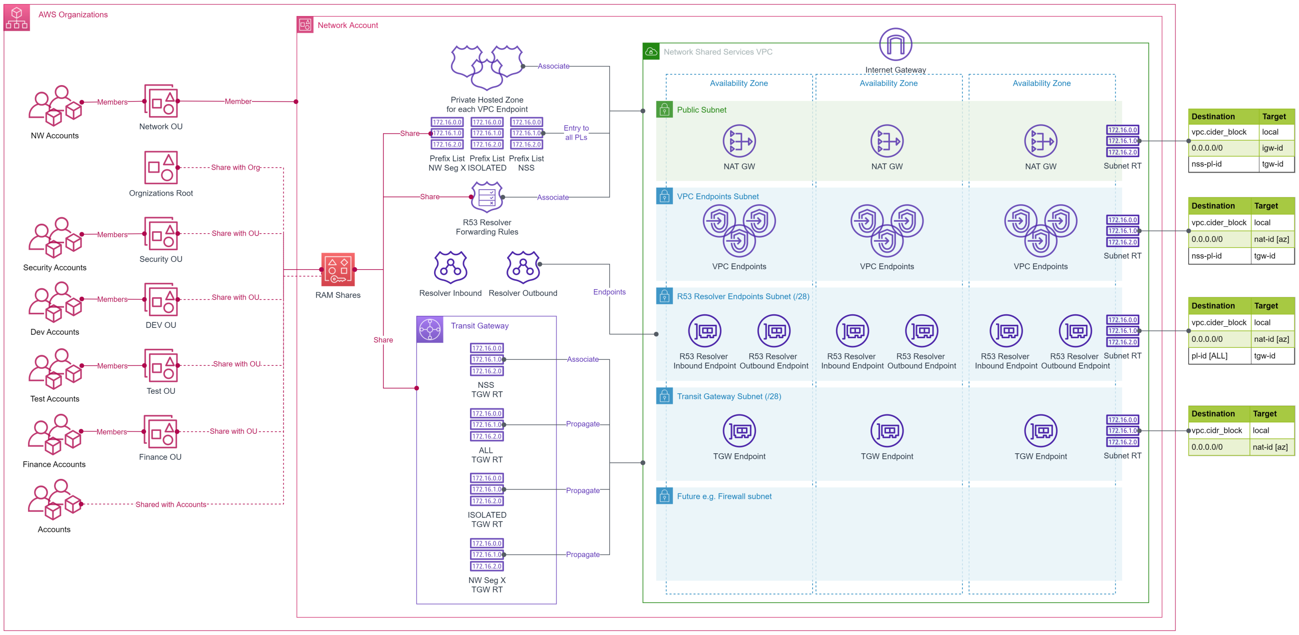
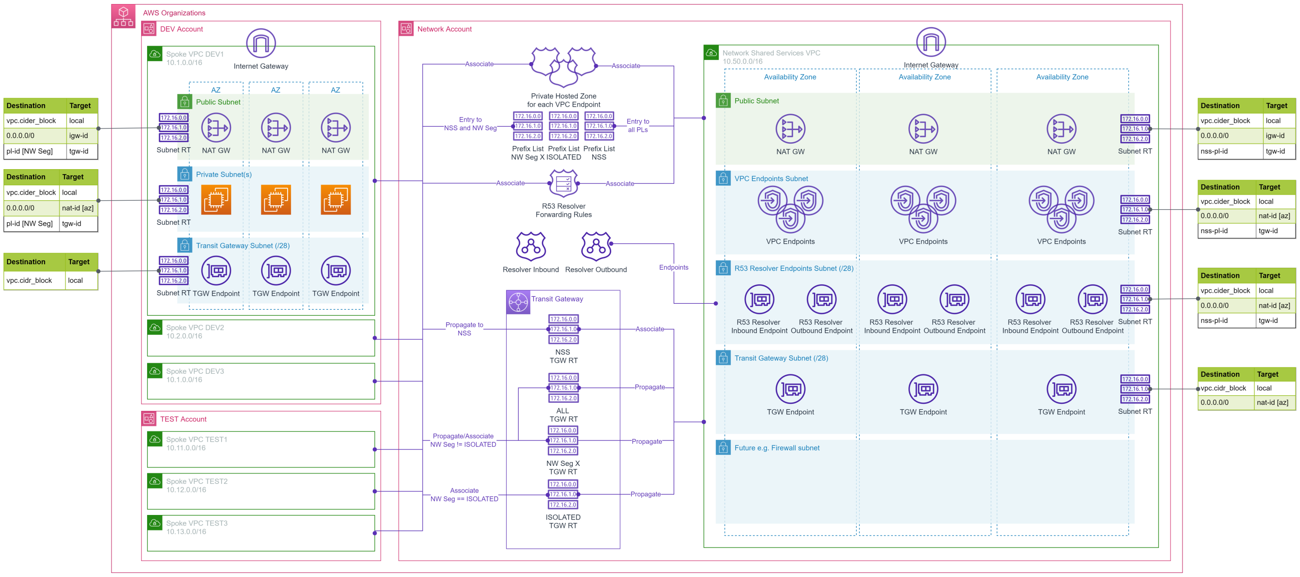
Build Multi-Account and Multi-VPC AWS network infrastructure with Network Shared Services (NSS)

This solution is a set of Terraform modules to build Multi-Account and Multi-VPC AWS network infrastructure. Using these modules you can:

