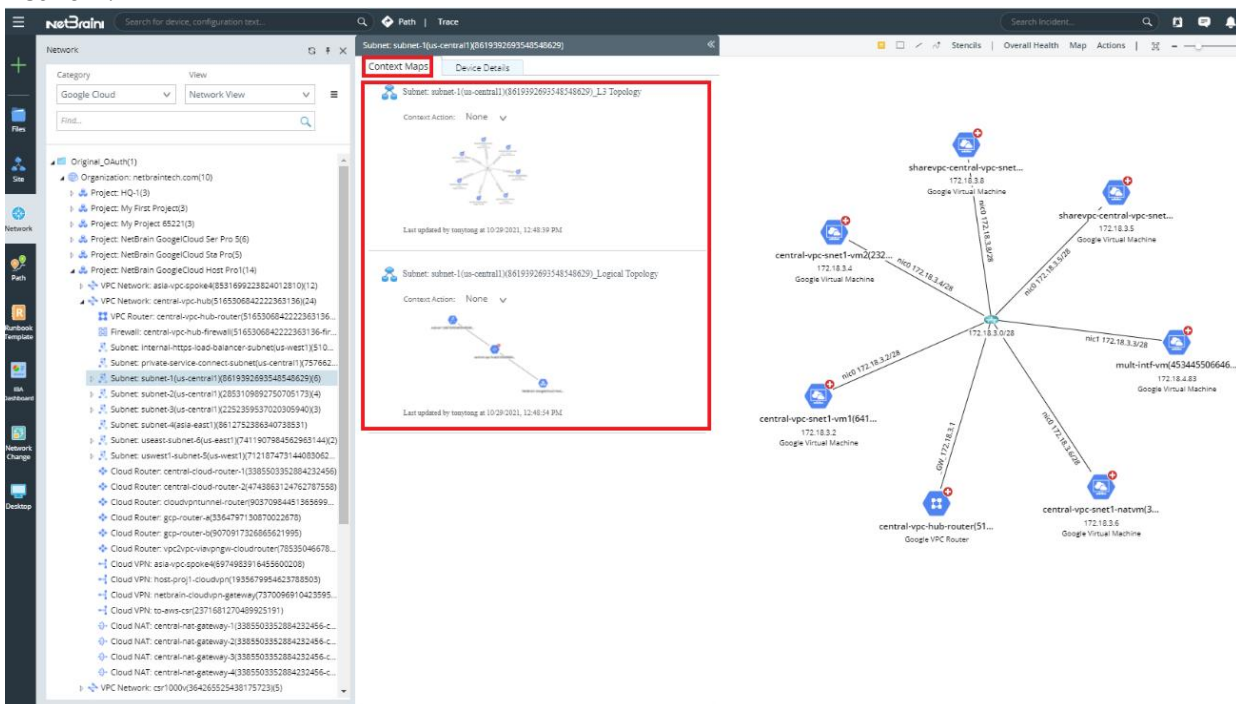


3.3. GCP Context Map Examples

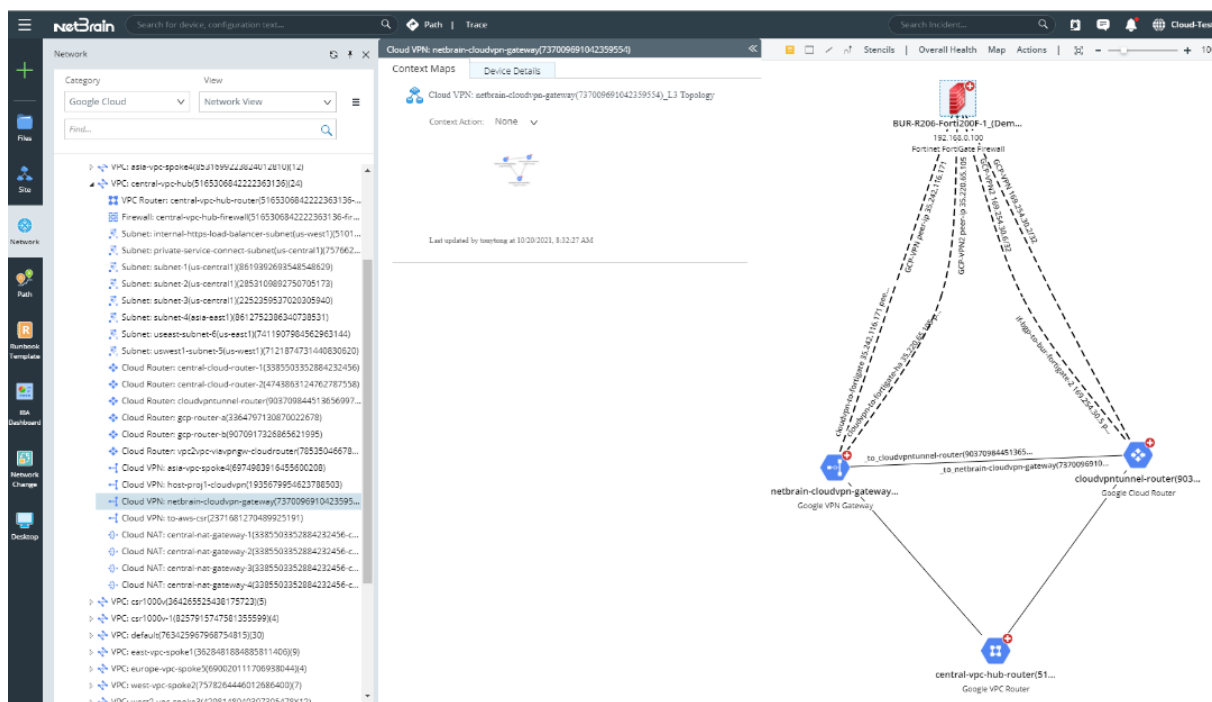
A GCP VPC Context Map demonstrates the Network reachability of a VPC Network.



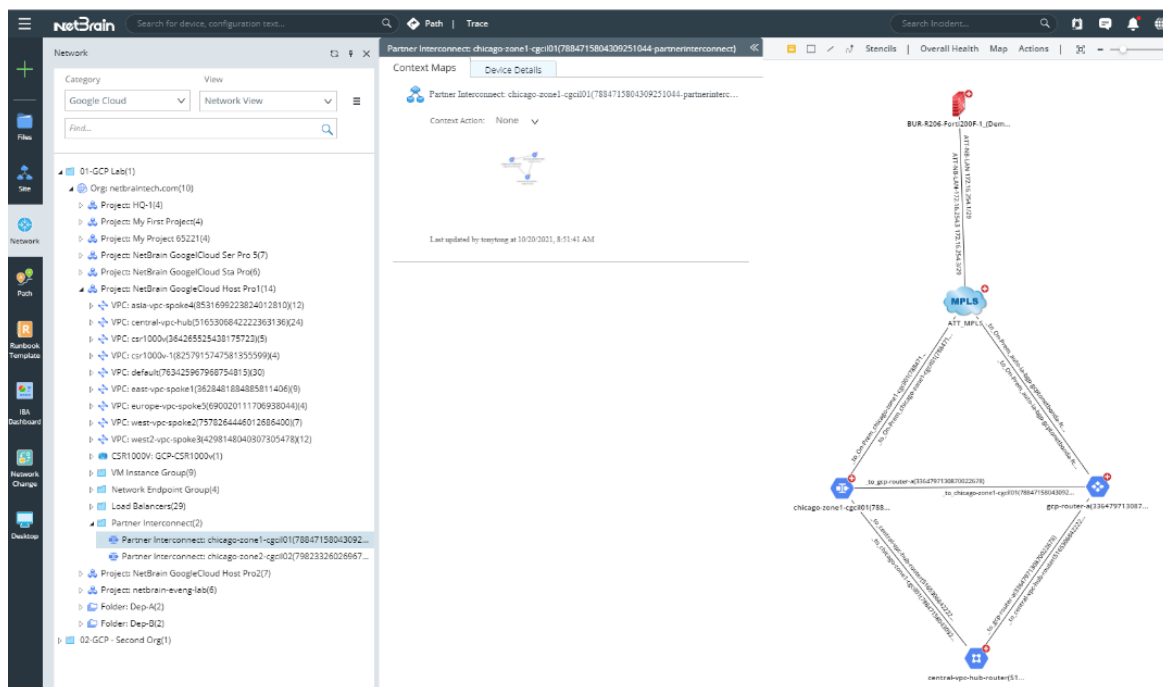
A subnet context map shows the virtual machine instances connected to the subnet within the VPC network.



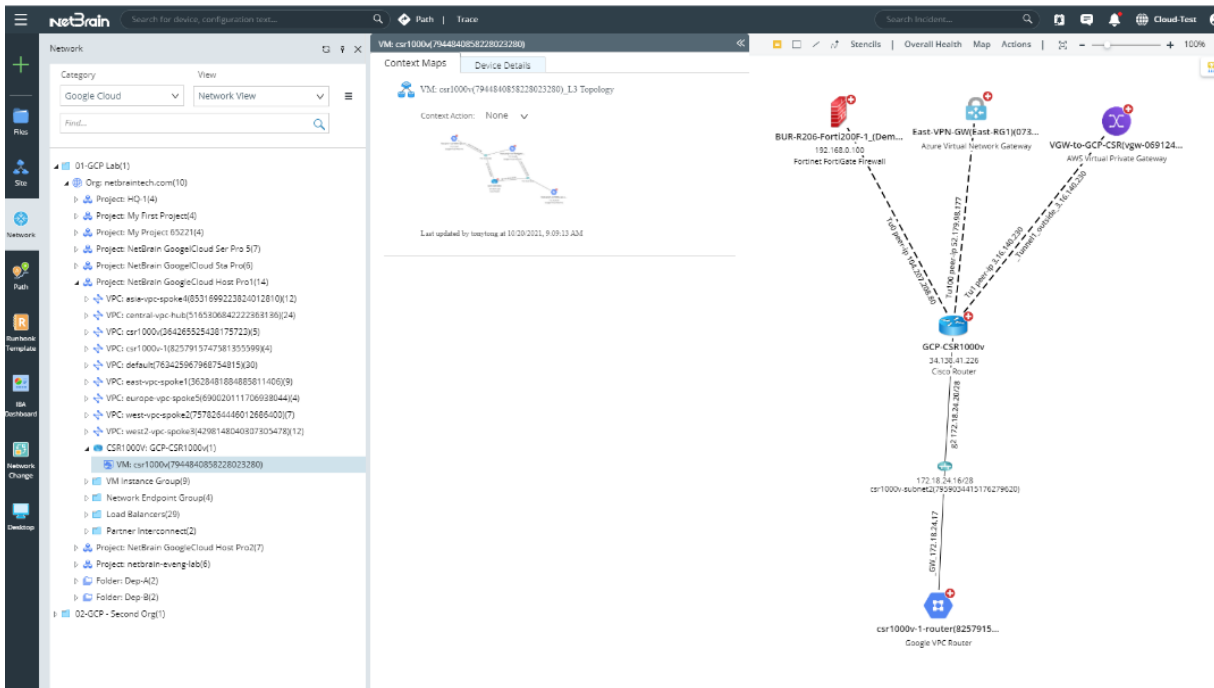
A VPN Gateway context map shows the relationship between Google Cloud and the on-premises network. The IPsec VPN connection between the VPN gateway and the on-premise edge device will be displayed. Also, the link for BGP Session between the Cloud Router and the on-premises edge device will be displayed.



A Partner Interconnect context map shows the relationship between Google Cloud and the on-premises network. The private link connection between Interconnect and on-premises edge devices is displayed. Also, the link for BGP Session between Cloud Router and on-premises edge devices will be displayed.

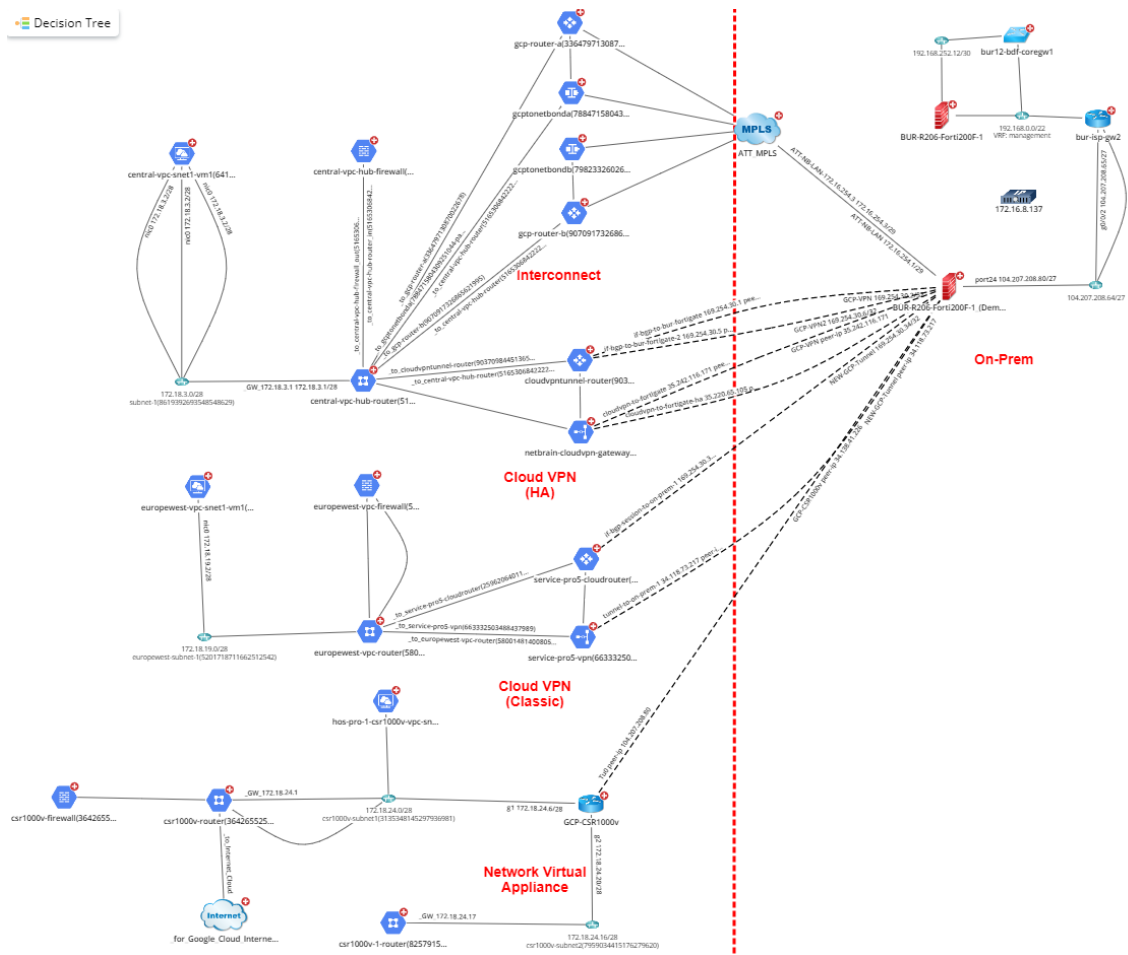


An NVA context map shows the relationship between NVA and the on-premises network. The IPsec Tunnel connection between NVA and on-premises edge device is displayed.



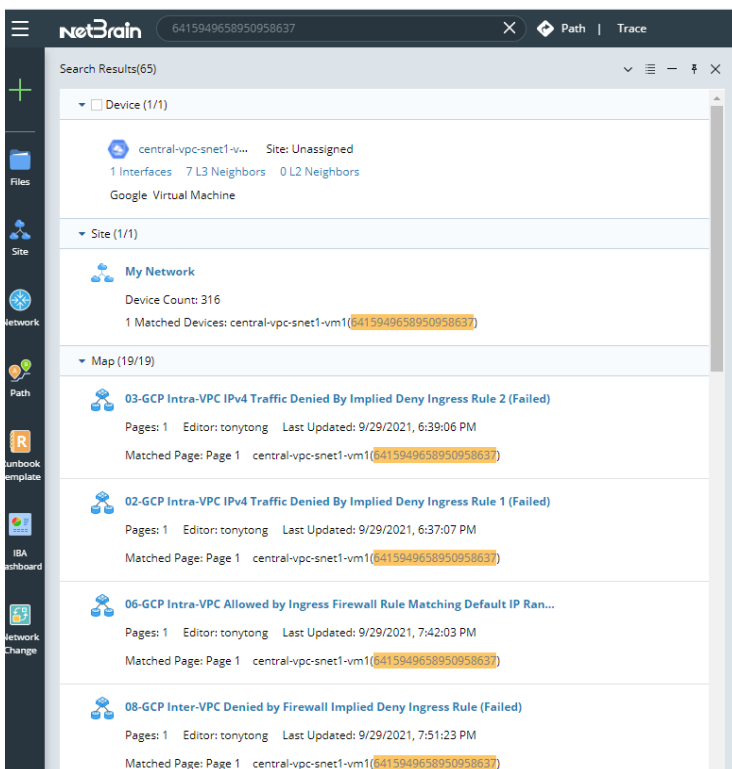
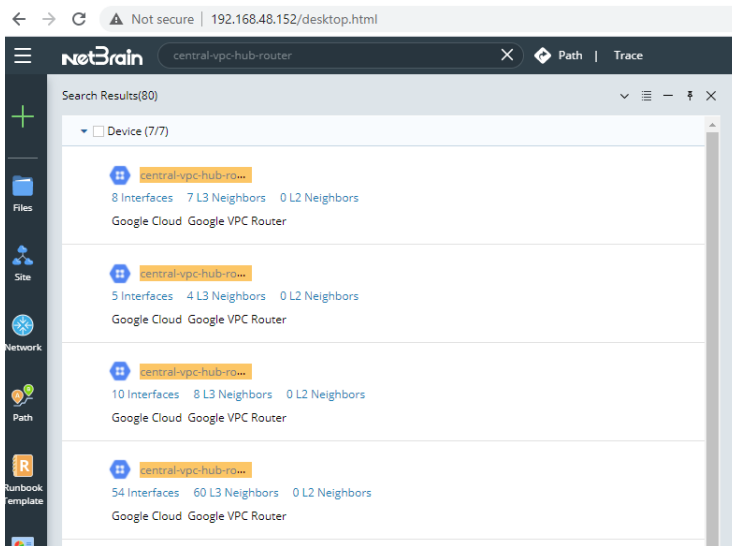
3.4. Hybrid Network Topology Map

You can create a map to display the connections between public cloud objects and on-premises network devices.



3.5. Search and Map

You can search a public object with its name, IP address, or ID to identify where the resource is located and create maps based on the search results.

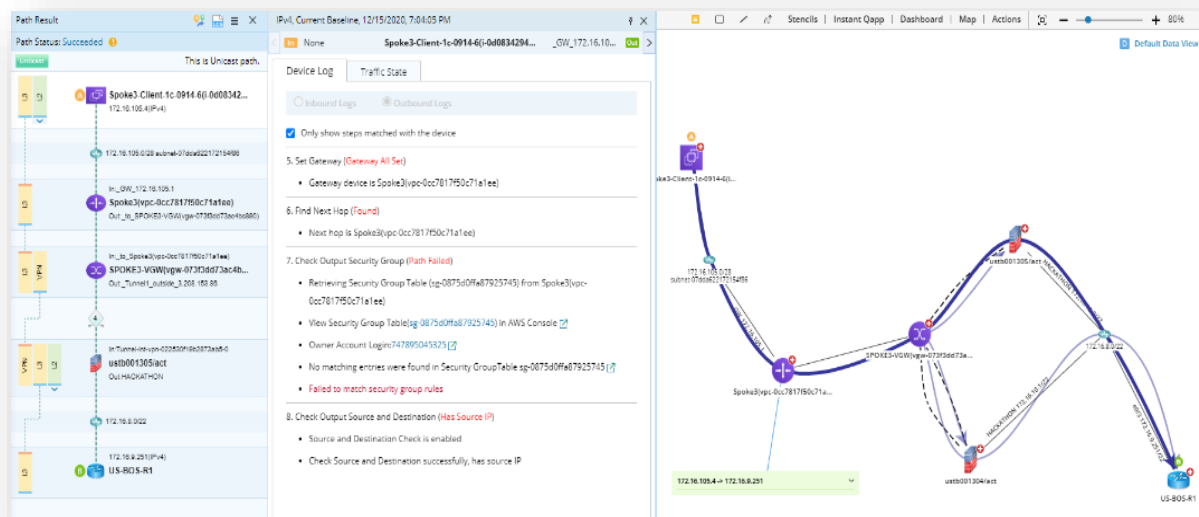


3.6. Extend Neighbors

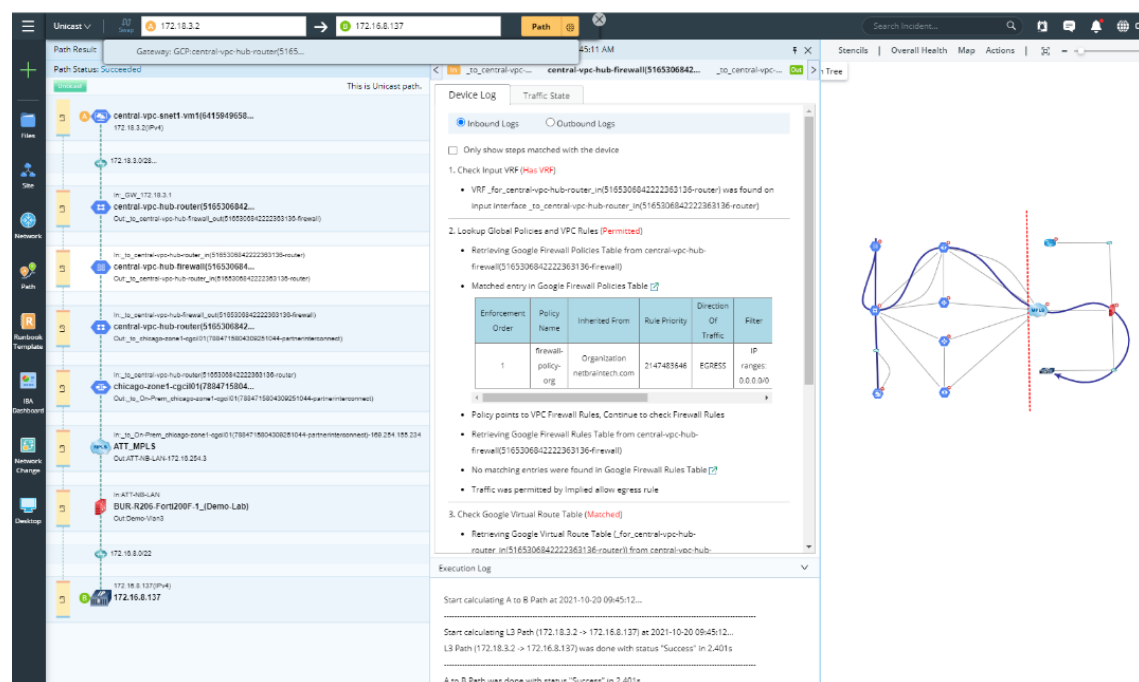
Another way to find your public cloud resources is through the extend neighbor function. Extend the neighbor of an On-Prem device to map out the public cloud environment connected to this device.

4. Application Path Across Hybrid and Multi-cloud

The path function has been extended to AWS and Azure in v10.0 and GCP in v10.1. The system supports end-to-end path calculation in a hybrid and multi-cloud environment, and you can analyze the traffic flow between two endpoints.

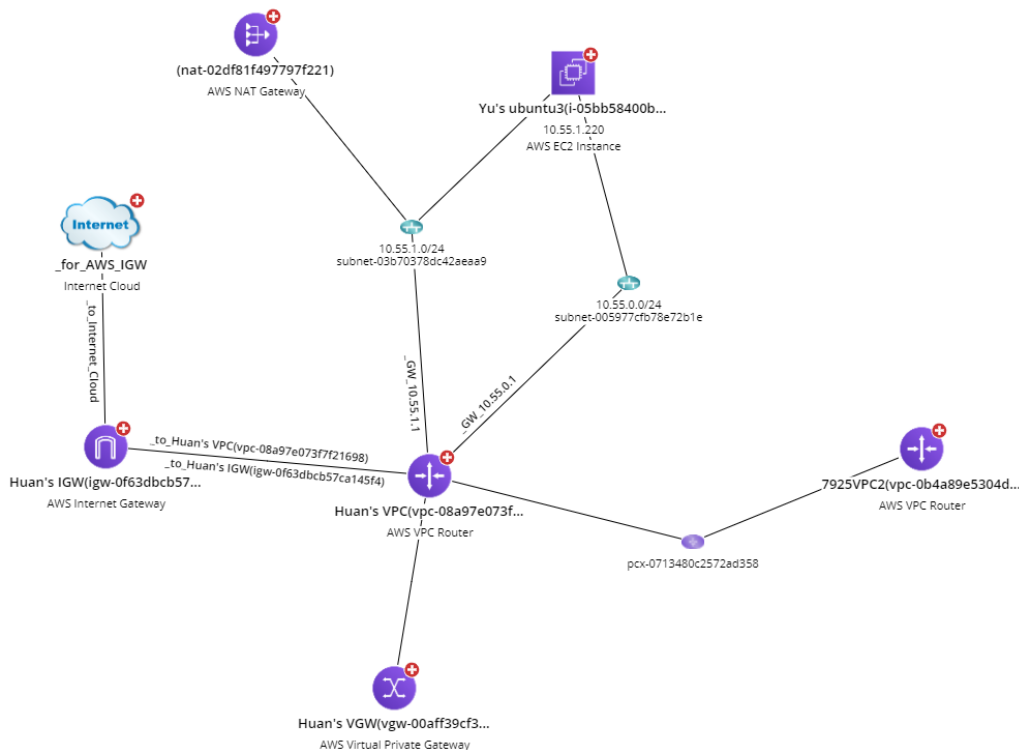


Path calculation will render the related routing and firewall rule/policy security check details.

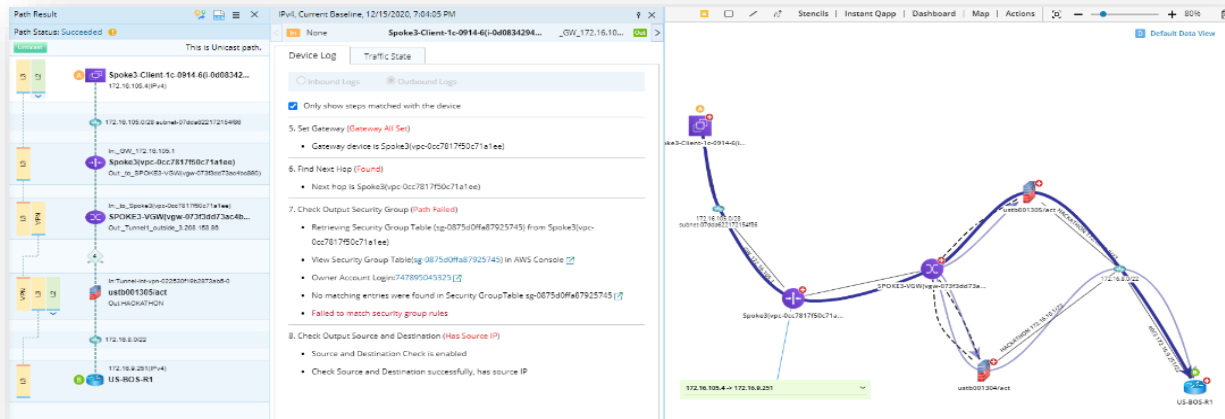


4.1. AWS Application Path

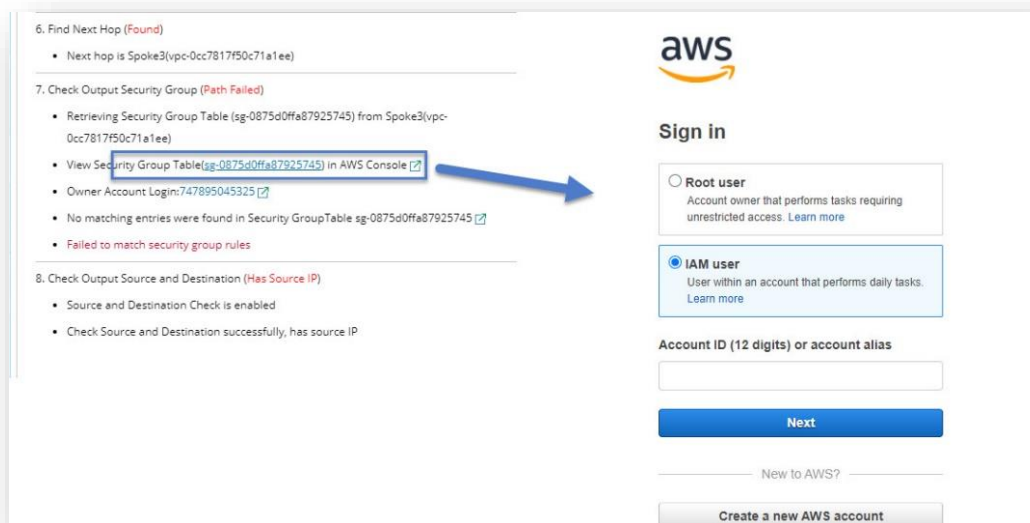
An AWS VPC consists of IP range and subnets, and it may also contain cloud-native networking services such as NAT gateway, IGW, VGW, etc. NetBrain will create an AWS VPC router for each VPC to simulate the routing and security check function for this VPC. The subnet is visualized in NetBrain's dynamic map via the concept called LAN media. From the dynamic map, you can view different networking objects and how they are connected. VPC peering is also supported, and the corresponding peering ID will be visualized in the dynamic map.



Path calculation will render the path log containing the related routing and security check details.

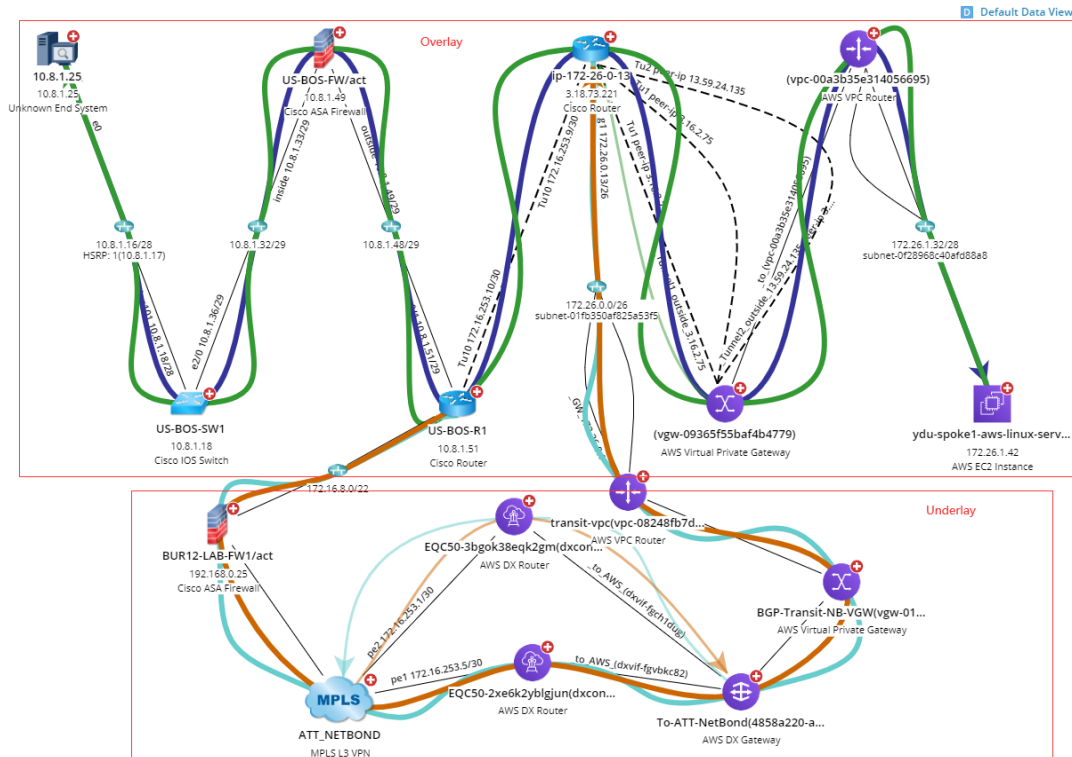


The link of each object will direct you to the AWS console, where you can view more information about the object or make desired changes.



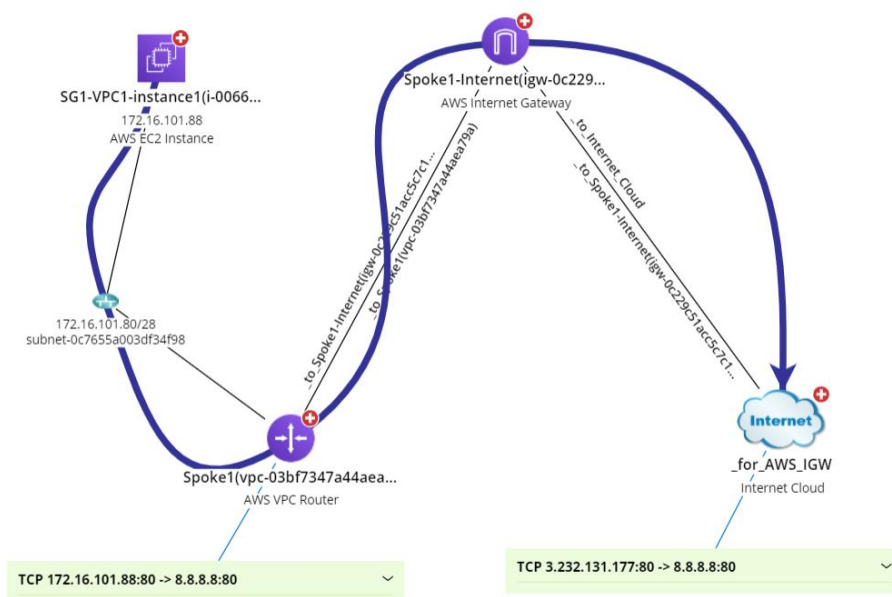
4.1.1. Traffic Across AWS and On-Premises Network

Below is an example demonstrating a path from an EC2 instance to an end system in the on-prem network. This transit VPC architecture builds the IPSEC tunnel between the customer gateway with the CSR1000v sitting in the transit VPC. The underlay communication is achieved via the direct connections via ATT Netbound.



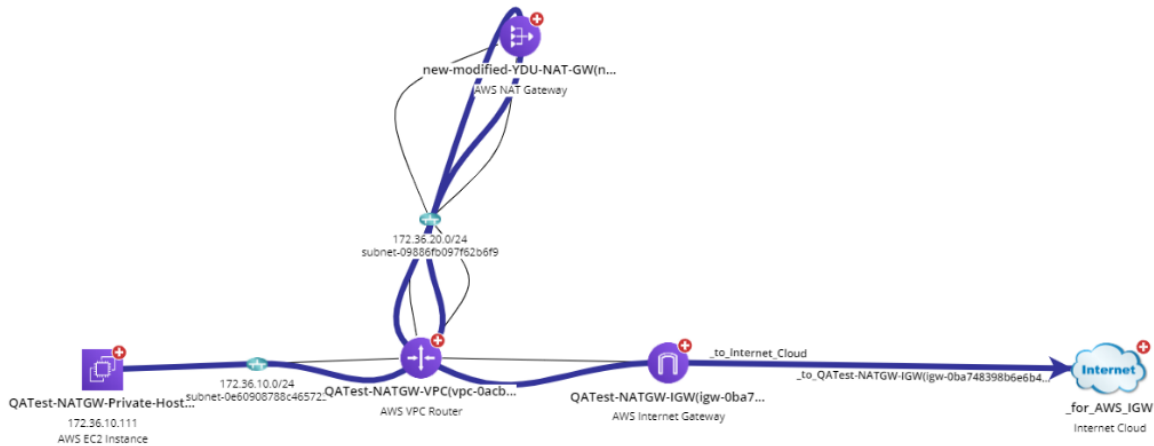
4.1.2. Access Internet Directly

The following path diagram demonstrates how an EC2 instance in a public subnet accesses the Internet directly.



4.1.3. Access Internet Via NAT Gateway

The following path diagram demonstrates how NetBrain can help you identify the traffic flow when an EC2 instance tries to access the Internet via NAT gateway. From the path log, you will better understand how the NAT works.



The key to supporting the end-to-end path for the public cloud environment is understanding all routing and security checks across the entire network. You may know AWS does not provide the routing tables for the following networking objects:

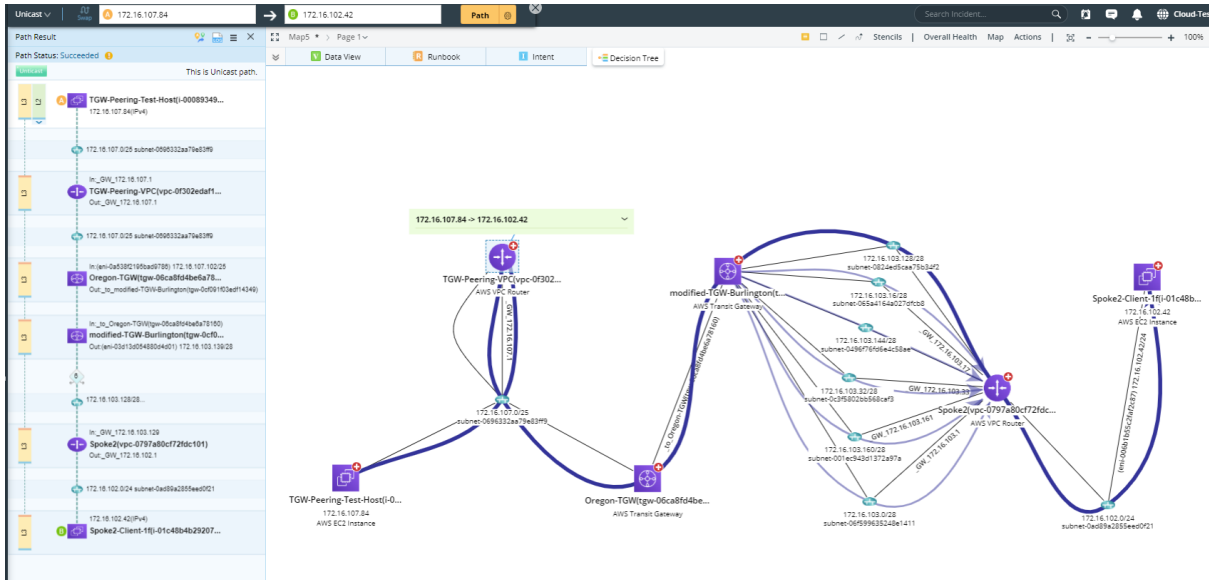
- Virtual private gateway
- Direct connect gateway
- Direct connect router

NetBrain invents a unique algorithm to build the virtual routing table based on the topology info and route advertisement it captures for the surrounding devices.

AWS Virtual Route Table of BGP-Transit-NB-VGW(vgw-01fc88164f72433e2)							
Data Source: Current Baseline		Execution Time: 12/22/2020, 2:56:00 PM					
NCT: AWS Virtual Route ...		Subname: _for_transit-vpc(vpc-08248fb...		Search...			
Destination	Type	ALG	Local Preferenc...	AS Path	DX Location	Out Interface	Originator
172.16.101.0/...	Direct Connect	B				_to_To-ATT-Net...	Spoke1(vpc-03...
172.16.8.0/22	Direct Connect	B		64665 64665 6...		_to_To-ATT-Net...	ustb001306/act
172.16.8.0/22	Direct Connect	B		64666 64665		_to_To-ATT-Net...	ustb001307/act

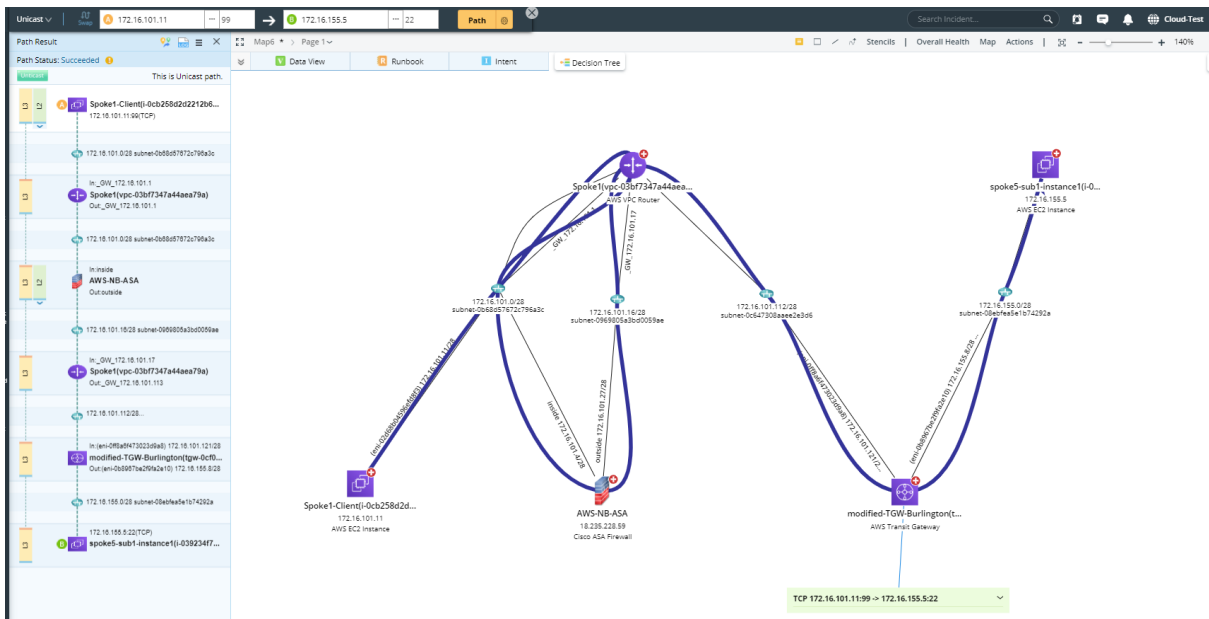
4.1.4. Internal Path via TGW

The following path diagram demonstrates how NetBrain can help you identify the traffic flow between two EC2 inside AWS via Transit Gateway (TGW).



4.1.5. Network Virtual Appliance Path

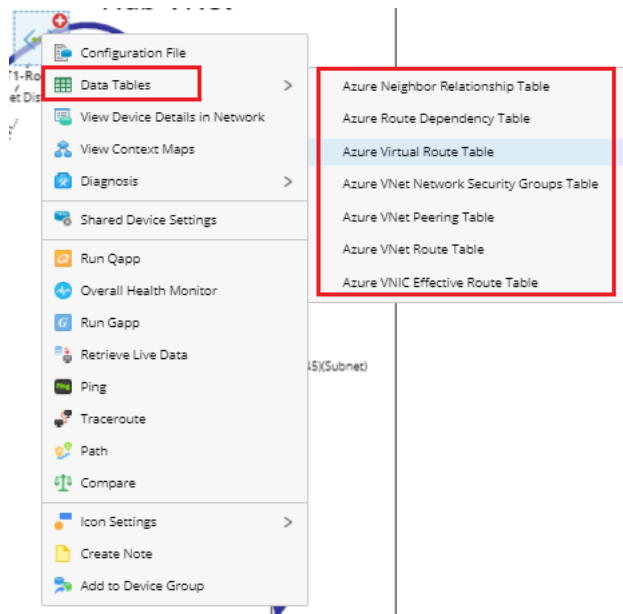
The following path diagram demonstrates how NetBrain can help you identify the traffic flow across Network Virtual Appliance (NVA) like Cisco ASA Firewall.



4.2. Azure Application Path

NetBrain invented the concept of Virtual Network Distributed Router (VNet Router) with various resources and features to simplify the Azure Cloud network connections inside and outside the Virtual Network. The resources/features include:

- Routing information such as User Defined Route and Virtual Route Table for Virtual Network.
- Security rule information such as Network/Application Security Group rule in subnet/interface level.
- Peering information for various VNet peering details.
- Network Interface (NIC) Effective Route Table information.



NetBrain invents the unique algorithm to build the virtual routing table based on the topology info and route advertisement it captures for the surrounding devices. We strictly follow Azure's route selection priority rules to choose the best path available if multiple paths exist to the destination.

Azure Virtual Route Table of Spoke-VNET3-Router(US-West-RG)(073e6f45)(VirtualNetworkDistributedRouter)

Data Source: Current Baseline Execution Time: 1/29/2021, 2:29:44 PM

NCT: Azure Virtual Rout... Subname: _for_GW_172.17.16.1 Search...

Destination	Type	ALG	Local Preference	AS Path	Out Interface	Next Hop IP Address	Next Hop Device	Originator
10.0.0.0/8	Default							Spoke-VNET3-Router(U...
100.64.0.0/10	Default							Spoke-VNET3-Router(U...
192.168.0.0/16	Default							Spoke-VNET3-Router(U...
0.0.0.0/0	Default				_to_Internet_Cloud		_for_Azure_Internet_Cl...	Spoke-VNET3-Router(U...
172.16.101.0/24	ExpressRoute	B		8030	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	Bur-Netbond(Primary)(...
172.17.18.0/24	ExpressRoute	B		65515 65520 65520 e	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	Canada-Central-VNET1...
172.17.19.0/24	ExpressRoute	B		65515	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	East-Test-VNET-Router(...
172.17.251.0/30	ExpressRoute	B		65515	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	Bur-Netbond(Primary)(...
172.17.253.0/24	ExpressRoute	B		65515	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	East-VHUB(East-RG1)(0...
172.18.1.0/24	ExpressRoute	B		65515	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	2nd-Sub-Vnet-Router(2...
172.16.101.0/24	ExpressRoute	B		8030	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	Bur-Netbond(Secondar...
172.17.251.0/30	ExpressRoute	B		65515	_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	Bur-Netbond(Secondar...
8.8.8.8/32	UDR	U				172.17.16.68		/subscriptions/073e6f4...
172.17.14.0/30	UDR	U				172.17.16.68		/subscriptions/073e6f4...
172.16.101.0/24	UDR	U				172.17.16.68		/subscriptions/073e6f4...
172.17.17.0/24	UDR	U			_to_East-VNET1(East-R...	172.17.15.20		/subscriptions/073e6f4...
172.17.13.0/24	UDR	U			_to_East-VNET1(East-R...	172.17.15.20		/subscriptions/073e6f4...
172.17.11.0/24	VNet Global Peering	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	East-VNET1-Router(Eas...
172.17.15.0/24	VNet Global Peering	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	East-VNET1-Router(Eas...
172.17.11.190/32	VPN	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	East-VPN-GW(East-RG1...
172.17.14.0/24	VPN	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	West-Hub-VNET-Router...
172.17.22.132/32	VPN	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	North-VPN-Gateway(Nor...
172.17.22.133/32	VPN	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	North-VPN-Gateway(Nor...
172.17.22.0/24	VPN	B			_to_East-VNET1(East-R...		East-VNET1-Router(Eas...	North-VNET-Router(Nor...

4.2.1. Traffic Across Azure and On-Premises Network

There are different ways to connect an on-premises network to an Azure Virtual Network (VNet).

- **VPN Gateway**

VPN Gateway is a virtual network gateway that sends encrypted traffic between an Azure virtual network and an on-premises location. The encrypted traffic goes over the public Internet. NetBrain supports visualizing the topology and path of VPN Gateway as well as the following data tables:

- Azure Neighbor Relationship Table
- Azure Route Dependency Table
- Azure Virtual Route Table
- IPsec VPN Table

- **ExpressRoute Circuit**

ExpressRoute circuits connect your on-premises infrastructure to Microsoft through a connectivity provider. NetBrain supports visualizing the topology and path of Microsoft Enterprise Edge (MSEE), which connects to ExpressRoute Circuit, as well as the following data tables:

- Azure MSEE ARP Table
- Azure MSEE Route Summary Table
- Azure MSEE Route Table
- Azure Virtual Route Table

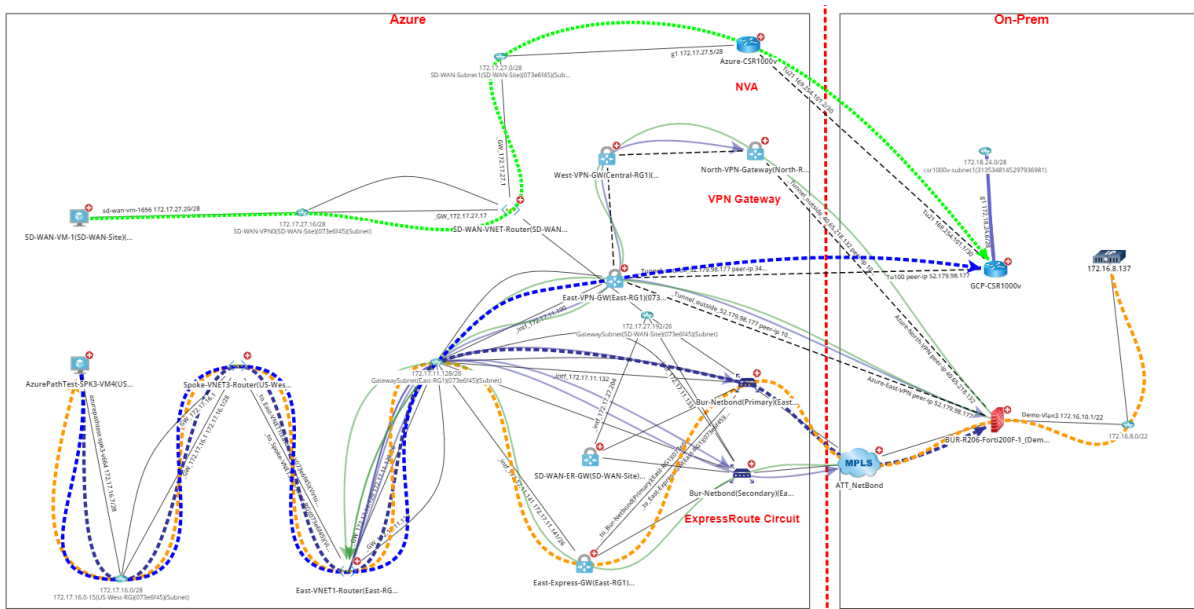
- BGP Advertised Routes Table

- **Network Virtual Appliance (NVA)**

NVA can be loaded with any vendor's virtual machine (VM) images to support the networking, security, and other functions. NetBrain supports visualizing the topology and path of the VPN Tunnel connection between Azure NVA and on-premises edge devices.

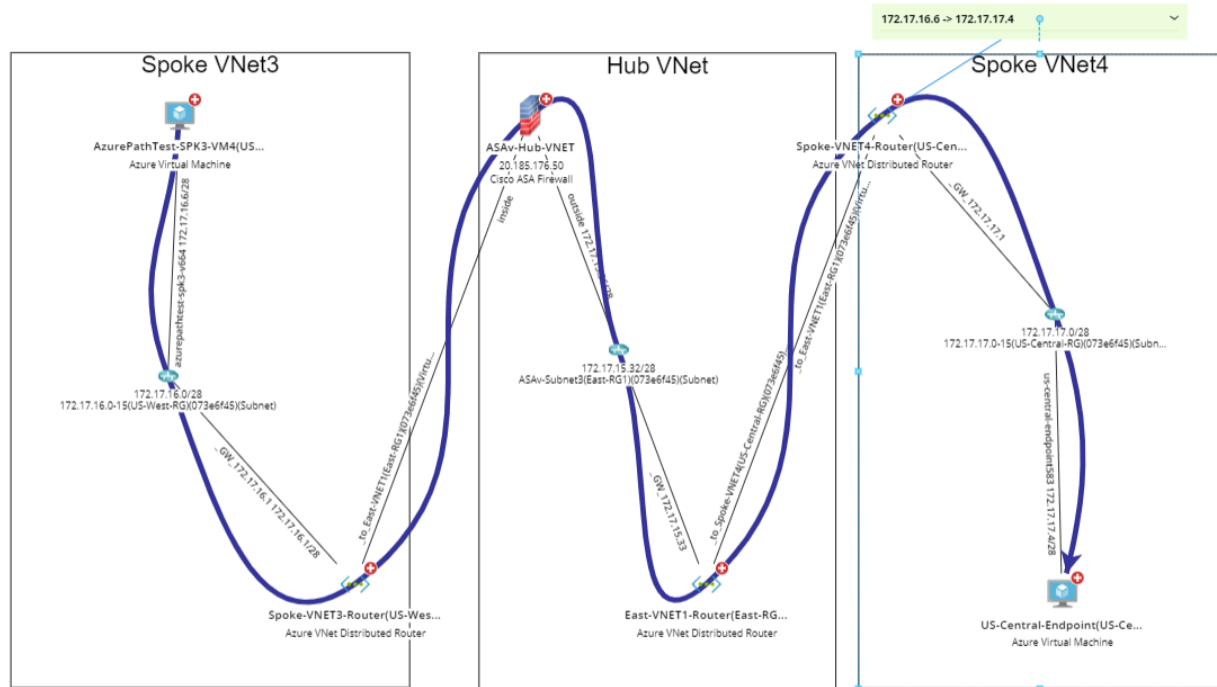
The following diagram demonstrates the path between Azure and the on-premises network, connected by the VPN, ExpressRoute, and VNA.

Path sample:



4.2.2. Hub-Spoke Network

Hub-Spoke Network path sample: you can visualize the abstract cloud traffic path between different Azure nodes and enhance your efficiency of troubleshooting cloud network issues. The Hub provides a secure network boundary using Network Virtual Appliance (NVA) such as Cisco ASA by checking all inbound and outbound network traffic and passing only the traffic that meets network security rules.

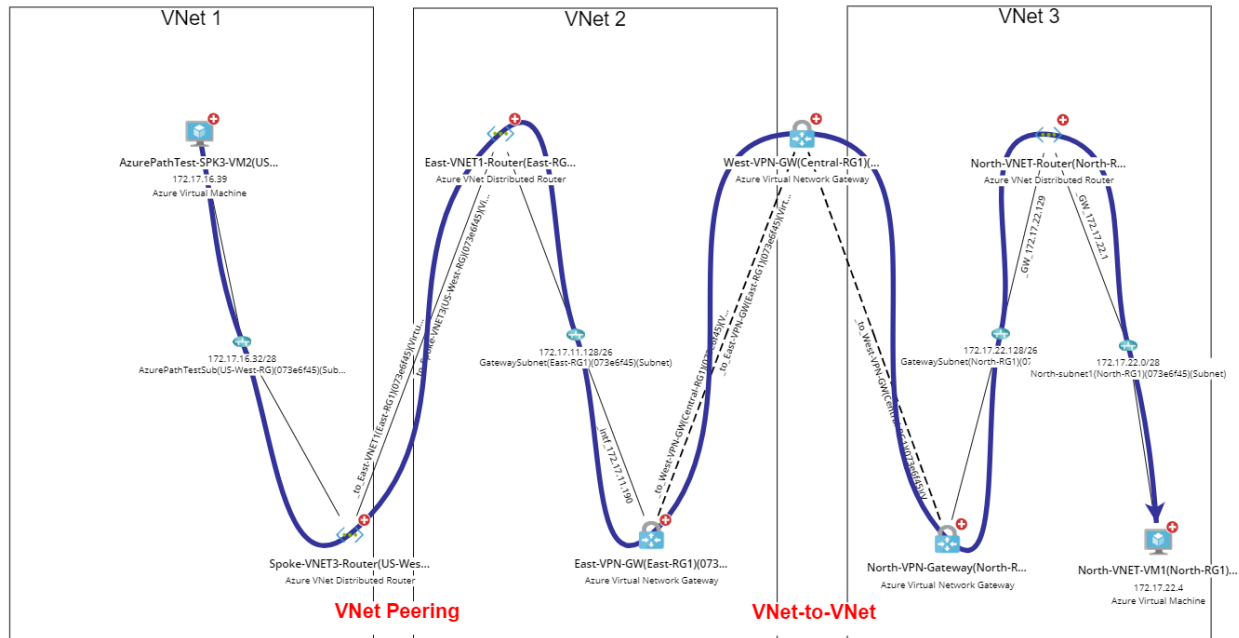


4.2.3. Virtual Network (VNet) Connect

Azure Virtual Network (VNet) can be connected via VPC peering or a VPN connection (VNet-to-VNet). NetBrain supports visualizing the topology and path of inter and intra Azure Virtual Networks, as well as the following data tables:

- Azure Neighbor Relationship Table
- Azure Route Dependency Table
- Azure Virtual Route Table
- Azure VNet Network Security Groups Table
- Azure VNet Peering Table
- Azure VNet Route Table
- Azure VNet Effective Route Table

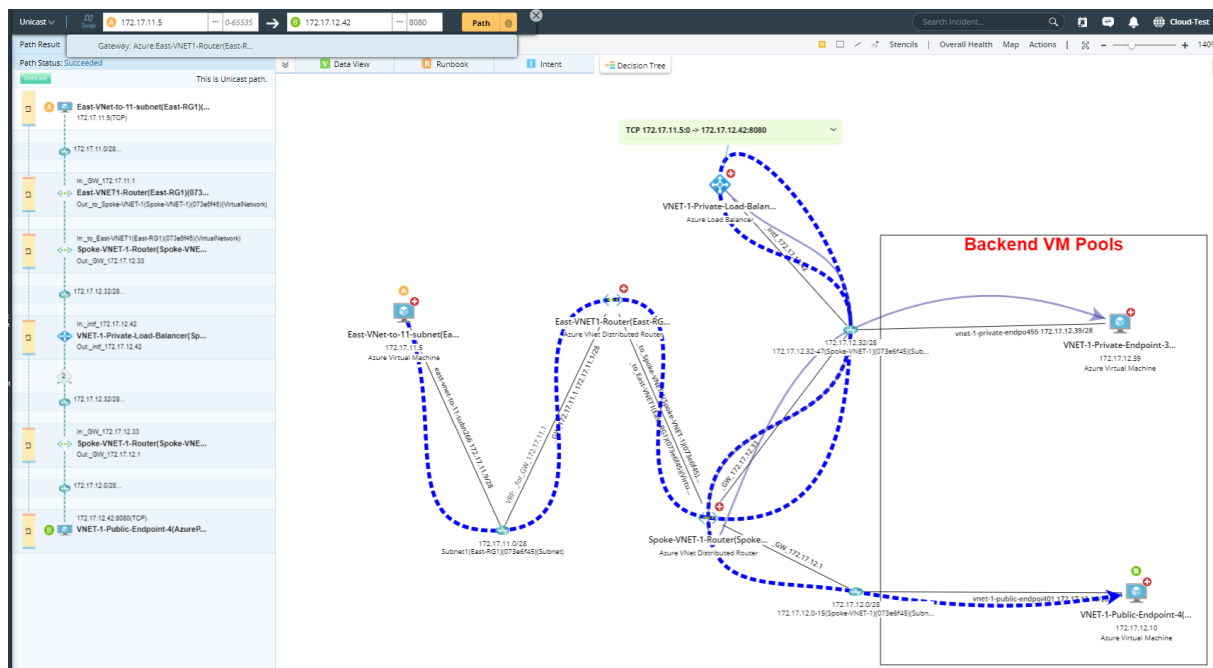
The following path demonstrates Azure VNet peering, which connects virtual networks so that workloads in different virtual networks can communicate internally. Thus, the traffic stays within the Azure backbone and does not traverse the public Internet.



4.2.4. Azure Load Balancer

Azure Cloud Load Balancing is a fully distributed, software-defined managed service. NetBrain supports visualizing the topology and path of both External and Internal Load Balancer, as well as the following data tables:

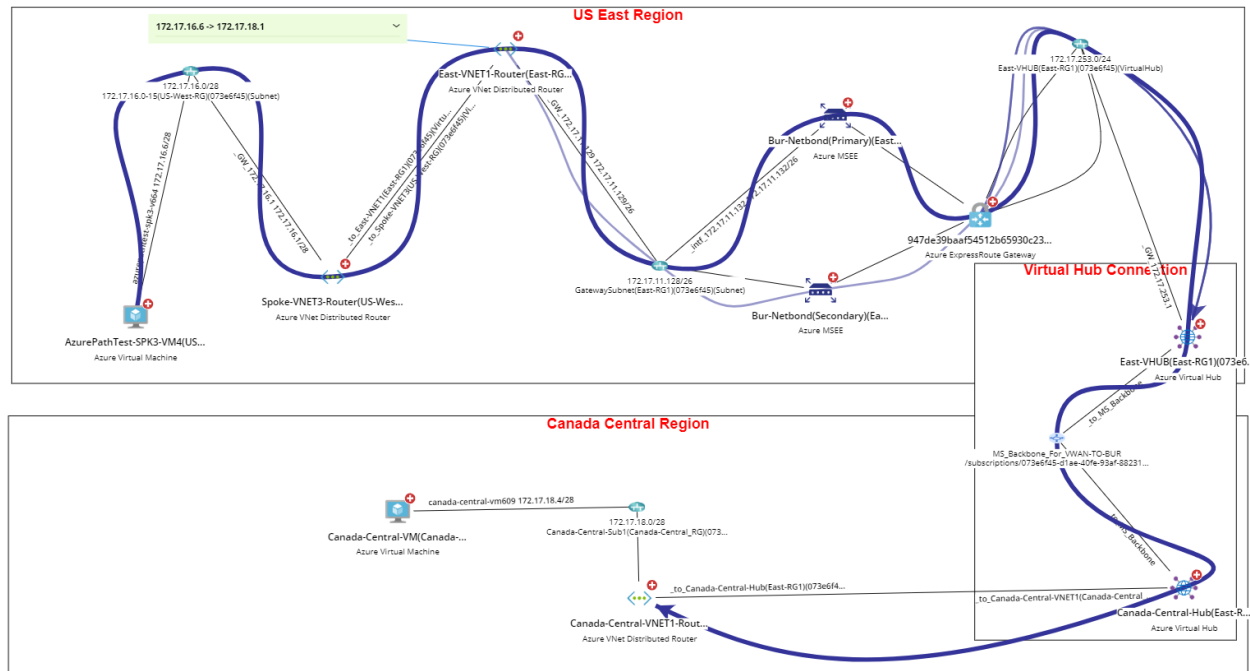
- Azure LoadBalancer Backend Pools Table
- Azure LoadBalancer Inbound NAT Rules Table
- Azure LoadBalancer Load Balancing Rules Table
- Azure LoadBalancer Outbound Rules Table
- Azure Virtual Route Table



4.2.5. Virtual WAN

Azure Virtual WAN is a networking service that brings networking, security, and routing functionalities together to provide a single operational interface. NetBrain supports visualizing the topology and path of Virtual Hub (VHub), ExpressRoute Gateway, and VPN Gateway of virtual WAN, as well as the following data tables:

- Azure VHub Effective Route Table
- Azure VHub Route Table
- Azure Virtual Route Table



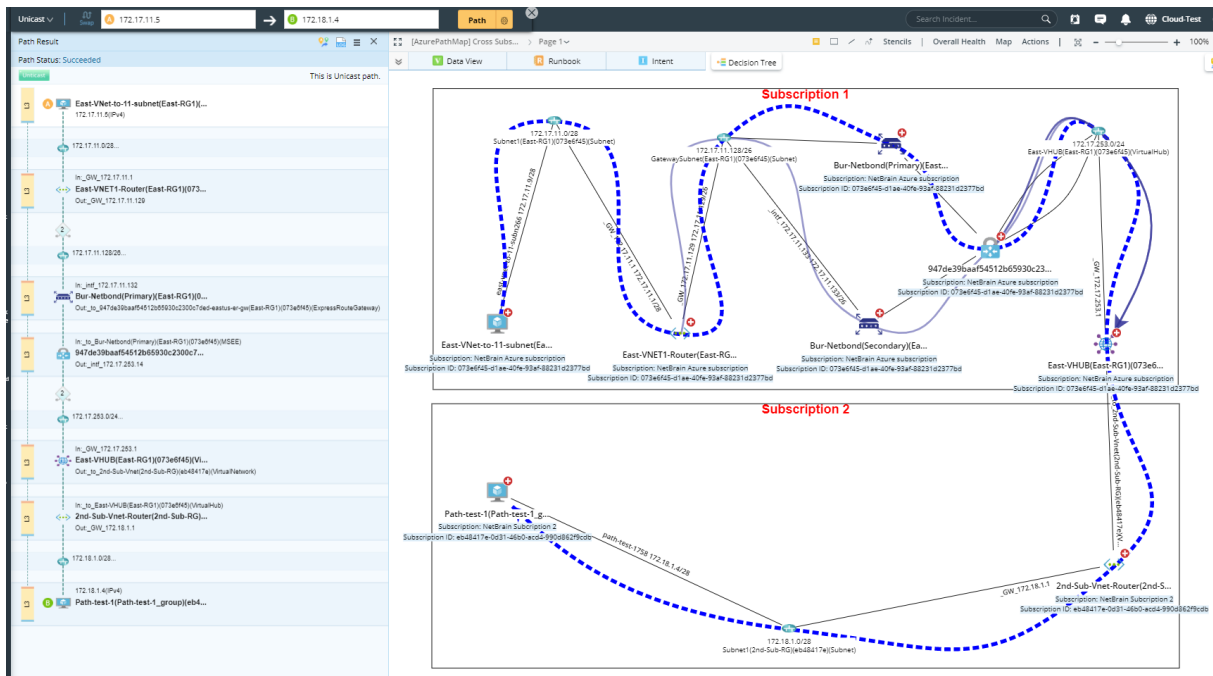
4.2.6. Cross Subscriptions/Tenants

Azure subscription is an agreement with Microsoft to use one or more Microsoft cloud platforms or services, for which charges accrue based on either a per-user license fee or on cloud-based resource consumption.

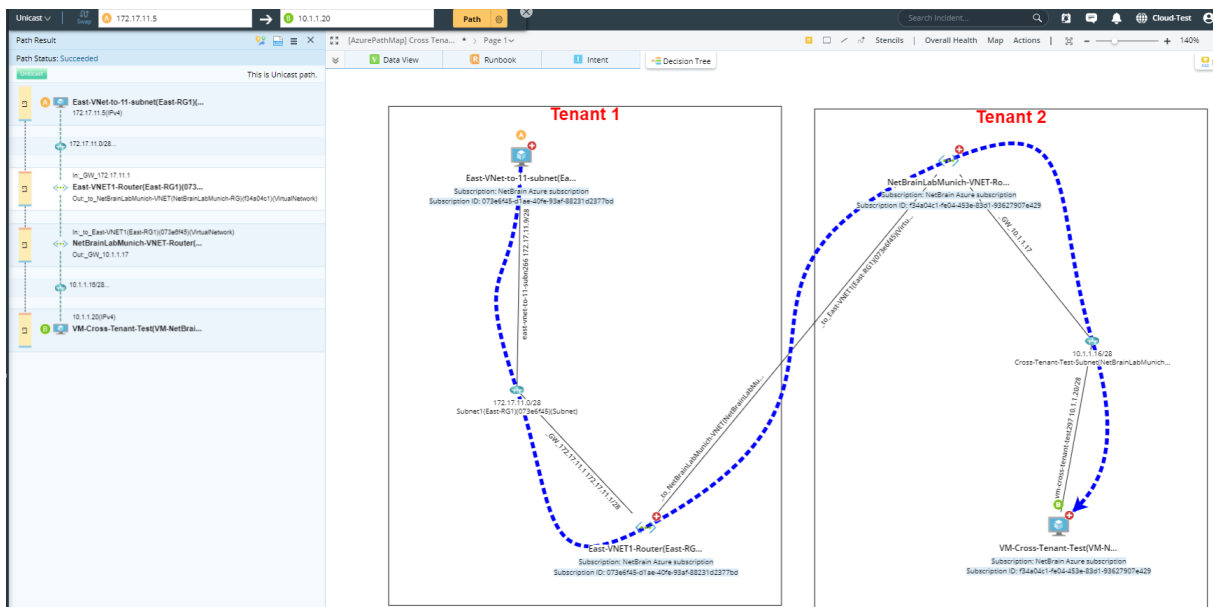
Azure tenant represents an organization, a dedicated and trusted instance of Azure AD that's automatically created when your organization signs up for a Microsoft cloud service subscription, such as Microsoft Azure, Microsoft Intune, or Microsoft 365. An Azure tenant represents a single organization.

NetBrain IE system supports dynamic map to show the cloud networking resource topology or path crossing different subscriptions or tenants.

- Cross Subscription



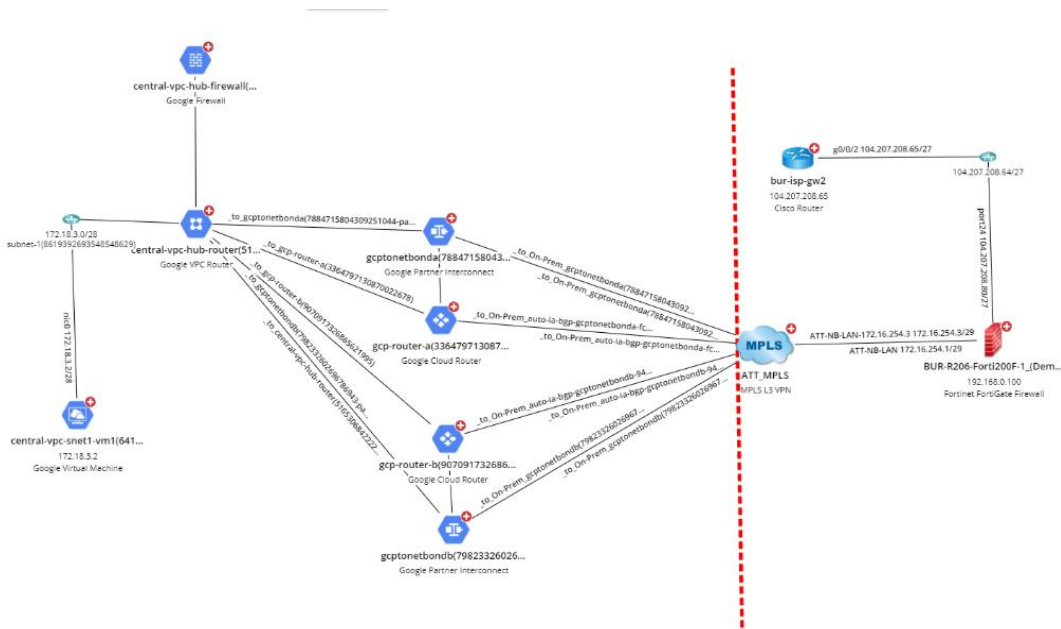
- Cross Tenants



4.3. GCP Application Path

A GCP VPC Network consists of IP range and subnets, and it may also contain cloud-native networking services such as GCP VPN Gateway, Cloud NAT, Cloud Router, and Interconnect, etc. NetBrain creates a VPC router for each VPC to simulate the routing and security check function for this VPC. The subnet is visualized

in NetBrain's dynamic map via the concept called LAN media. From the dynamic map, you can view the different networking objects and understand how they are connected. VPC peering is also supported with the peering ID displayed on the map.



4.3.1. Traffic across GCP and On-Premises Network

There are different ways to connect an on-premises network to a GCP VPC Network:

- **VPN Gateway Connect**

VPN Gateway securely connects your peer network to your Virtual Private Cloud (VPC) network through an IPsec VPN connection. Traffic traveling between the two networks is encrypted by one VPN gateway and then decrypted by the other. NetBrain supports visualizing the topology and path of VPN Gateway as well as the following data tables:

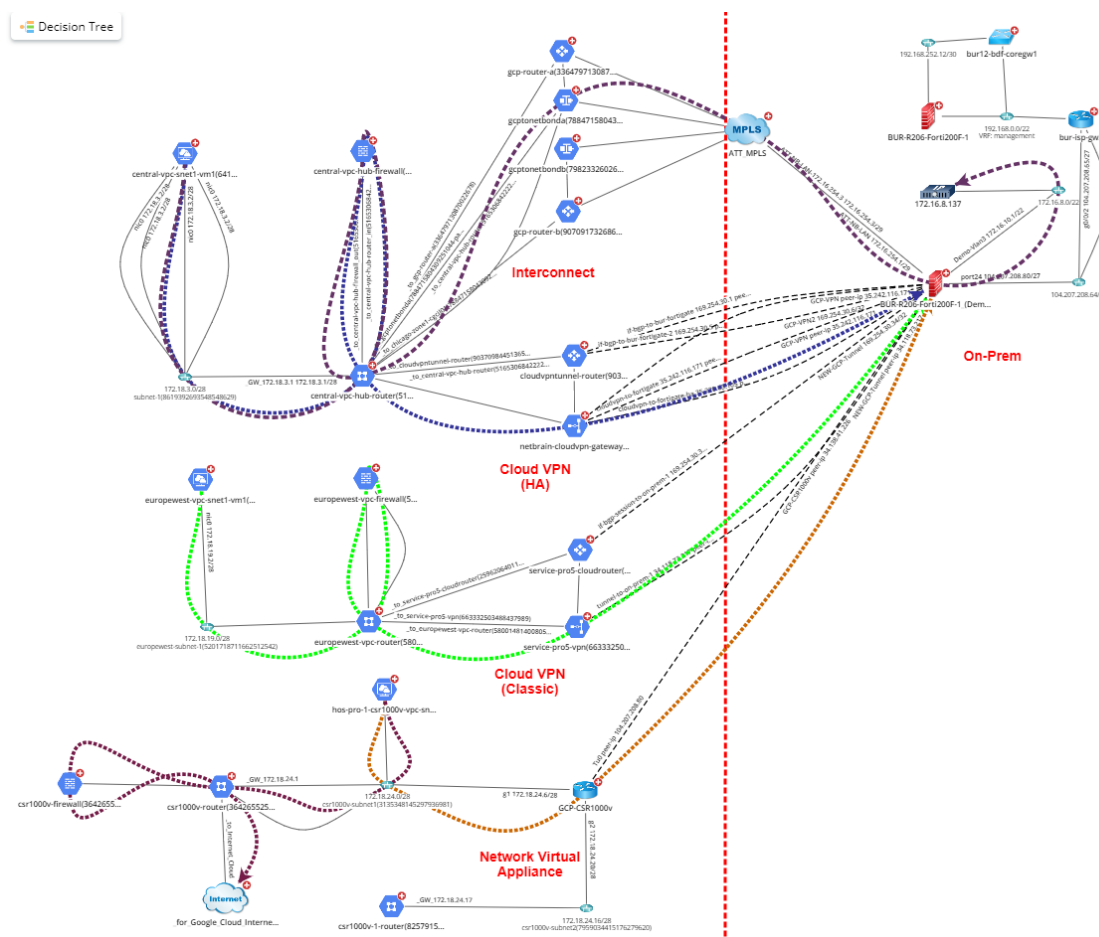
- Google Virtual Route Table
- Google Cloud VPN Tunnels Table

- **Partner/Dedicated Interconnect**

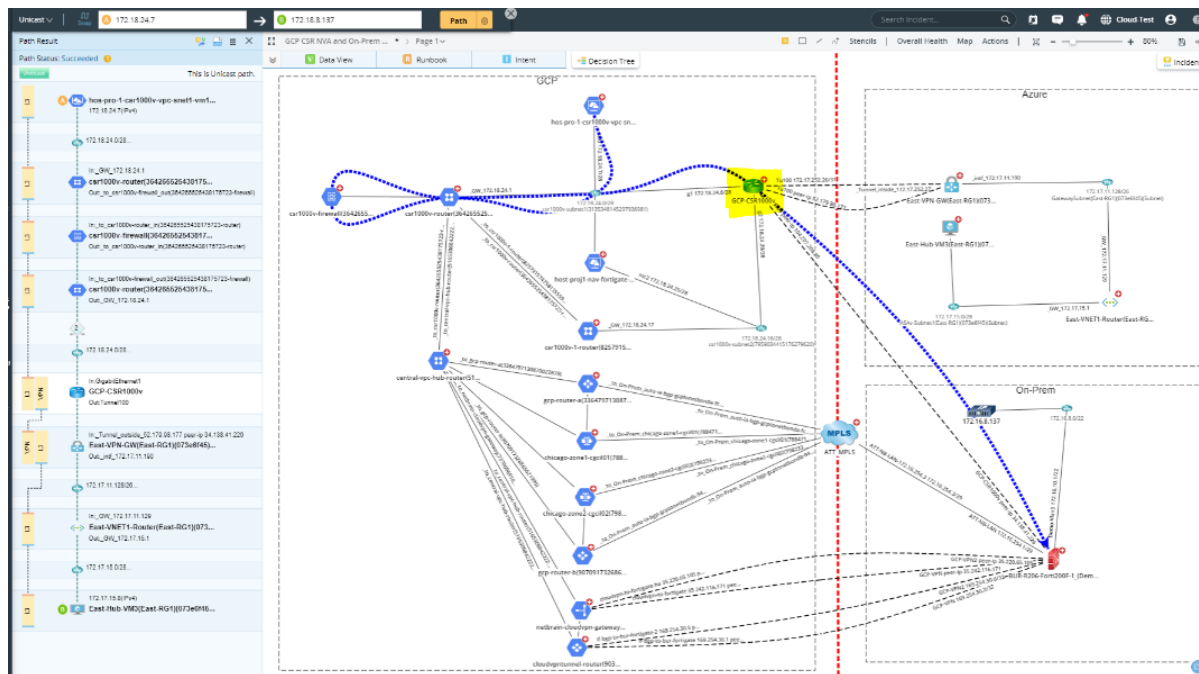
Cloud Interconnect extends your on-premises network to Google's network through a highly available, low latency connection. You can use Dedicated Interconnect to connect directly to GCP or use Partner Interconnect to connect to GCP through a supported service provider. NetBrain supports visualizing the topology and path of Partner/Dedicated Interconnect, as well as the following data tables:

- **Network Virtual Appliance (NVA)**

The following diagram demonstrates the path between GCP and the on-premises network, connected by the Interconnect, VPN, and VNA.

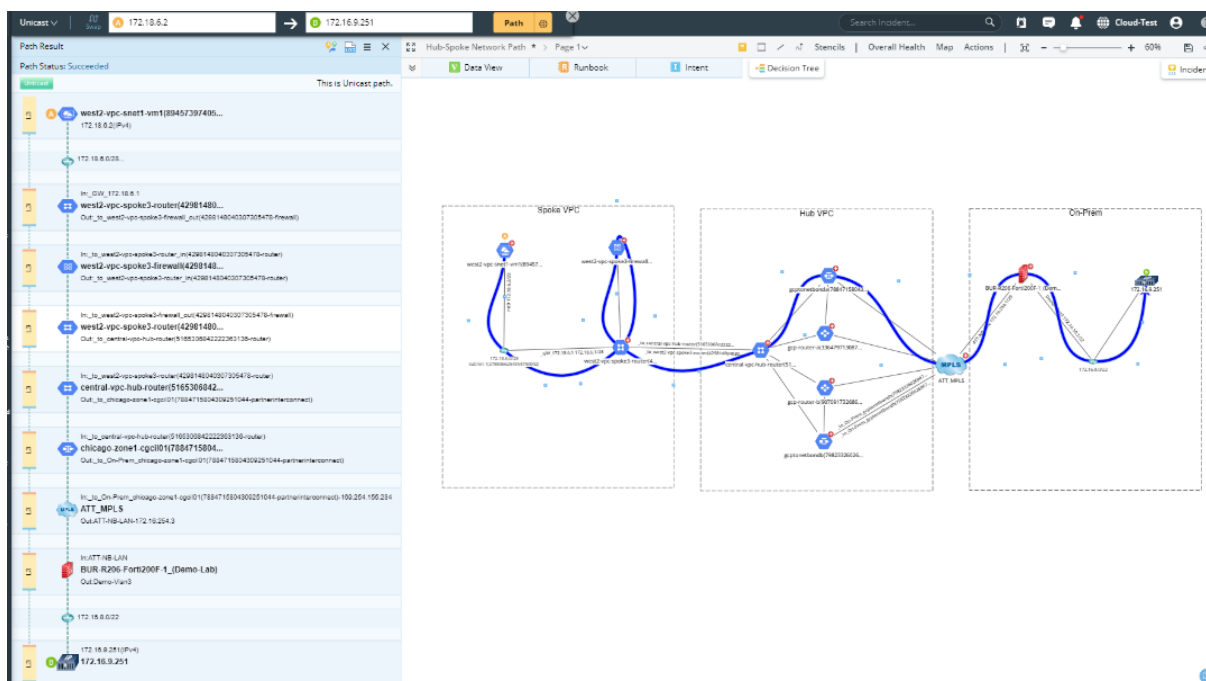


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4.3.2. Hub-Spoke Network

The Hub VPC Network in GCP acts as a central point of connectivity to your on-premises network. The spokes VPC Network has peer with the Hub. Shared services are deployed in the Hub, while individual workloads are deployed as spokes. The following path shows that the Hub provides a shared Interconnect resource for all Spokes VPC networks to visit the on-premises devices.

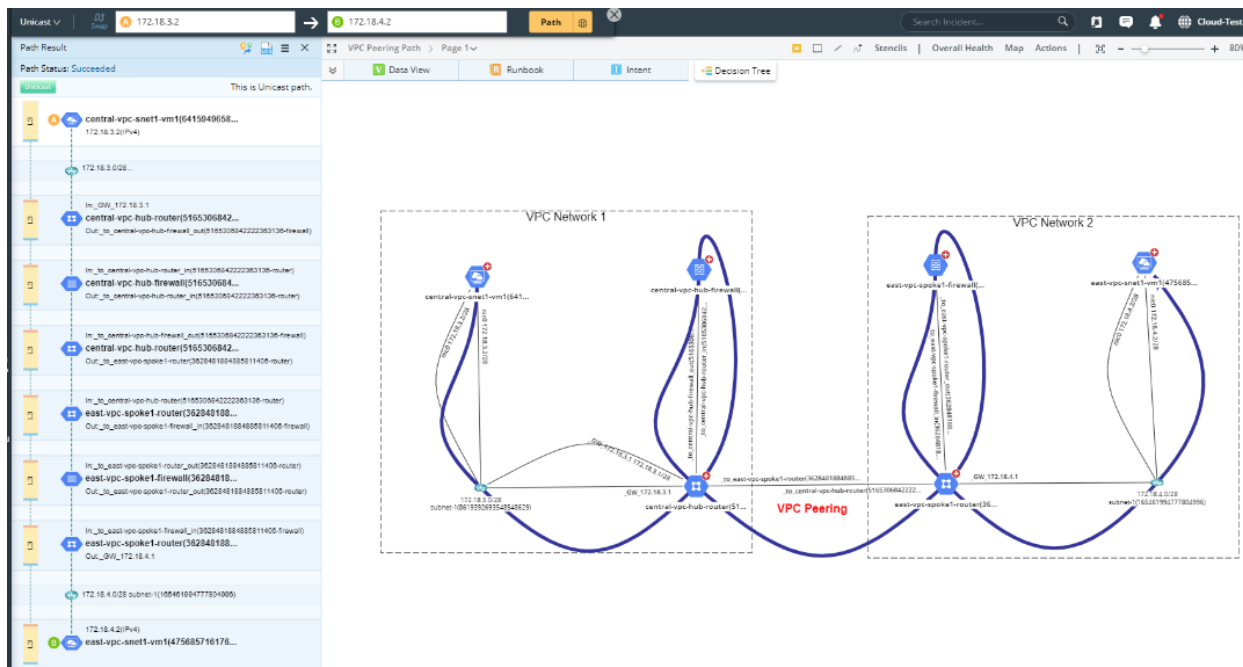


4.3.3. VPC Network Connect

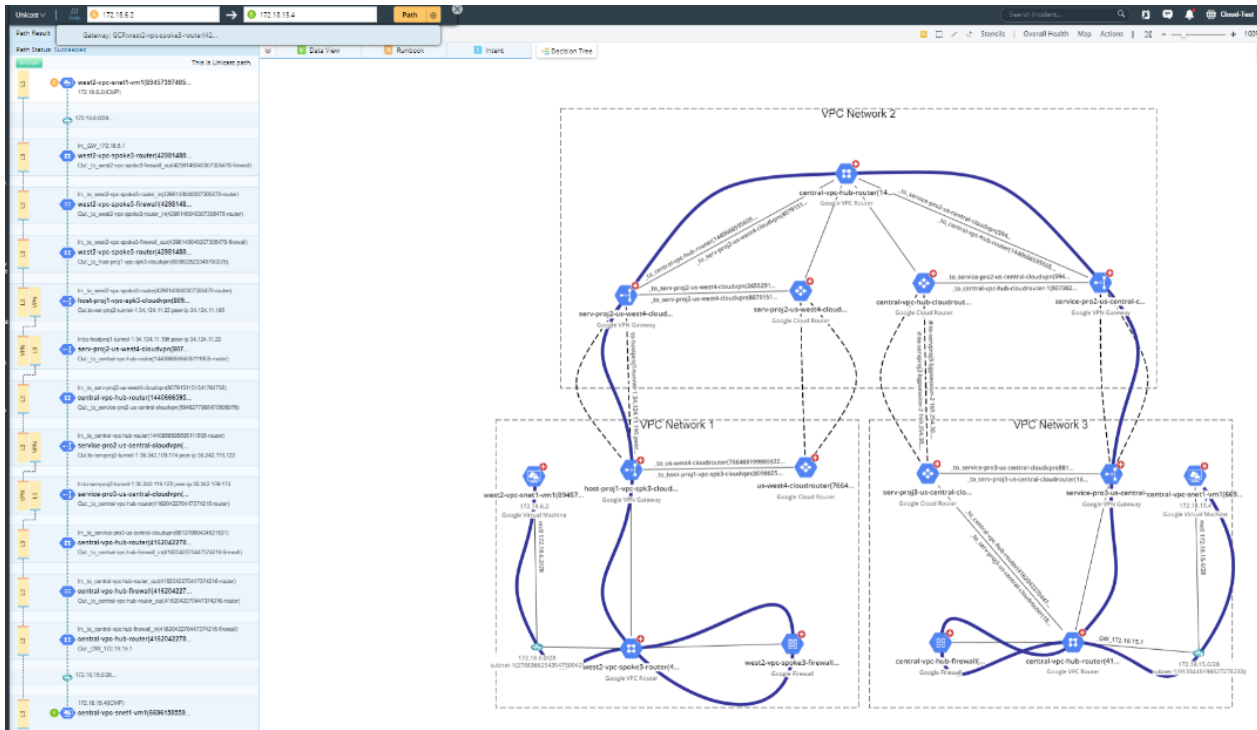
You can connect VPC networks with VPC peering or a VPN connection. NetBrain supports visualizing the topology and path of inter and intra VPC networks, as well as the following data tables:

- Google Virtual Route Table
- Google VPC Endpoint Group Table
- Google VPC Instance Group Table
- Google VPC Instance Group Members Table
- Google VPC Peering Table
- Google VPC Routes Table
- Google VPC Subnets Table

The following path demonstrates VPC network peering, which connects VPC networks so that workloads in different VPC networks can communicate internally. Thus, the traffic stays within the GCP and does not traverse the public Internet.



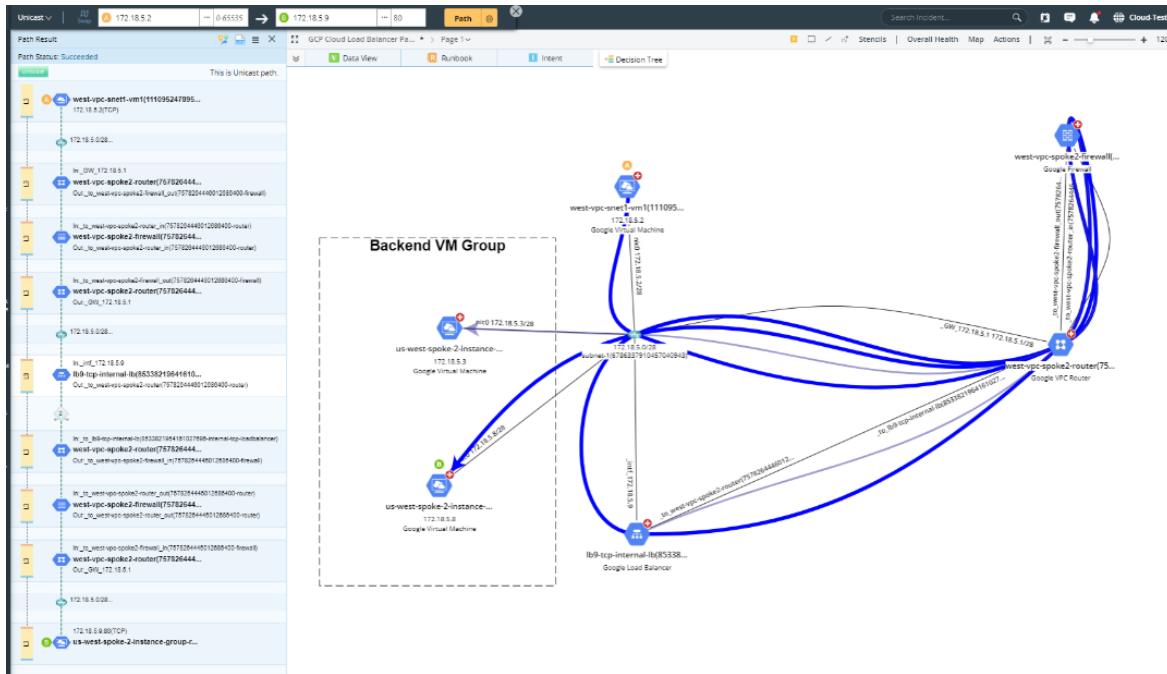
The following diagram demonstrates the path through an IPsec VPN connection. Traffic traveling between the two networks is encrypted by one VPN gateway and then decrypted by the other, protecting your data as it travels over the Internet.



4.3.4. GCP Load Balancer

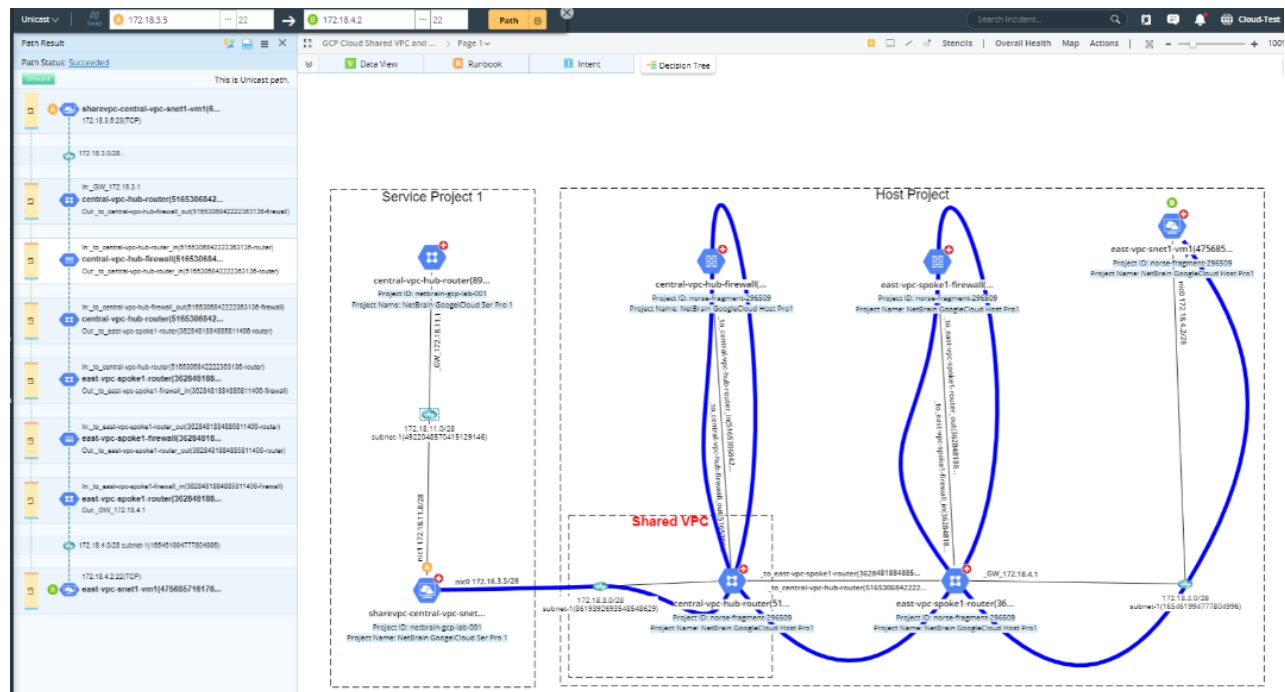
GCP Cloud Load Balancing is a fully distributed, software-defined managed service. NetBrain supports visualizing the topology and path of both External and Internal Load Balancer, as well as the following data tables:

- Google Load Balancer Backend Table
- Google Load Balancer Forwarding Rules Table
- Google Load Balancer Host and Path Rules Table
- Google Virtual Route Table



4.3.5. Shared VPC

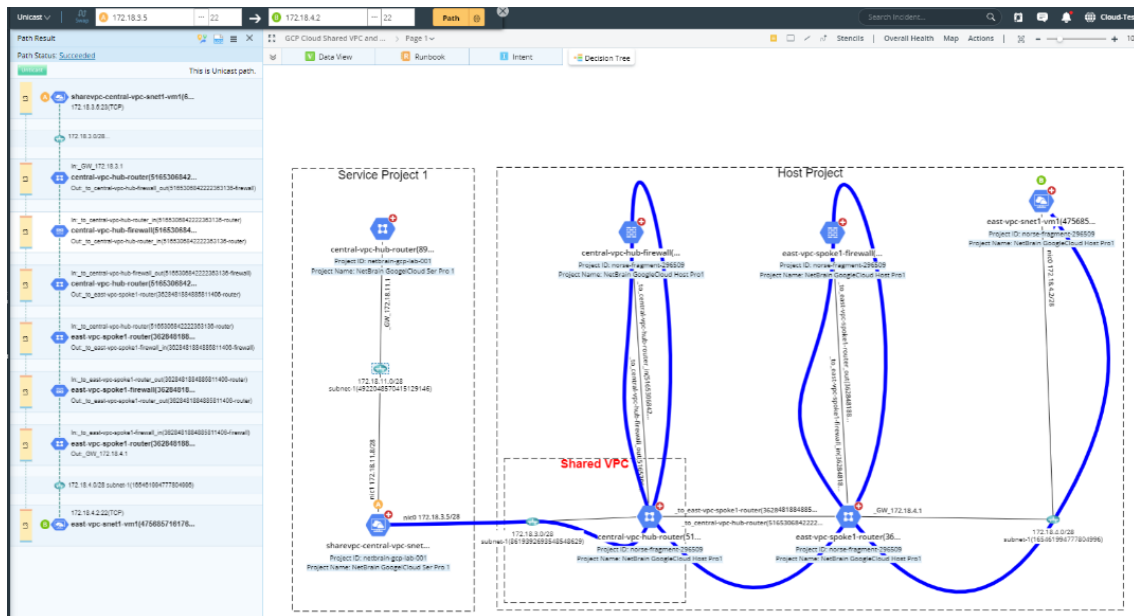
GCP Shared VPC allows an organization to connect resources from multiple projects to a common Virtual Private Cloud (VPC) network to communicate with each other securely and efficiently using internal IPs from that network.



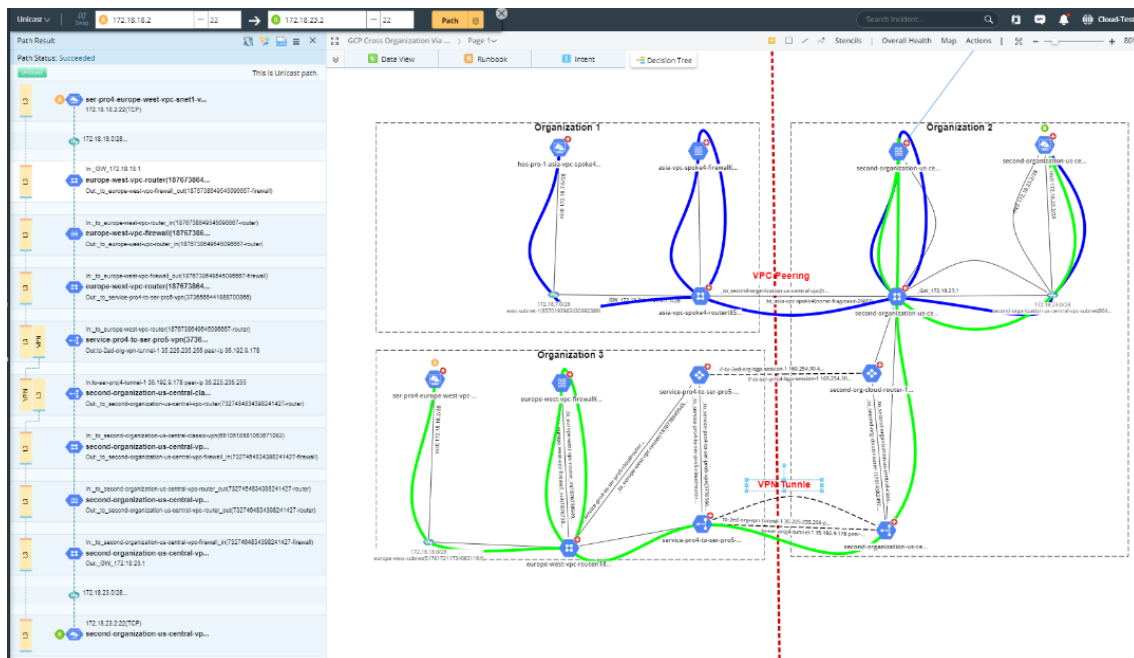
4.3.6. Cross Projects/Organizations

NetBrain supports visualizing the topology and path of the resources crossing multiple projects or organizations.

The following diagram demonstrates the path through Service Project 1 and Host Project.



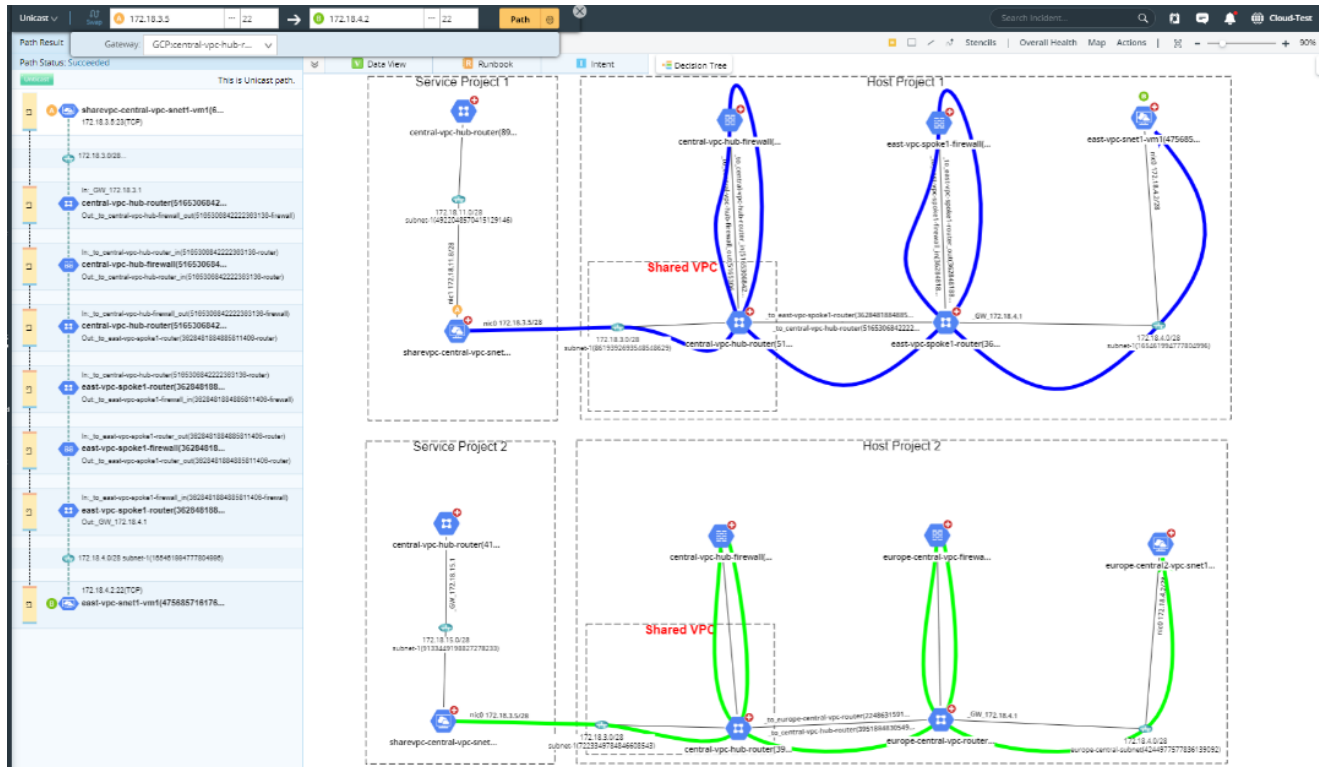
The following diagram demonstrates a path crossing two organizations via VPC Peering or VPN Tunnel.



4.3.7. Duplicated IP

If multiple projects or organizations are discovered in a domain, you may have duplicated IP addresses, which can be resolved by putting them into different zones.

The following diagram shows two paths crossing different networks in the domain. Users can select different Gateways, and the system will calculate the path for different zones accordingly.

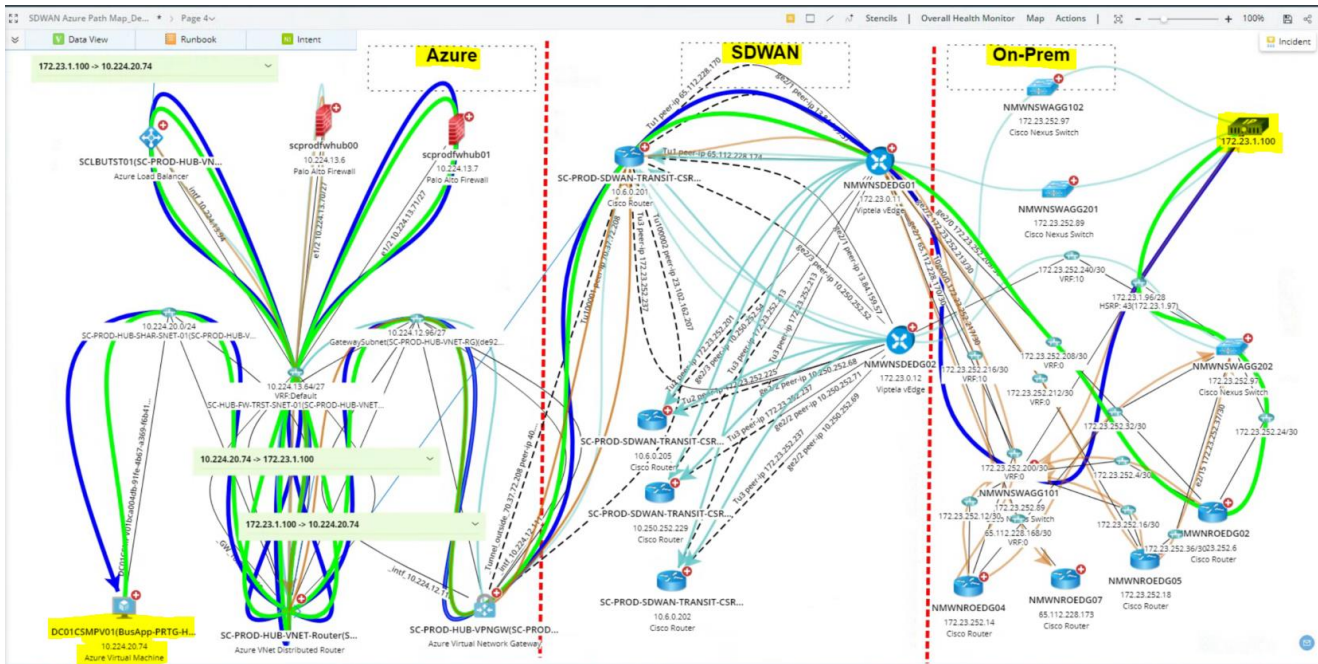


4.4. Hybrid Path Across Different Vendors and Technologies

4.4.1. Azure and Viptela SDWAN and CSR1000V and On-Premises Network

NetBrain supports visualizing the topology and path across different networks, such as Cisco Viptela SDWAN, API, and public cloud.

The following path shows traffic across Azure, CSR1000v, SDWAN, and On-Premises networks. First, traffic inside the Azure cloud, originating from Azure Virtual Machine (VM), is sent to Azure load balancer according to the User-Defined Route (UDR). Next, the traffic hits the load balancing rule and is redirected to the load balancer backend VM pool, including several VMs acting as different Network Virtual Appliance (NVA) like the Palo Alto firewall. Then, the traffic goes through Azure VPN Gateway according to Virtual Route Table (VRT) and goes outside the Azure network via a site-to-site VPN tunnel to CSR1000v. Finally, the traffic reaches the destination device located in the On-Premises network.



4.4.2. Across Multiple Public Clouds

NetBrain IE system supports visualizing the topology and path across different public clouds such as GCP, Azure, and AWS. In addition, the path can go through different public clouds via VPN Gateway, Provider MPLS network, or interconnect devices like CSR1000v.

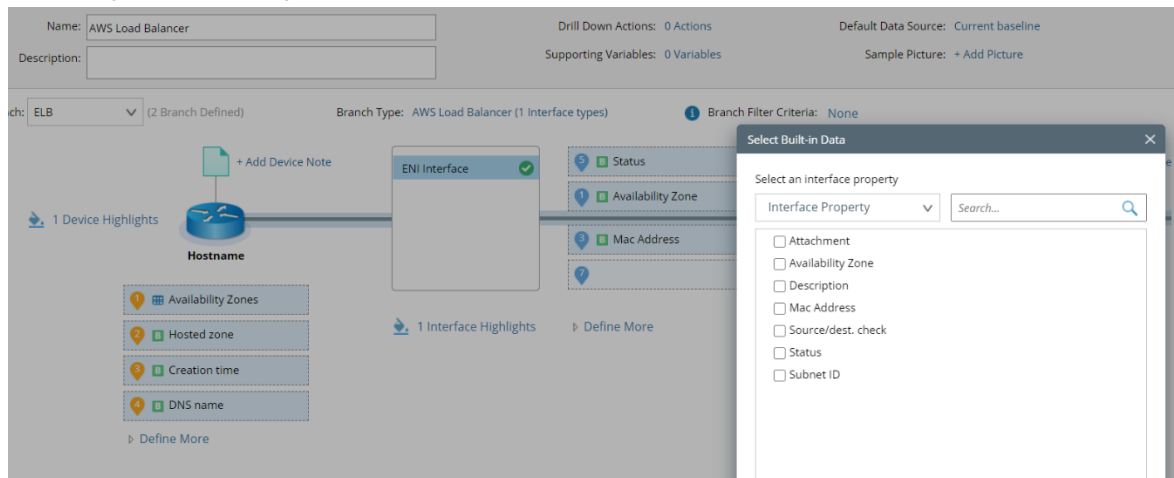
5. SPOG with Cloud Native Management Tools

Data view (DVT) allows you to monitor public data in the dynamic map. There are two kinds of data that can be displayed via DVT:

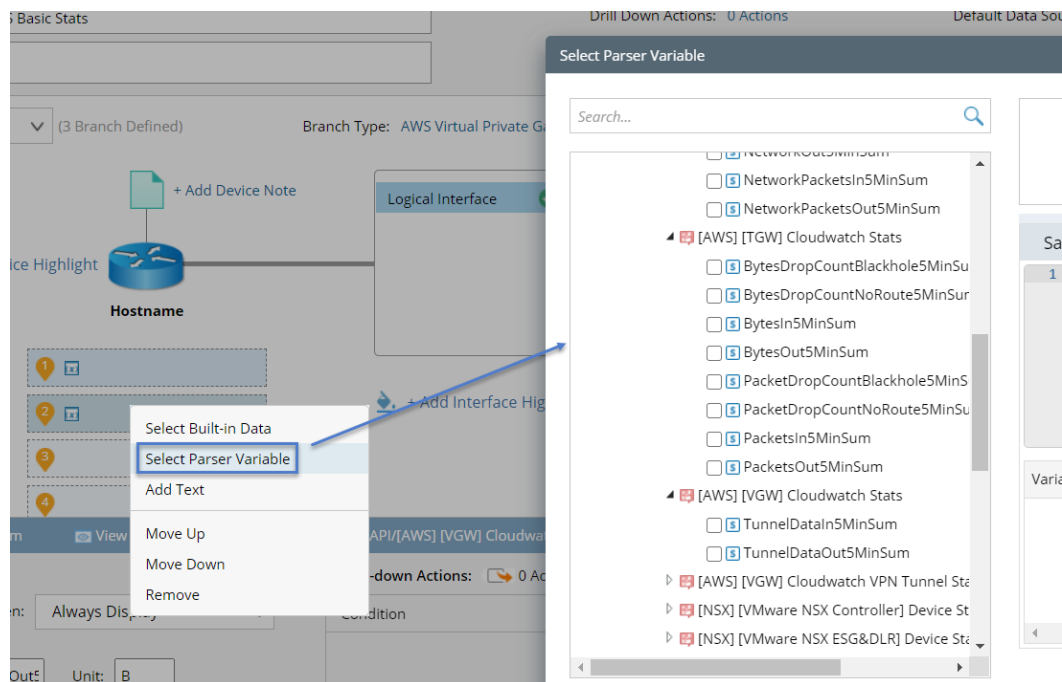
- **Public Cloud Infrastructure Data:** the basic information of cloud operational status, routing/security, tag information, etc.
- **Cloud Monitoring Metrics:** the metrics from the cloud native monitoring tools, such as AWS CloudWatch and Azure Monitoring. These metrics are usually data plane status that can be visualized in NetBrain maps.

To visualize the relevant data using DVT, you can leverage the following two types of data:

- **GDR Data:** GDR data is already available for use since this type of data is retrieved during the discovery/benchmark process.



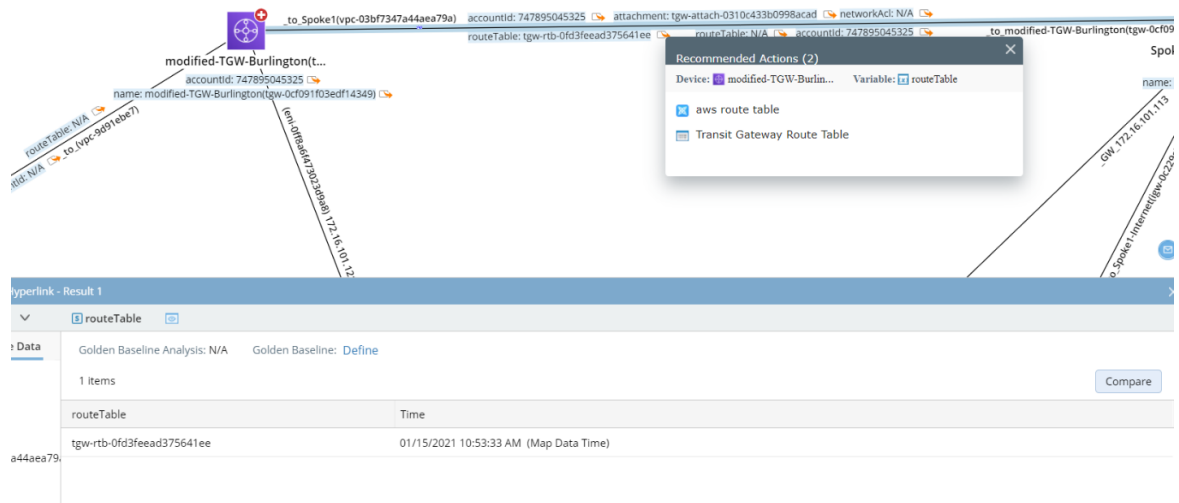
- **API Parser Data:** You can retrieve any data from the public cloud provider using the API parser.



5.1. Built-in DVT Examples for AWS Infrastructure

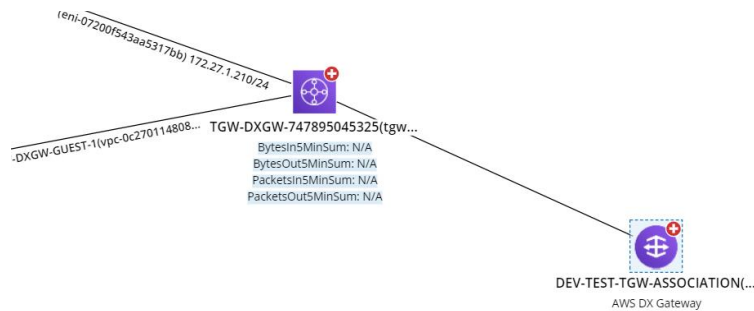
- Resource Links and Account Info**

Visualize the account information for different networking objects linked to the AWS management console. Links are also available for resources such as ENI interfaces, security groups, and network ACLs.



- Infrastructure View for Resources**

Visualize the infrastructure information for different networking objects.

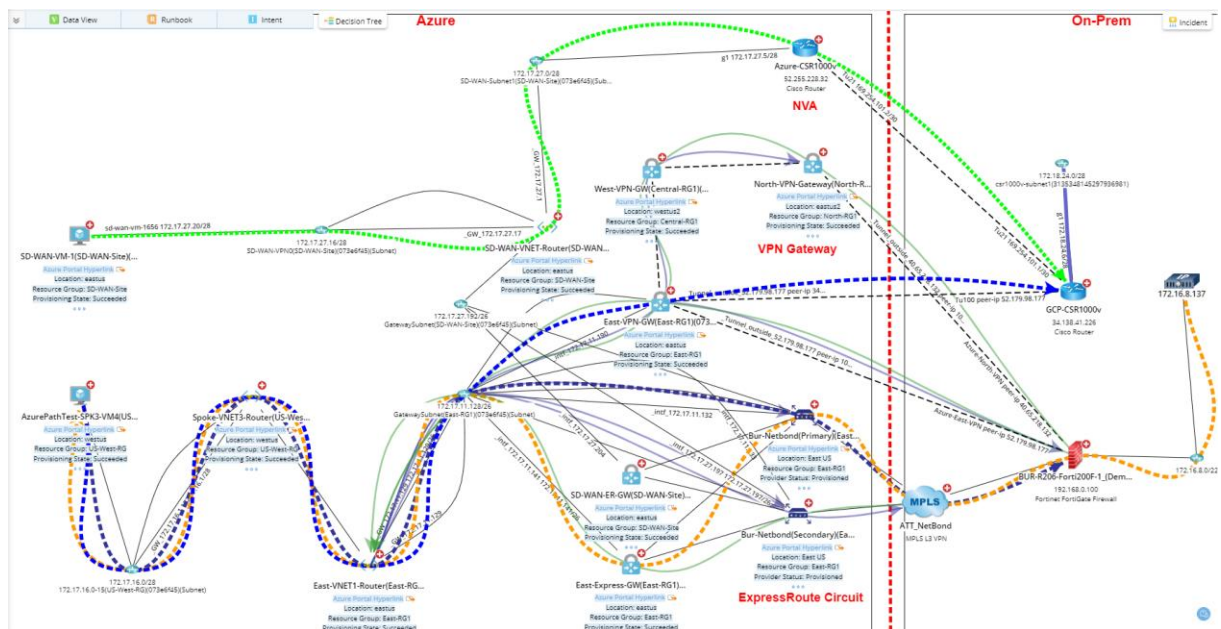


5.2. Built-in DVT Examples for Azure Infrastructure

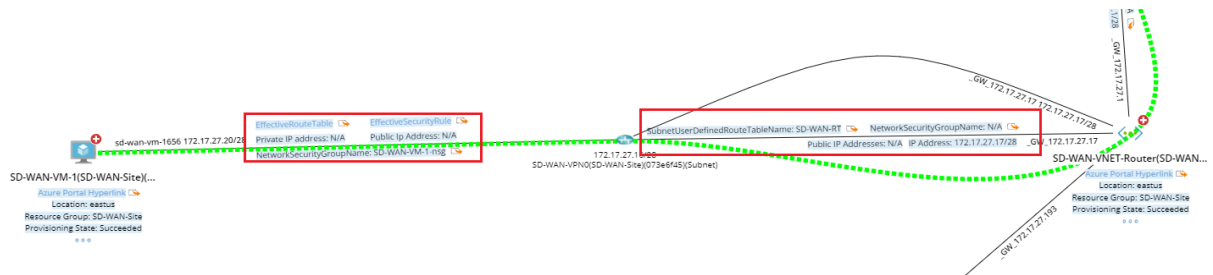
This type of DVT shows the logs we retrieve from GCP Monitor and Logs and the analytic results on a map.

- **[Azure] Basic Info**

This DVT displays the basic information or properties of an Azure resource. The different types of resources have different types of properties. For example, Address Space, Location of Virtual Network, or LoadBalancer Type, SKU of Load Balancer, Network security group and Project name, VPC ID, and VPC name for the Google Firewall; subnet auto creation, MTU, and routing configuration for the Google VPC router.

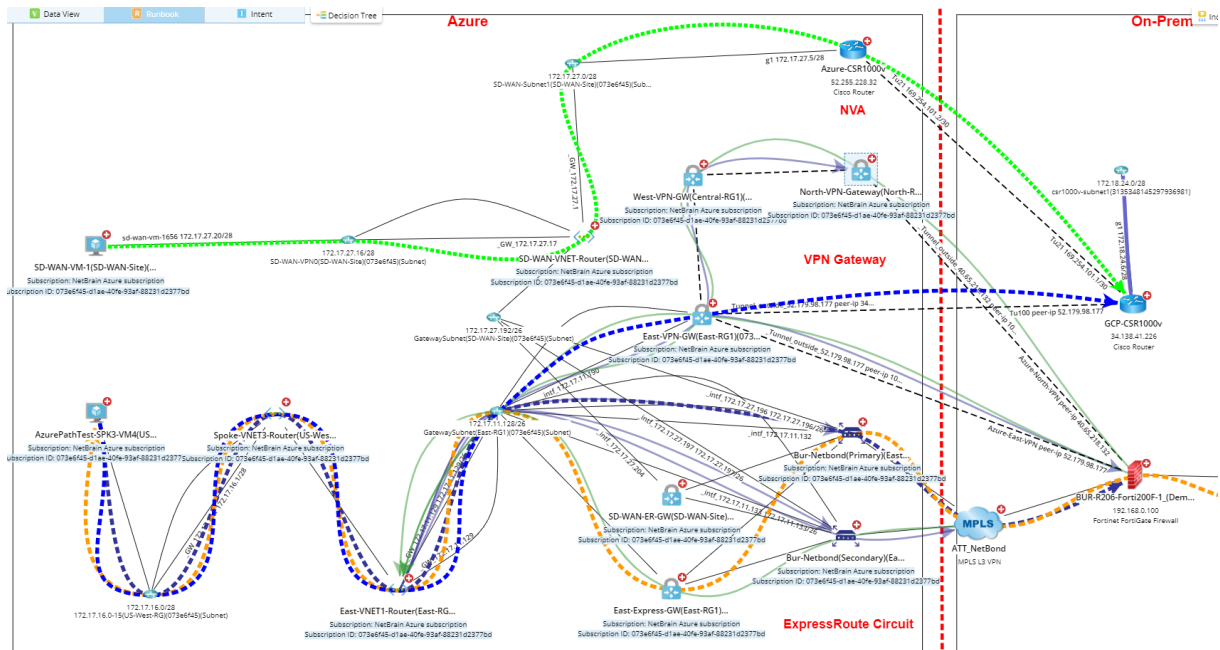


Also, this DVT includes **Effective Route Table**, **Effective Security Rules**, and **User Defined Route Table** associated with a network interface (NIC) or subnet level.



- **[Azure] Subscription Info**

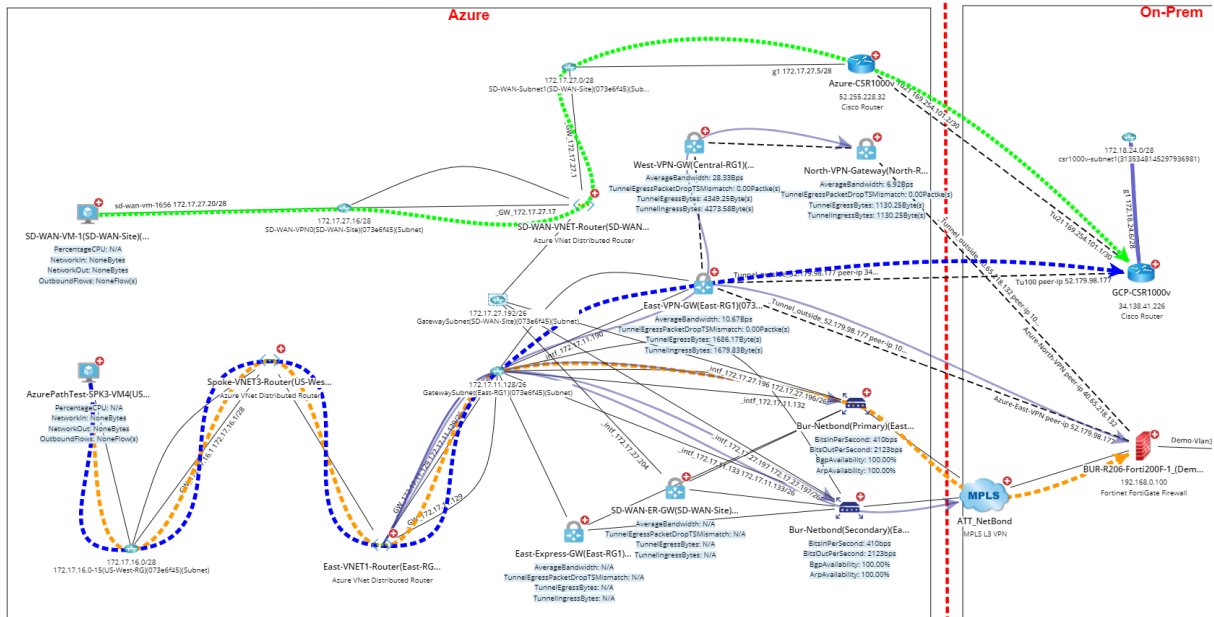
This DVT displays the subscription name and ID information:



5.3. Built-in DVT Examples for Azure Insight Metrics

- **[Azure Insights] Monitoring Azure Metrics**

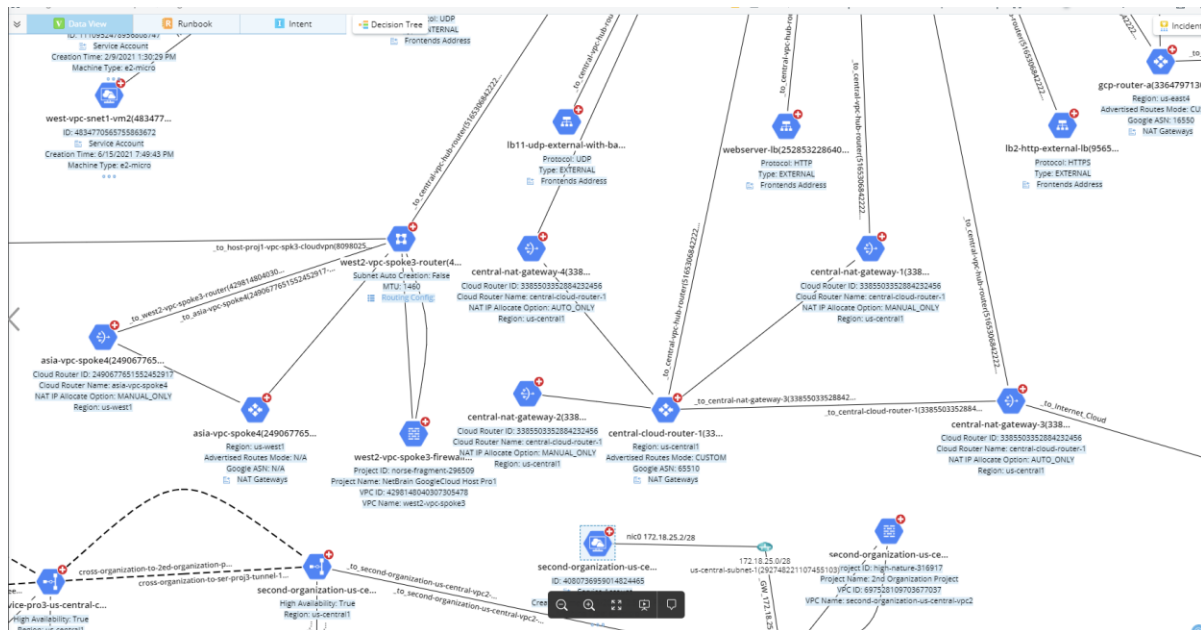
This DVT displays the pre-defined Azure Insight Metrics for different network objects.



5.4. Built-in DVT Examples for GCP Infrastructure

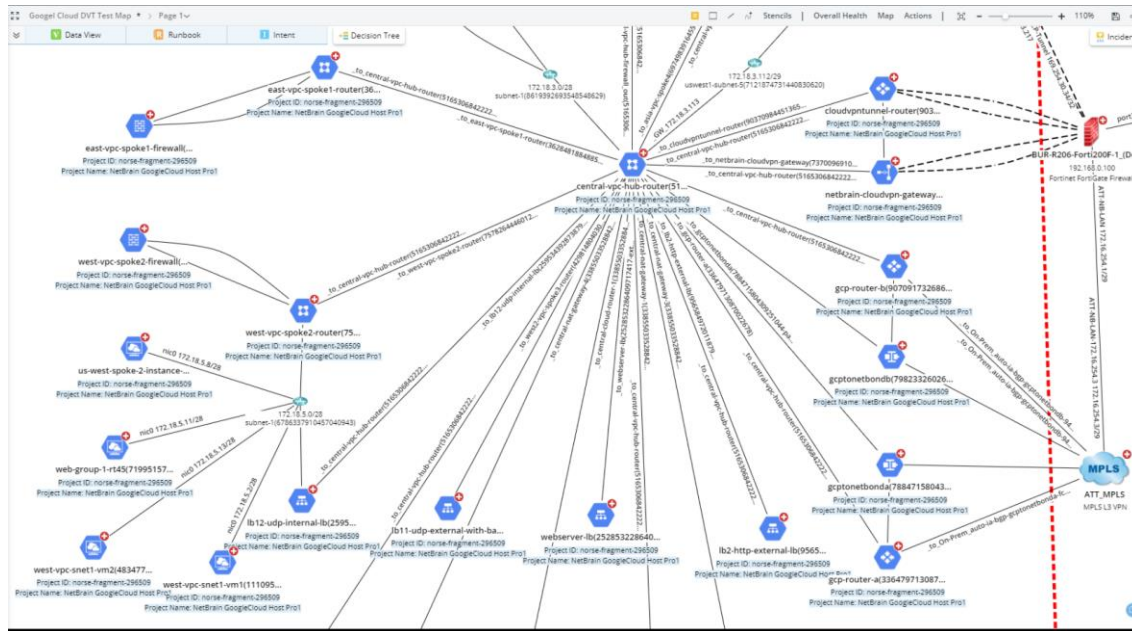
- GCP Basic Info**

This DVT displays the basic information or properties of a GCP resource. The different types of resources have different types of properties. For example, project ID, Project name, VPC ID, and VPC name for the Google Firewall; subnet auto creation, MTU, and routing configuration for the Google VPC router.



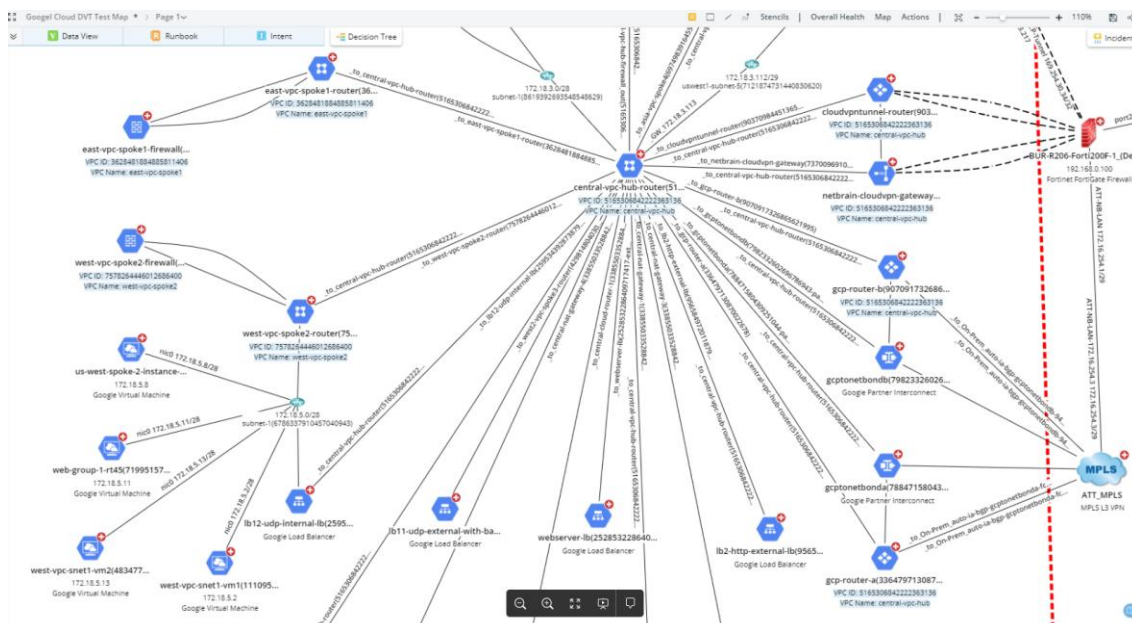
- **GCP Project Info**

This DVT displays the project name and ID.



- **GCP VPC Info**

This DVT shows the VPC name and ID.



5.5. Built-in DVT Examples for GCP Logs Analytics

This type of DVT shows the logs we retrieve from GCP Monitor and Logs and the analytic results on a map.

- **GCP Firewall Rule Log Analysis**

This DVT monitors the top hit denied/allowed rule to find abnormal cases. For example, a sharp increase of Rule Hit Count can be due to mistaken configure Firewall Deny Rule.



- **VPC Flow Logs Analysis**

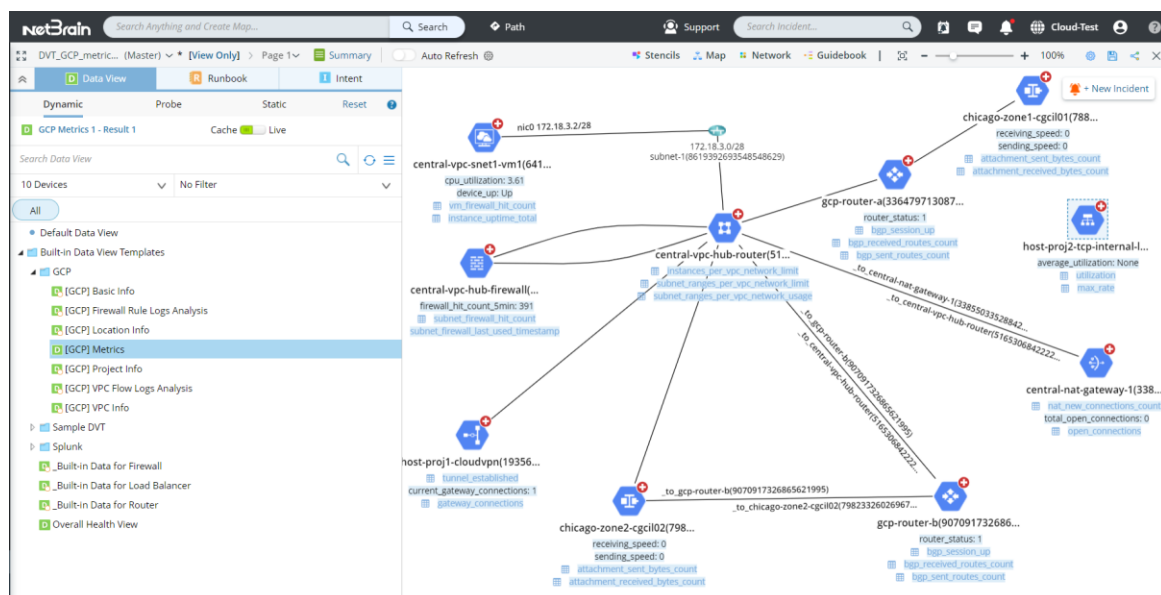
This DVT monitors the abnormal VPC traffic from specific IPs and regions. For example, if the GCP Network is attacked by DDOS, the source IP from a specific region will increase sharply.



5.6. Built-in DVT Examples for GCP Metrics

- **[GCP] Metrics**

This DVT displays the pre-defined GCP Metrics for different network objects. Customize or modify it from Date View Template Management page.



6. SPOG with 3rd Party Cloud Management Tools

The ability to visualize data from 3rd Party cloud management tools enables NetBrain dynamic map to render a complete view of your cloud infrastructures. The integration with 3rd Party cloud management tools is highly customizable, meaning that NetBrain can be integrated with any cloud management tools to suit your specific needs.

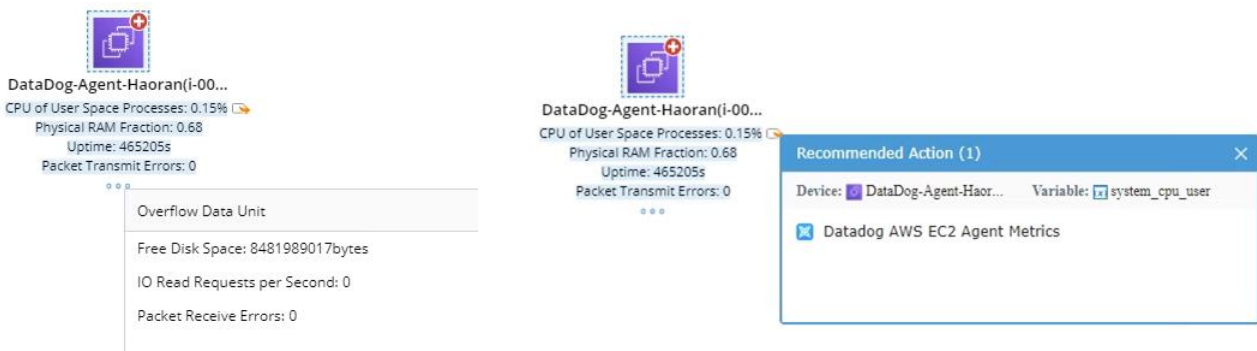
6.1. AWS Integration with 3rd Party Tools

- **Datadog – AWS Monitoring Metrics**

The following data view demonstrates the integration with Datadog- the metrics are retrieved from the Datadog agents installed on EC2 instances. NetBrain can retrieve and demonstrate the following types of metrics through the data view template:

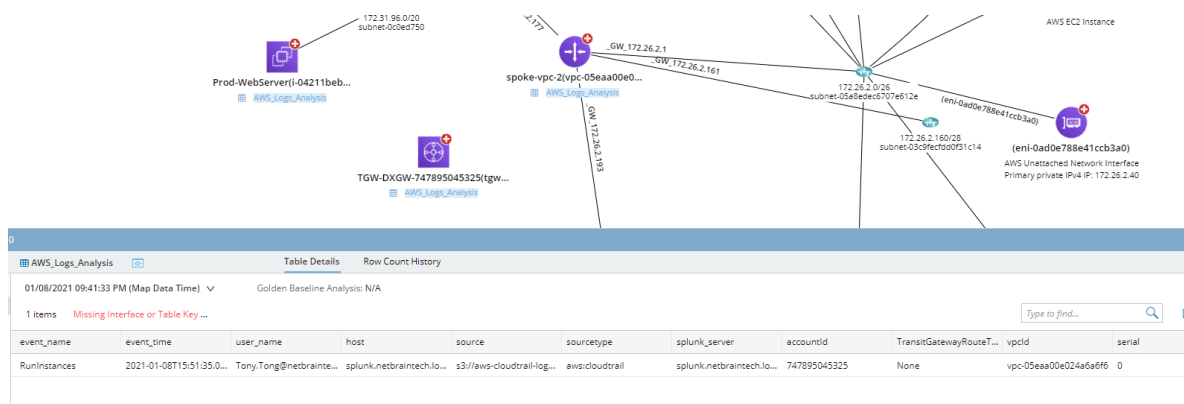
- system.cpu.user (5 min avg - double)
- system.mem.pct_usable (5 min avg - double)
- system.uptime (The last non-empty value of the 5 min - int)
- system.net.packets_out.error (5 min avg - int)
- system.disk.free (5 min avg - int)
- system.io.r_s (5 min avg - int)
- system.net.packets_in.error (5 min avg - int)

NetBrain also provides a link to Datadog, so you can easily switch to Datadog to explore more details.



- **Splunk – VPC Security Group Check Log**

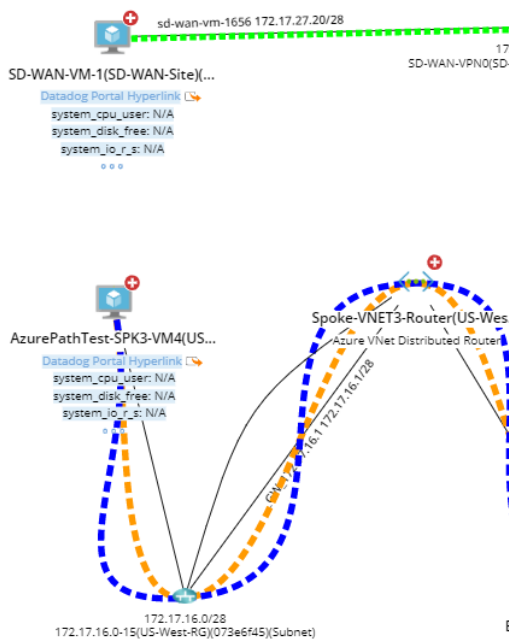
AWS CloudTrail is a service that allows you to log, continuously monitor, and retain account activity related to actions across your AWS infrastructure. The integration with Splunk allows you to view the change log of security groups/network ACL and VPCs during a specific period.



6.2. Azure Integration with 3rd Party Tools

- **[Azure] Monitoring Azure Metrics**

This DVT displays the Azure Metrics information collecting metrics from Datadog. First, you need to set up the Datadog configuration to collect the source data from Datadog:



- **[Splunk] Monitoring Azure Logs**

This DVT displays the Azure Logs Analytics information collecting logs from Splunk. You need to set up the Datadog configuration to collect the source data from Datadog:

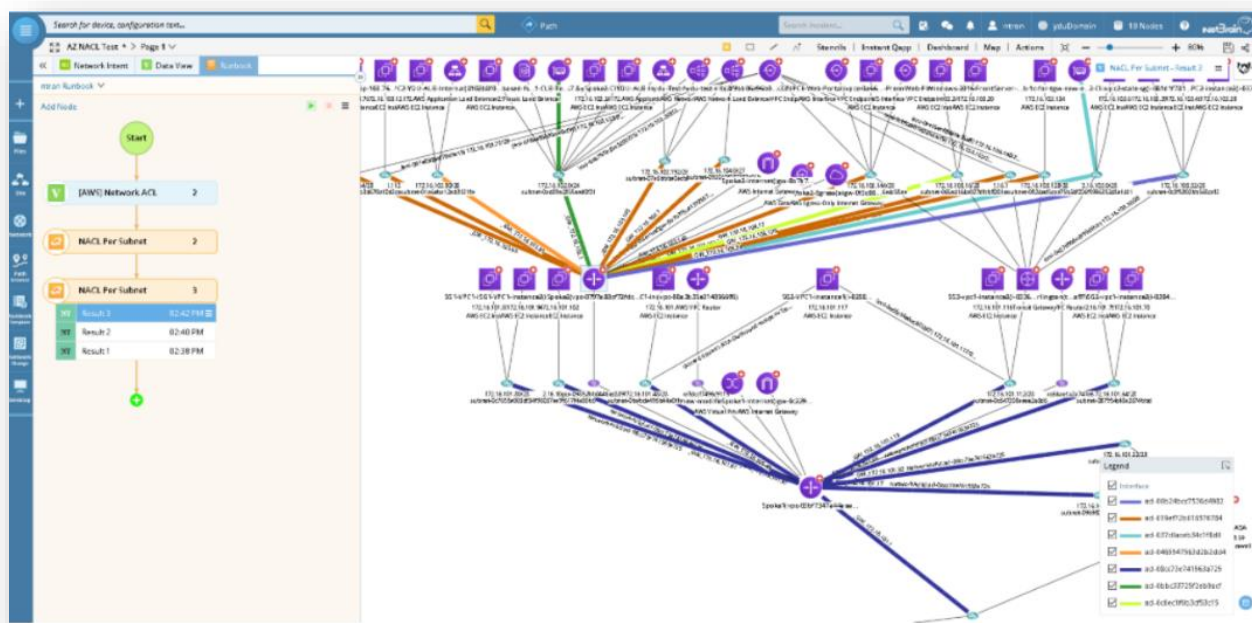
7. Runbook Automation for Public Cloud

Runbook Template can help you understand the network design and troubleshoot network problems based on certain scenarios. Many useful functions such as DVT, Qapp, Gapp, and Compare can be wrapped into Runbook to accomplish your tasks.

7.1. AWS Runbook Examples

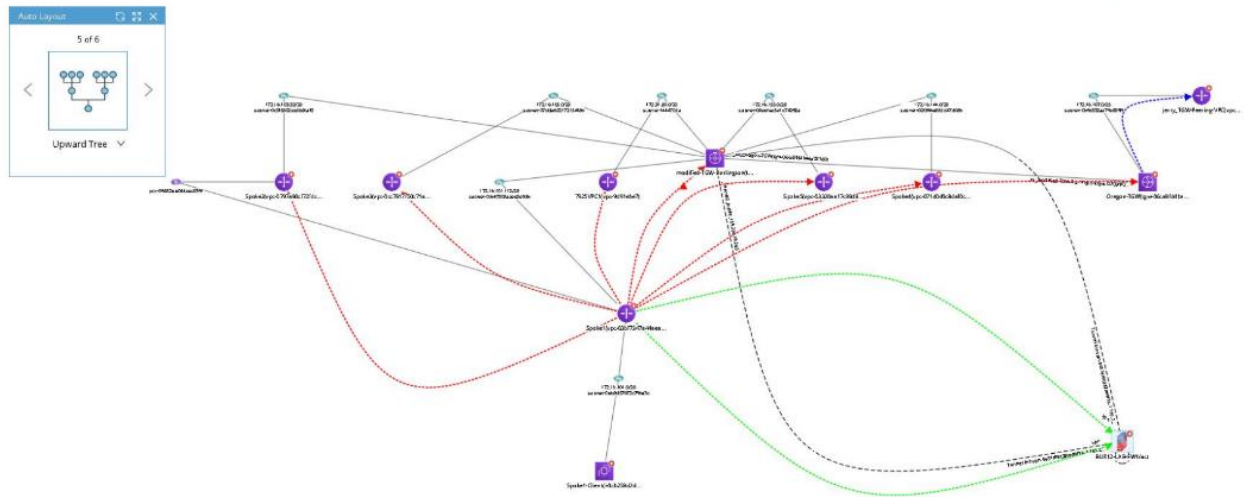
A built-in Runbook for AWS general info can help you quickly identify important resource information for the devices on the map, which includes:

- Path - Application Path
- DVT - [AWS] Resource Links and Account Info
- DVT - [AWS] Infrastructure View for Resources
- DVT - [AWS CloudWatch] Basic Stats
- Qapp - Security Group
- Qapp - Network ACL



Another AWS built-in runbook can help you troubleshoot the transit gateway routing issue and understand the current deployment. This Runbook includes:

- Path - Application Path
- DVT - AWS basic stats DVT
- Qapp - Map reachability from specific VPC
- Qapp - Map reachability from specific TGW Route Table
- Compare - Compare TGW NCT Tables (Attachment table/Route Table)



7.2. GCP Runbook Examples

A built-in Runbook for GCP Firewall Rule Monitor Qapp can help you quickly identify important Firewall Rules related logs for each VPC on the map:

publish_time	patch	name	route	type	domain	number	timezone	ipAddress	email	project_id	firewall_rule_id
2021-09-27T13:09:...	4430	v1.compute.firewalls.insert	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	25966229971
2021-09-27T13:09:...	4430	operation-1632748181218-5ccf9cf59634b-c...	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	25966229971
2021-09-27T11:26:...	4430	v1.compute.firewalls.insert	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	73687362575
2021-09-27T11:26:...	4430	operation-1632742014219-5ccf85f47511-8...	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	73687362575
2021-09-24T23:18:...	4430	v1.compute.firewalls.insert	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	60954103741
2021-09-24T23:18:...	4430	operation-1632525506550-5ccc5f6e79ac4-0...	104.152.160.0...	gce_firewall_r...	ciktcl.com	A554614	America/Toro...	104.152.160.1...	tony.tong@ne...	norse-frage...	60954103741
2021-09-24T19:23:...	4577	beta.compute.firewalls.get	76.66.0.0/16	gce_firewall_r...	bell.ca	A5577	America/Toro...	76.66.148.75	yiayangyong@...	norse-frage...	52076227841
2021-09-24T19:23:...	4577	beta.compute.firewalls.get	76.66.0.0/16	gce_firewall_r...	bell.ca	A5577	America/Toro...	76.66.148.75	yiayangyong@...	norse-frage...	52076227841

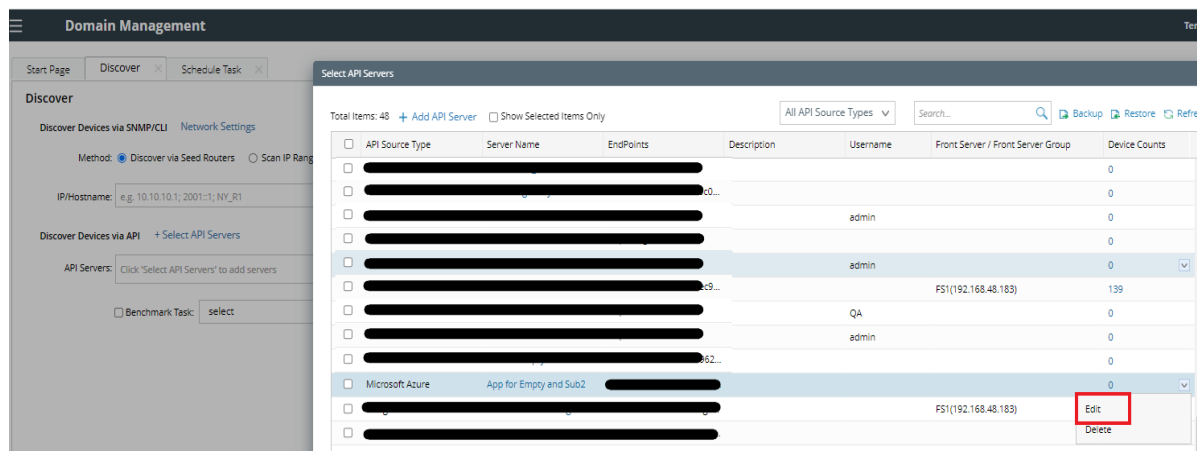
8. Enhanced Features

8.1. Azure Enhanced Discovery with Excluded/Included VNets

This feature provides the flexibility to discover the specified virtual networks listed in the included virtual network configuration or not listed in the excluded virtual network configuration. Note that the feature has been available since version IE10.1.0.

To do so, follow the steps below:

1. On the **Domain Management** page, select the **API Server** under the **Discover** tab.
2. Click **Edit** from the dropdown menu.



3. In the **Advanced** area, click **Add** to select the **Excluded Virtual Networks** or **Included Virtual Networks** key, type the **VNet Resource IDs** separated by a comma in the **Value** field, and click **Save**.




8.2. Public Cloud Configuration File Support

Basic configuration file is a critical data source to understand the basic configuration and specification of different devices/nodes. It includes one or more APIs data and is also a useful and important way for Public Cloud management and maintenance. Note that the feature has been available since version IE10.1.7.

8.2.1. Feature Scope

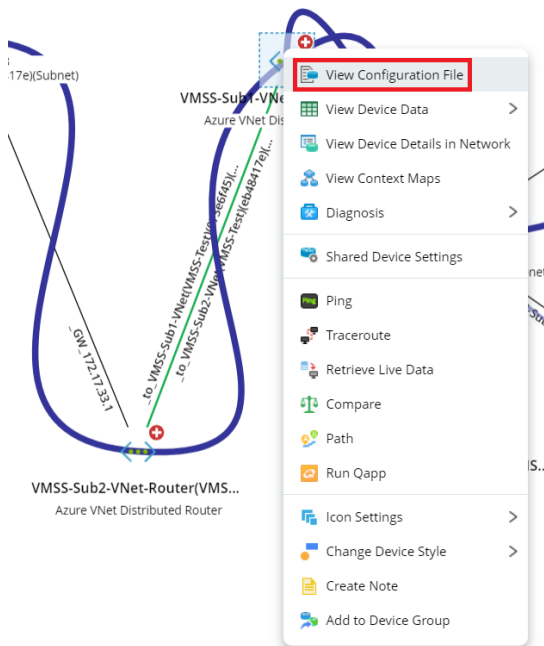
- AWS
 - AWS VPC Router
 - AWS VPC Endpoint (Type: Gateway/ Interface/GatewayLoadBalancer)
 - AWS Transit Gateway
 - AWS Internet Gateway
 - AWS ELB(ALB/NLB)
 - AWS NAT Gateway
 - AWS Gateway Endpoint
 - AWS Firewall
- Azure
 - Azure VNet Router
 - Azure Virtual Network Gateway (VNet, Type: VPN/ExpressRoute)
 - Azure Load Balancer
 - Azure NAT Gateway
 - Azure Firewall
 - Azure MSEE
 - Azure vHub
 - Azure VPN Gateway (vHub)
 - Azure Express Route Gateway (vHub)
 - Azure Application Gateway
 - Azure Private Link End Point
- GCP
 - Google Cloud VPC Router
 - Google Cloud Firewall
 - Google Cloud VPN Gateway
 - Google Cloud Router
 - Google Cloud Partner Interconnect
 - Google Cloud Dedicated Interconnect
 - Google Cloud Load Balancer
 - Google Cloud NAT Gateway
 - Google Cloud Internet Gateway
 - Google Cloud Private Service Endpoint

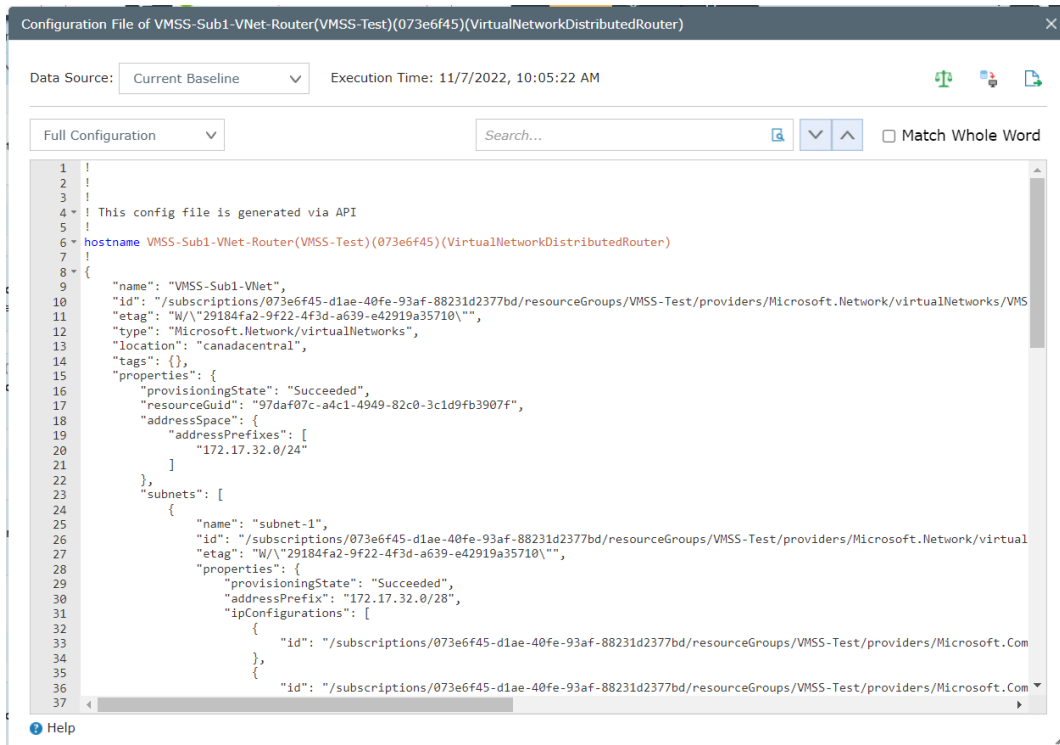
8.2.2. Feature Usage

Right-click the device/node on the map, select **View Configuration File** to open the configuration file. The feature provides compare , live retrieve  or export  functions by clicking the dedicated icon.

The configuration file can be used for:

- Public Cloud management and maintenance if you need to analyze or monitor the basic key configuration or specifications of the device/node.
- Automation flow to monitor the system health status or troubleshooting procedure.





8.3. Azure VM Scale Sets Support

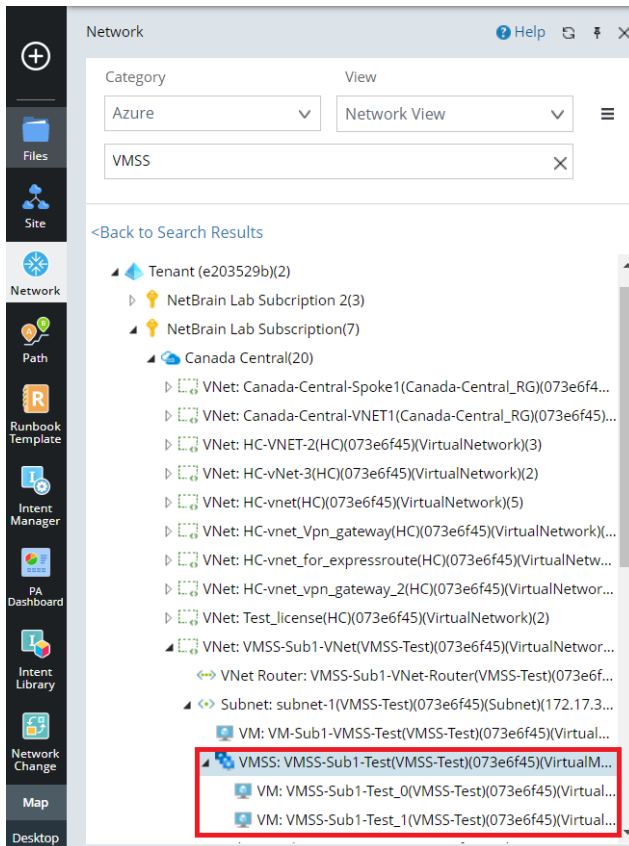
Azure Virtual Machine Scale Sets (VMSS) allow you to create and manage a group of Load Balanced VMs. It includes visibility of the basic node like VMSS instance and topology between VMSS instance and Virtual Network and Load Balancer. Note that the feature has been available since version IE10.1.7.

8.3.1. Feature Scope

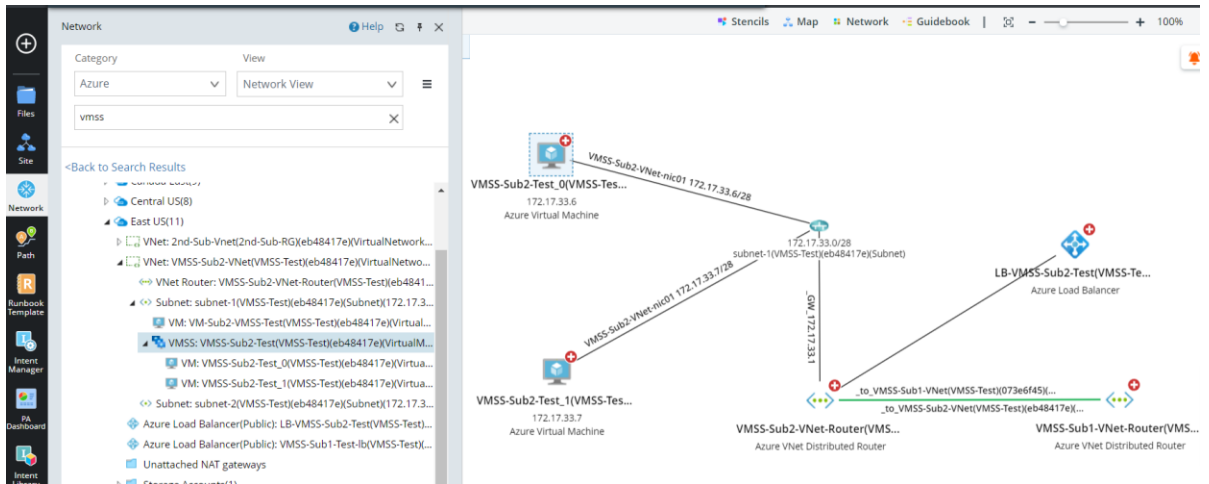
- Azure
 - Azure VM Scale Sets (VMSS)
 - Azure VM Scale Sets Instance (VMSS Instance)
 - Network Tree
 - Node/Topology on Map
 - Device/Node Details
 - Context Map
 - Data View Template (DVT)
 - Data Table (NCT)
 - Path

8.3.2. Feature Usage

- Locate the Virtual Machine Scale Sets (VMSS) from Network Tree. The Network Tree clearly shows the resource hierarchy relationship for VMSS and VMSS instance inside a Tenant /Subscription/Virtual Network level.



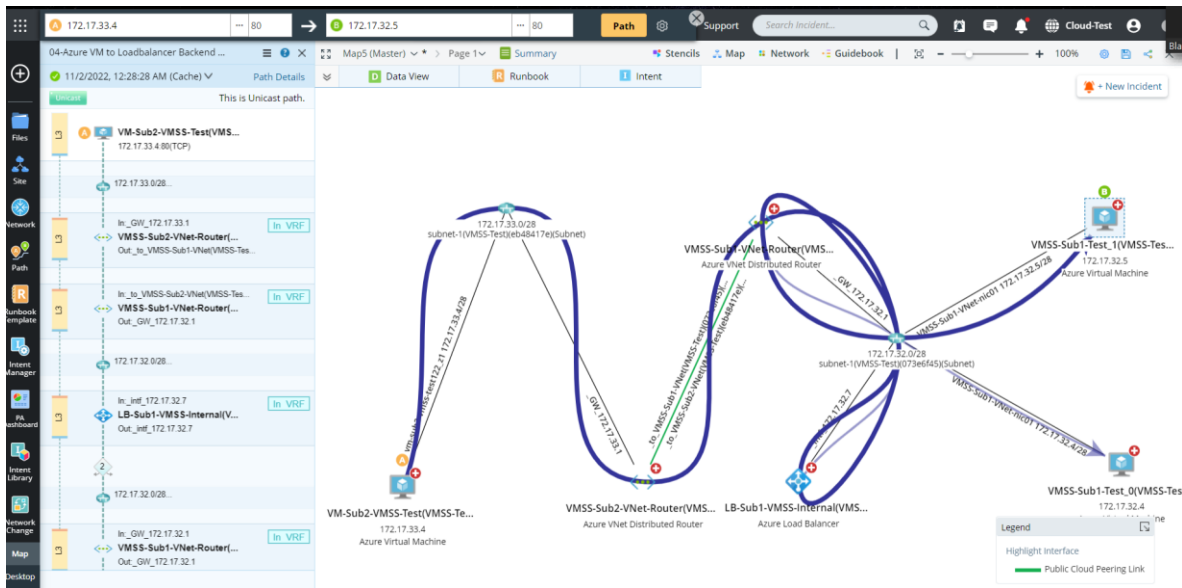
- Browse the node and topology on the map.



- Check device/node and interface details.

VMSS-Sub2-Test_1(VMSS-Test)(eb48417e)(VirtualMachine)	
Context Maps	Device Details
Property Interfaces IP Interfaces	
Hostname:	VMSS-Sub2-Test_1(VMSS-Test)(eb48417e)(Virt...
Mgmt IP:	172.17.33.7
Mgmt Interface:	VMSS-Sub2-VNet-nic01
Device Type:	Azure Virtual Machine
Vendor:	Microsoft
Model:	Virtual Machine
Software Version:	
Serial Number:	
Location:	
Contact:	
sysObjectID:	
Driver:	Azure Virtual Machine
SNMP Name:	

- Path shows up the end-to-end traffic flow, which is critical to diagnose the network reachability or service availability hop by hop with key information like route and security check details.







8.4. Azure PaaS Services Support

Azure Platform as a Service (PaaS) provides a framework that developers can build on to develop or customize a variety of cloud-based applications. NetBrain can show the visibility about various PaaS services like database and topology between different Service Endpoint, Private Endpoint and various PaaS services. Also, the path feature can show the end-to-end traffic flow hop by hop from Azure or On-Prem server to the destination PaaS service, which can be used for issue troubleshooting and network traffic analysis, planning, and optimization. Note that the feature has been available since version IE10.1.7.

8.4.1. Feature Scope

1. Supported PaaS Services and network object/node:

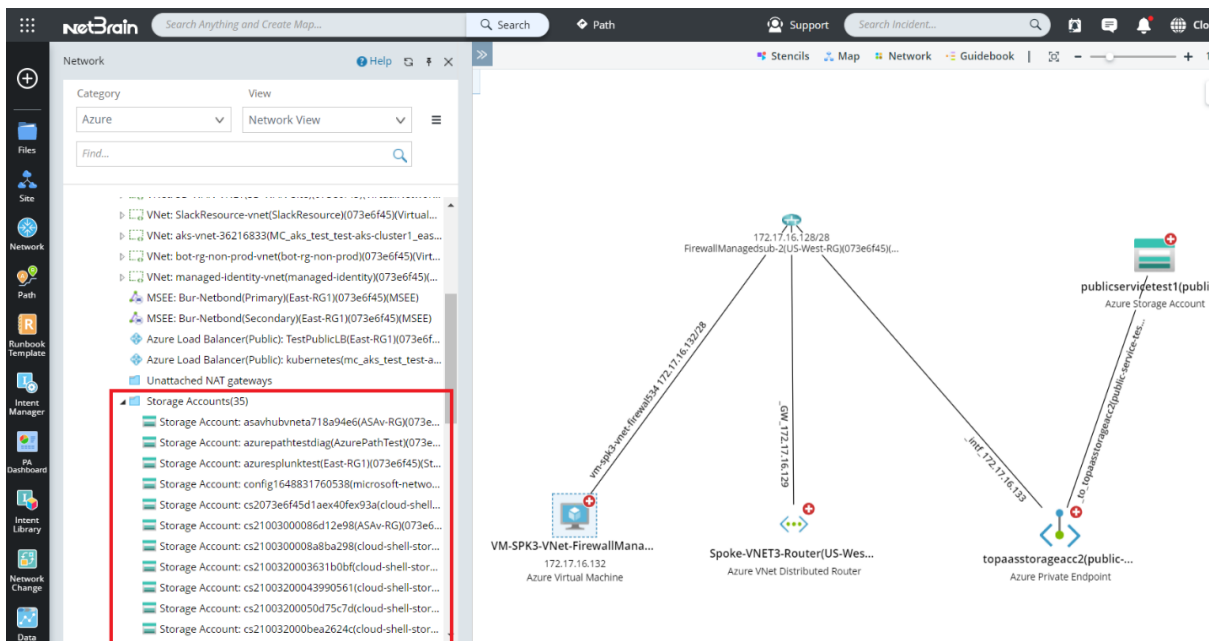
#	ICON	NAME
1		Azure Service Endpoint
2		Azure Private Endpoint
3		Azure Private Link Services
4		Azure Storage Account
5		Azure Cosmos DB

#	ICON	NAME
6		Azure Database for MySQL
7		Azure Database for PostgreSQL
8		Azure Database for MariaDB
9		Azure Database for SQL Server

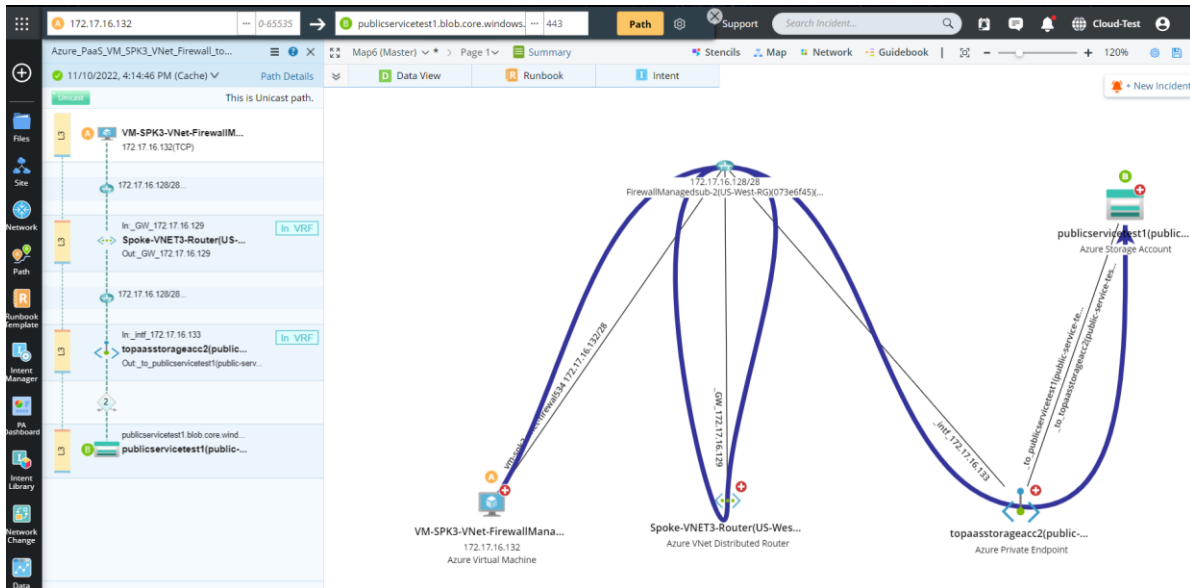
2. Supported sub-features:
 - Device/Node Details
 - Context Map
 - Data View Template (DVT)
 - Path

8.4.2. Feature Usage

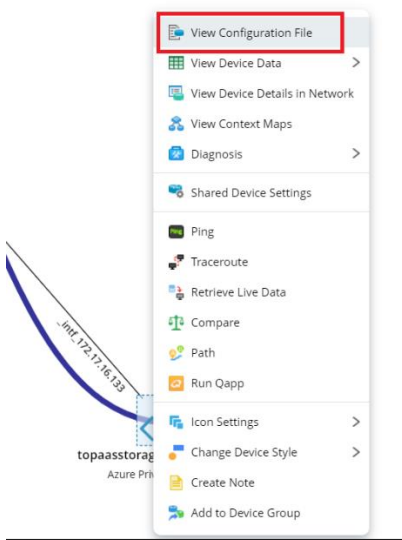
- Browse the node and topology on the map.



- Path shows up the end-to-end traffic flow, which is critical to diagnose the network reachability or service availability hop by hop with key information like route and security check details.



- Use enhanced sub-features including analyzing Device/Node Details, Context Map, Data View Template (DVT), Configuration File, and so on. For example, right-click the node icon on the map and select **View Configuration File**, find the basic key information for the current node retrieved by one or multiple APIs.



Configuration File of topaasstorageacc2(public-service-test)(073e6f45)(PrivateEndpoint)

Data Source: Current Baseline Execution Time: 11/7/2022, 10:05:03 AM

Full Configuration Search... Match Whole Word

```
1 !
2 !
3 !
4 ! This config file is generated via API
5 !
6 - hostname topaasstorageacc2(public-service-test)(073e6f45)(PrivateEndpoint)
7 !
8 {
9   "name": "topaasstorageacc2",
10  "id": "/subscriptions/073e6f45-d1ae-40fe-93af-88231d2377bd/resourceGroups/public-service-test/providers/Microsoft.Network/privateEndpoints/topaasstorageacc2",
11  "etag": "W/\"356e5c37-7060-4333-a079-c4181fb076fc\"",
12  "type": "Microsoft.Network/privateEndpoints",
13  "location": "westus",
14  "tags": {
15    "test": "paas"
16  },
17  "properties": {
18    "provisioningState": "Succeeded",
19    "resourceGuid": "6257a6a6-38e2-46dc-922b-637406fe92f0",
20    "privateLinkServiceConnections": [
21      {
22        "name": "topaasstorageacc2",
23        "id": "/subscriptions/073e6f45-d1ae-40fe-93af-88231d2377bd/resourceGroups/public-service-test/providers/Microsoft.Network/privateLinkServices/topaasstorageacc2",
24        "etag": "W/\"356e5c37-7060-4333-a079-c4181fb076fc\"",
25        "properties": {
26          "provisioningState": "Succeeded",
27          "privateLinkServiceId": "/subscriptions/073e6f45-d1ae-40fe-93af-88231d2377bd/resourceGroups/public-service-test/providers/Microsoft.Network/privateLinkServices/topaasstorageacc2",
28          "groupIds": [
29            "file"
30          ],
31          "privateLinkServiceConnectionState": {
32            "status": "Approved",
33            "description": "Auto-Approved",
34            "actionsRequired": "None"
35          },
36          "privateLinkService": {
37            "sku": {
38              "name": "Standard_BA2BS"
39            }
40          }
41        }
42      }
43    ]
44  }
45 }
```

Help

publicservicest1(public-service-test)(073e6f45)(PrivateEndpoint) Azure Storage Account







topaasstorageacc2(public-service-test)(073e6f45)(PrivateEndpoint) Azure Private Endpoint

publicservicet2(public-service-test)(073e6f45)(PrivateEndpoint) Azure Storage






9. Appendix

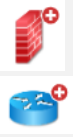





9.1. AWS Supported Network Objects and Services

The following table outlines the AWS network objects and public services that NetBrain supports.

#	Icon	Objects	Supported Technology Details	Map	Topology	Path
1		AWS Account	<ul style="list-style-type: none"> Device Details Context Map 	Yes	Yes	No
2		AWS Region	<ul style="list-style-type: none"> Device Details Context Map 	Yes	Yes	No
3		AWS Availability Zone	<ul style="list-style-type: none"> Device Details Context Map 	Yes	Yes	No
4		AWS Subnet	<ul style="list-style-type: none"> Device Details Context Map 	Yes	Yes	No
5		AWS VPC	<ul style="list-style-type: none"> Device Details Context Map Security Group Network ACL ENI Interface details per VPC VPC Sharing across Multiple Accounts VPC Route Table Ingress Routing Configuration File 	Yes	Yes	Yes
6		AWS VPC Router	<ul style="list-style-type: none"> Device Details Context Map Security Group Network ACL 	Yes	Yes	Yes


#	Icon	Objects	Supported Technology Details	Map	Topology	Path
			<ul style="list-style-type: none"> ▪ ENI Interface details per VPC ▪ VPC Sharing across Multiple Accounts ▪ VPC Route Table ▪ Ingress Routing ▪ Configuration File 			
7		AWS VPC Peering	<ul style="list-style-type: none"> ▪ VPC Peering within Same Accounts ▪ Cross Account VPC Peering 	Yes	Yes	Yes
8		AWS Internet Gateway	<ul style="list-style-type: none"> ▪ Device Details ▪ Context Map ▪ Private to Public IP Mapping Table 	Yes	Yes	Yes
9		AWS VPN Gateway	<ul style="list-style-type: none"> ▪ Device Details ▪ Context Map ▪ Virtual Route Table (based on NetBrain's unique algorithm) ▪ Cloudhub function ▪ Site-2-Site VPN details 	Yes	Yes	Yes
10		AWS Application Load Balancer	<ul style="list-style-type: none"> ▪ Target Group <ul style="list-style-type: none"> ○ IP/Instance as targets ▪ Listener Table 	Yes	Yes	Yes
11		AWS Network Load Balancer	<ul style="list-style-type: none"> ▪ Device Details ▪ Context Map ▪ Target Group <ul style="list-style-type: none"> ○ IP/Instance as targets ▪ Listener Table 	Yes	Yes	Yes
		AWS Classic Load Balancer	<ul style="list-style-type: none"> ▪ Device Details ▪ Context Map ▪ Target Group 	Yes	Yes	Yes

#	Icon	Objects	Supported Technology Details	Map	Topology	Path
			<ul style="list-style-type: none"> ○ IP/Instance as targets ▪ Listener Table 			
12		AWS NAT Gateway	<ul style="list-style-type: none"> ▪ ENI interfaces provisioned for VPCs 	Yes	Yes	Yes
13		AWS DX Device (Direct Connect)	<ul style="list-style-type: none"> ▪ Virtual Route Table for DX Router ▪ Virtual Interfaces details <ul style="list-style-type: none"> ○ Private virtual interface ○ Transit virtual interface ▪ Traffic engineering (As Path prepend, local preference for BPG community). ▪ DX Connection details ▪ LAG details 	Yes	Yes	Yes
14		AWS Direct Connect Gateway	<ul style="list-style-type: none"> ▪ Virtual Route Table ▪ Allowed Prefix for VGW/TGW ▪ Cross Account association to VGW/TGW 	Yes	Yes	Yes
15		AWS Transit Gateway	<ul style="list-style-type: none"> ▪ Transit Gateway attachments ▪ Transit Gateway route tables ▪ Transit Gateway associations ▪ Transit Gateway propagation ▪ Transit Gateway peering ▪ ENI interfaces provisioned for VPCs ▪ Transit Gateway sharing for VPC attachments 	Yes	Yes	Yes
16		EC2 Instance	<ul style="list-style-type: none"> ▪ EC2 Data Details ▪ Network Interface Details ▪ Security Groups 	Yes	Yes	Yes




#	Icon	Objects	Supported Technology Details	Map	Topology	Path
17		Network Virtual Appliances (ASAv, CSR1000v, Vedge etc.)	<ul style="list-style-type: none"> Relationship to EC2 hosts EC2 details 	Yes	Yes	Yes
18		AWS Gateway VPC Endpoint	<ul style="list-style-type: none"> Device Details Context Map Virtual Route Table Configuration File 	Yes	Yes	Yes
19		AWS Interface VPC Endpoint	<ul style="list-style-type: none"> ENI interfaces provisioned for VPCs Device Details Context Map Virtual Route Table Configuration File 	Yes		
20		AWS PrivateLink Service	<ul style="list-style-type: none"> Device Details Context Map Virtual Route Table Configuration File 			
21		AWS Network Interface	<ul style="list-style-type: none"> Device Details 			
22		AWS Network Firewall	<ul style="list-style-type: none"> Device Details Context Map Virtual Route Table Configuration File 			

9.2. Azure Supported Network Objects and Services



The following table outlines the Azure network objects and public services that NetBrain supports.

#	ICON	OBJECT NAME	SUPPORTED TECHNOLOGIES	MAP	TOPOLOGY	PATH	UNSUPPORTED FEATURES
1		Azure Tenant	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	No	
2		Azure Subscription	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	No	
3		Azure Region	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	No	
4		Virtual Machine (VM)	<ul style="list-style-type: none"> VNIC Interface details Device Details Network Security Group (Interface Level) 	Yes	Yes	Yes	
5		Virtual Network (VNet)	<ul style="list-style-type: none"> Network Security Group (Subnet Level) Application Security Group Across Multiple Accounts Across Multiple subscriptions User Defined Route Table (UDR) VNet Peering Table VNIC Effective Route Table Virtual Route Table (based on NetBrain's algorithm) Configuration File 	Yes	Yes	Yes	
6		Azure Subnet	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	No	
7		VNet Peering	<ul style="list-style-type: none"> VNet Peering within the same subscription VNet Peering across Multiple subscriptions VNet Peering within the same Account/Tenant VNet Peering across Multiple Account/Tenant 	Yes	Yes	Yes	
4		Virtual Network Gateway	<ul style="list-style-type: none"> VPN/ExpressRoute Gateway device details 	Yes	Yes	Yes	

#	ICON	OBJECT NAME	SUPPORTED TECHNOLOGIES	MAP	TOPOLOGY	PATH	UNSUPPORTED FEATURES
		(Vpn/Expressroute Gateway)	<ul style="list-style-type: none"> Virtual Route Table (based on NetBrain's algorithm) Configuration File 				
5		Azure Load Balancer (Public)	<ul style="list-style-type: none"> Device details Inbound NAT Rules Table Load Balancing Rule Table Outbound Rules Table Virtual Route Table (based on NetBrain's algorithm) Configuration File 	Yes	Yes	Yes	
6		Azure Load Balancer (Internal)	<ul style="list-style-type: none"> Device details Inbound NAT Rules Table Load Balancing Rule Table Virtual Route Table (based on NetBrain's algorithm) Configuration File 	Yes	Yes	Yes	
7		Azure NAT Gateway	<ul style="list-style-type: none"> Device details NAT Table Virtual Route Table (based on NetBrain's algorithm) Configuration File 	Yes	Yes	Yes	
8		Azure Firewall	<ul style="list-style-type: none"> Device Details Network Rule Collection Table Dnat Rule Collection Table Application Rule Collection Table Configuration File Virtual Route Table (based on NetBrain's algorithm) 	Yes	Yes	Yes	







#	ICON	OBJECT NAME	SUPPORTED TECHNOLOGIES	MAP	TOPOLOGY	PATH	UNSUPPORTED FEATURES
9		Azure Application Gateway	<ul style="list-style-type: none"> • Device Details • Listener Table • Rules Table • Http Setting Table • Virtual Route Table (based on NetBrain's algorithm) • Configuration File 	Yes	Yes	No	OSI Layer 7 Path (URL/Http/Https)
10		Network Virtual Appliances (ASAv, CSR1000v, Vedge Etc.)	<ul style="list-style-type: none"> • Relationship To Virtual Machine Host • Virtual Machine Details 	Yes	Yes	Yes	
11		Azure Virtual Wan	<ul style="list-style-type: none"> • Context Map • Device Details • Topology for different objects like VHub and VNet and VPN/ExpressRoute Gateway 				
12		Azure Virtual Hub (VHub)	<ul style="list-style-type: none"> • Context Map • Device Details • VHub Effective Route Table • VHub Virtual Route Table • Configuration File 				
13		Azure VPN Gateway (VHub)	<ul style="list-style-type: none"> • Context Map • Device Details • Neighbor Relationship Table • Virtual Route Table • Configuration File 				
14		Azure ExpressRoute Gateway (VHub)	<ul style="list-style-type: none"> • Context Map • Device Details • Neighbor Relationship Table • Virtual Route Table • Configuration File 				
15		Azure Microsoft Enterprise Edge Router (MSEE)	<ul style="list-style-type: none"> • Context Map • Device Details • Route Table • Route Summary Table 				




#	ICON	OBJECT NAME	SUPPORTED TECHNOLOGIES	MAP	TOPOLOGY	PATH	UNSUPPORTED FEATURES
			<ul style="list-style-type: none"> • ARP Table • BGP Advertised Route Table • Virtual Route Table • Configuration File 				
16		Internet Cloud	<ul style="list-style-type: none"> • Device Details 	Yes	Yes	Yes	<ul style="list-style-type: none"> • NCT route table • Path Originated from the Internet
17		MPLS Cloud	<ul style="list-style-type: none"> • Device Details • Virtual Route Table (based on NetBrain's algorithm) 	Yes	Yes	Yes	
18		Azure Service Endpoint	<ul style="list-style-type: none"> • Context Map • Device Details • Virtual Route Table • Configuration File 	Yes	Yes	Yes	
19		Azure Private Endpoint	<ul style="list-style-type: none"> • Context Map • Device Details • Virtual Route Table • Configuration File 	Yes	Yes	Yes	
20		Azure Private Link Services	<ul style="list-style-type: none"> • Context Map • Device Details • Virtual Route Table • Configuration File 	Yes	Yes	Yes	
21		Azure Storage Account	<ul style="list-style-type: none"> • Context Map • Device Details • 	Yes	Yes	Yes	
22		Azure Cosmos DB	<ul style="list-style-type: none"> • Context Map • Device Details 	Yes	Yes	Yes	
23		Azure Database for MySQL - Single Server	<ul style="list-style-type: none"> • Context Map • Device Details 	Yes	Yes	Yes	
24		Azure Database for PostgreSQL - Single Server	<ul style="list-style-type: none"> • Context Map • Device Details 	Yes	Yes	Yes	






#	ICON	OBJECT NAME	SUPPORTED TECHNOLOGIES	MAP	TOPOLOGY	PATH	UNSUPPORTED FEATURES
25		Azure Database for MariaDB Server	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	Yes	
26		Azure SQL Server	<ul style="list-style-type: none"> Context Map Device Details 	Yes	Yes	Yes	




9.3. GCP Supported Network Objects and Services



The following table outlines the GCP network objects and public services that NetBrain supports.




#	Icon	Object Name	Supported Features Details	Map	Topology	Path
1		Google Organization	<ul style="list-style-type: none"> Organization Details (Name/ID) Topology between Organization and Folder/Project Hyperlink to GCP Portal Organization Details Page 	Yes	Yes	N/A
2		Google Folder	<ul style="list-style-type: none"> Folder Details (Name/ID) Topology between Folder and Organization/Sub-folder/Project Hyperlink to GCP Portal Folder Details Page 	Yes	Yes	N/A
3		Google Project	<ul style="list-style-type: none"> Project Details (Name/ID) Topology between Project and Organization/Folder/Resources Hyperlink to GCP Portal Project Details Page 	Yes	Yes	N/A
4		Google Region	<ul style="list-style-type: none"> Location is displayed on the map via DVT or Node Details 	Yes	N/A	N/A
5		Google Zone	<ul style="list-style-type: none"> Location is displayed on the map via DVT or Node Details 	Yes	N/A	N/A
6		Google VPC Network	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal VPC Details Page Subnets Subnet Auto Creation Dynamic Routing Mode MTU 	Yes	Yes	Yes

#	Icon	Object Name	Supported Features Details	Map	Topology	Path
			<ul style="list-style-type: none"> • Firewall Rules • Firewall Policies • Routes • Static Internal IP Addresses • Private Service Connection • Shared VPC • VPC Peering within Same Organization • VPC Peering crossing different Organizations • VPC Flow Logs Analytics 			
7		Google VPC Router*	<ul style="list-style-type: none"> • Name/ID • Hyperlink to GCP Portal VPC Details Page • Subnets • Subnet Auto Creation • Dynamic Routing Mode • MTU • Firewall Rules • Firewall Policies • Routes • Static Internal IP Addresses • Private Service Connection • Shared VPC • VPC Peering within Same Organization • VPC Peering crossing different Organizations • VPC Flow Logs Analytics 	Yes	Yes	Yes
8		Google Subnet	<ul style="list-style-type: none"> • Name/ID • Hyperlink to GCP Portal Subnet Details Page • Project Name/ID (Hyperlink to GCP Portal) • IP Ranges • Region • Gateway • Private Google Access • Flow Logs (Hyperlink to GCP Portal) 	Yes	Yes	N/A
9		Google Virtual Machine	<ul style="list-style-type: none"> • Name/ID • Hyperlink to GCP Portal VM Details Page • Project Name/ID (Hyperlink to GCP Portal) • Network Interface Nic Details (Name/IP) • Zone • Machine Type • CPU Platform • Creation Time • Network Tags • Service Account • Public IPV4 Address 	Yes	Yes	Yes

#	Icon	Object Name	Supported Features Details	Map	Topology	Path
			<ul style="list-style-type: none"> Remote Access (Hyperlink to GCP Portal) Tags Logs (Hyperlink to GCP Portal) 			
10	 	Network Virtual Appliances (FortiGate Firewall, Cisco CSR1000v, ASAv, Viptela, etc.)	<ul style="list-style-type: none"> Host Name Management IP Vendor Model Software Version Serial Number Relationship to VM Hosts Multi-Source Data Merge Interfaces Details (Name/IP) 	Yes	Yes	Yes
11		Google VPN Gateway	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal VPN Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region High Availability HA and Classic VPN Gateway Site-to-Site VPN Tunnel BGP Advertised Route Logs (Hyperlink to GCP Portal) 	Yes	Yes	Yes
12		Google Cloud Router	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Cloud Router Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region Google ASN Advertised Routes Mode BGP Session Information Logs (Hyperlink to GCP Portal) 	Yes	Yes	Yes
13		Google Cloud NAT	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Cloud NAT Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region Endpoint-Independent Mapping Enabled Cloud Router Name/ID Minimum Ports Per VM Instance UDP Timeout(sec) 	Yes	Yes	Yes

#	Icon	Object Name	Supported Features Details	Map	Topology	Path
			<ul style="list-style-type: none"> TCP Established Timeout(sec) TCP Transitory Timeout(sec) ICMP Timeout(sec) Stackdriving Logging Monitoring (Hyperlink to GCP Portal) NAT Mapping Rule Cloud Router Details Logs (Hyperlink to GCP Portal) 			
14		Google Load Balancer	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Load Balancer Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region Protocol (TCP/UDP/HTTP/HTTPS) Type: (Internal/External) Backend and Frontend Details Load Balancing Rule Host and Path Rule 	Yes	Yes	Yes (Layer 3)
15		Firewall	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Firewall Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Firewall Policy Firewall Rule Firewall Rule Logs Analytics (DVT) 	Yes	Yes	Yes
16		Partner Interconnect	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Load Balancer Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region Interconnect Name Partner (Hyperlink to Partner Website) Admin Enabled Bandwidth Cloud Router IP Address Customer Router IP Address Creation Time Edge Availability Domain Pairing Key Partner ASN State: (e.g. ACTIVE) 	Yes	Yes	Yes

#	Icon	Object Name	Supported Features Details	Map	Topology	Path
			<ul style="list-style-type: none"> Type: (e.g. PARTNER) VLAN Tag 8021q: (e.g. 1141) Cloud Router: (e.g. gcp-router-a) VLAN Attachment Physical Connection BGP Advertised Routes 			
17		Dedicated Interconnect	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal Load Balancer Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Region Interconnect Name Admin Enabled Bandwidth Cloud Router IP Address Customer Router IP Address Creation Time Edge Availability Domain State: (e.g. ACTIVE) Type: (e.g. DEDICATED) VLAN Tag 8021q: (e.g. 1141) Cloud Router: (e.g. gcp-router-b) VLAN Attachment Physical Connection BGP Advertised Routes 	Yes	Yes	Yes
18		Google Private Service Connect Endpoint	<ul style="list-style-type: none"> Name/ID Hyperlink to GCP Portal PSC Details Page Project Name/ID (Hyperlink to GCP Portal) VPC Name/ID (Hyperlink to GCP Portal) Private Service Connect PSC Connection ID Target IP address Namespace Cloud DNS Topology to VPC Network and Public Service 	Yes	Yes	No
19		Google Public Service **	<ul style="list-style-type: none"> Topology for VPC/Private Service Connect and Public Service 	Yes	Yes	No







#	Icon	Object Name	Supported Features Details	Map	Topology	Path
20		Google Cloud Internet Gateway***	<ul style="list-style-type: none"> Topology to VPC Network and Public Service Topology to Internet Cloud 	Yes	Yes	No
21		Google VM Instance Group***	N/A	No	No	No
22		Google Network Endpoint Group***	N/A	No	No	No

Notes:



















- * Google VPC Router: Google VPC Router is not an actual object of Google Cloud. NetBrain creates the Google VPC router for each VPC Network as an interconnect/functional object to simulate the routing/security check function and store the VPC Network data like VPC Peering and VPC Subnet.
- ** Google Public Service: Refer to section [GCP Supported PaaS Services](#) for more details.
- *** Google Cloud Internet Gateway, Google VM Instance Group, and Google Network Endpoint Group are on the roadmap.








9.4. GCP Supported PaaS Services

The following table outlines the Google public services that NetBrain supports.

#	Icon	Category	Public Service Name	DNS Record	API Reference
1		Compute	Google Cloud App Engine	appengine.googleapis.com	https://cloud.google.com/appengine/docs/admin-api/reference/rest/
2		Compute (Database)	Google Cloud Bear Mental	baremetalsolution.googleapis.com	https://cloud.google.com/bare-metal/docs/reference/rest/
3		Compute	Google Cloud Run	run.googleapis.com	https://cloud.google.com/run/docs/reference/rest/
4		Compute	Google Cloud Compute Engine	compute.googleapis.com	https://cloud.google.com/compute/docs/reference/rest/v1/
5		Compute	Google Cloud Recommender	recommender.googleapis.com	https://cloud.google.com/recommender/docs/reference/rest/
6		Compute	Google Cloud SQL Server	sqladmin.googleapis.com	https://cloud.google.com/sql/docs/postgres/admin-api/rest/

#	Icon	Category	Public Service Name	DNS Record	API Reference
7		Compute	Google Cloud Functions	cloudfunctions.googleapis.com	https://cloud.google.com/functions/docs/reference/rest/
8		Storage	Google Cloud Storage Transfer Service	storagetransfer.googleapis.com	https://cloud.google.com/storage-transfer/docs/reference/rest/
9		Storage	Google Cloud Storage	storage.googleapis.com	https://cloud.google.com/storage/docs/json_api/v1/
10		Storage	Google Cloud Storage for Firebase	firebasestorage.googleapis.com	https://firebase.google.com/docs/reference/rest/storage/rest/
11		Storage (Database)	Google Cloud Firestore	firestore.googleapis.com	https://cloud.google.com/firestore/docs/reference/rest/
12		Database	Google Cloud Bigtable	bigtableadmin.googleapis.com	https://cloud.google.com/bigtable/docs/reference/admin/rest/
13		Database	Google Cloud Spanner	spanner.googleapis.com	https://cloud.google.com/spanner/docs/reference/rest/
14		Database	Google Cloud Database Migration Service	datamigration.googleapis.com	https://cloud.google.com/database-migration/docs/reference/rest/
15		Database	Google Cloud Firebase Realtime Database	firebase.database.googleapis.com	https://firebase.google.com/docs/reference/rest/database/database-management/rest/
16		Database	Google Cloud Memorystore	redis.googleapis.com	https://cloud.google.com/memorystore/docs/redis/reference/rest/
17		Database	Google Cloud Datastream	datastream.googleapis.com	
18		Database	Google Cloud Datastore	datastore.googleapis.com	https://cloud.google.com/datastore/docs/reference/data/rest/
19		Hybrid and Multicloud	Google Cloud Apigee	apigee.googleapis.com	
20		Hybrid and Multicloud	Google Cloud Build	cloudbuild.googleapis.com	https://cloud.google.com/cloud-build/docs/api/reference/rest/
21		Operations	Google Cloud Debugger	clouddebugger.googleapis.com	https://cloud.google.com/debugger/api/reference/rest/
22		Operations	Google Cloud Logging	logging.googleapis.com	https://cloud.google.com/logging/docs/reference/v2/rest/
23		Operations	Google Cloud Monitoring	monitoring.googleapis.com	https://cloud.google.com/monitoring/api/ref_v3/rest/
24		Management Tools	Google Cloud Shell	cloudshell.googleapis.com	https://cloud.google.com/shell/docs/reference/rest/
25		Management Tools	Google Cloud Cost Management	cloudbilling.googleapis.com	https://cloud.google.com/billing/reference/rest/
26		Data Analytics	Google Cloud BigQuery	bigquery.googleapis.com	https://cloud.google.com/bigquery/docs/reference/rest/
27		Data Analytics	Google Cloud Dataproc	dataproc.googleapis.com	https://cloud.google.com/dataproc/docs/reference/rest/

#	Icon	Category	Public Service Name	DNS Record	API Reference
28		Data Analytics	Google Cloud Dataflow	dataflow.googleapis.com	https://cloud.google.com/dataflow/docs/reference/rest/
29		Data Analytics	Google Cloud Pub/Sub	pubsub.googleapis.com	https://cloud.google.com/pubsub/docs/reference/rest/
30		Data Analytics	Google Cloud Data Fusion	datafusion.googleapis.com	https://cloud.google.com/datafusion/docs/reference/rest/
31		Data Analytics	Google Cloud Data Catalog	datacatalog.googleapis.com	https://cloud.google.com/datacatalog/docs/reference/rest/
32		Data Analytics	Google Cloud Composer	composer.googleapis.com	https://cloud.google.com/composer/docs/reference/rest/
33		Data Analytics	Google Cloud Data Studio	datastudio.googleapis.com	
34		Data Analytics	Google Cloud Life Sciences	lifesciences.googleapis.com	https://cloud.google.com/life-sciences/docs/reference/rest/
35		AI and Machine Learning	Google Cloud Vertex AI	aiplatform.googleapis.com	
36		AI and Machine Learning	Google Cloud Notebooks	notebooks.googleapis.com	https://cloud.google.com/ai-platform/notebooks/docs/reference/rest/
37		AI and Machine Learning	Google Cloud AutoML	automl.googleapis.com	
38		AI and Machine Learning	Google Cloud Vision AI	vision.googleapis.com	https://cloud.google.com/vision/docs/reference/rest/
39		AI and Machine Learning	Google Cloud Natural Language	language.googleapis.com	https://cloud.google.com/natural-language/docs/reference/rest/
40		AI and Machine Learning	Google Cloud Translation	translate.googleapis.com	https://cloud.google.com/translate/docs/reference/rest/
41		AI and Machine Learning	Google Cloud Text-to-Speech	texttospeech.googleapis.com	https://cloud.google.com/text-to-speech/docs/reference/rest/
42		AI and Machine Learning	Google Cloud Speech-to-Text	speech.googleapis.com	https://cloud.google.com/speech-to-text/docs/reference/rest/
43		AI and Machine Learning	Google Cloud Dialogflow	dialogflow.googleapis.com	https://cloud.google.com/dialogflow-enterprise/docs/reference/rest/v2-overview
44		AI and Machine Learning	Google Cloud Inference API	infer.googleapis.com	
45		AI and Machine Learning	Google Cloud Recommendations AI	recommendationengine.googleapis.com	https://cloud.google.com/recommendations-ai/docs/reference/rest/

#	Icon	Category	Public Service Name	DNS Record	API Reference
46		AI and Machine Learning	Google Cloud AI Infrastructure	ml.googleapis.com	
47		AI and Machine Learning	Google Cloud TPU	tpu.googleapis.com	https://cloud.google.com/tpu/docs/reference/rest/
48		API Management	Google Cloud Healthcare API	healthcare.googleapis.com	https://cloud.google.com/healthcare/docs/reference/rest/
49		AI and Machine Learning	Google Cloud API Gateway	apigateway.googleapis.com	https://cloud.google.com/apigateway/docs/reference/rest/
50		Containers	Google Cloud Artifact Registry	artifactregistry.googleapis.com	https://cloud.google.com/artifacts/docs/reference/rest/
51		Containers	Google Cloud Container Registry	containeranalysis.googleapis.com	
52		Containers	Google Kubernetes Engine (GKE)	container.googleapis.com	https://cloud.google.com/kubernetes-engine/docs/reference/rest/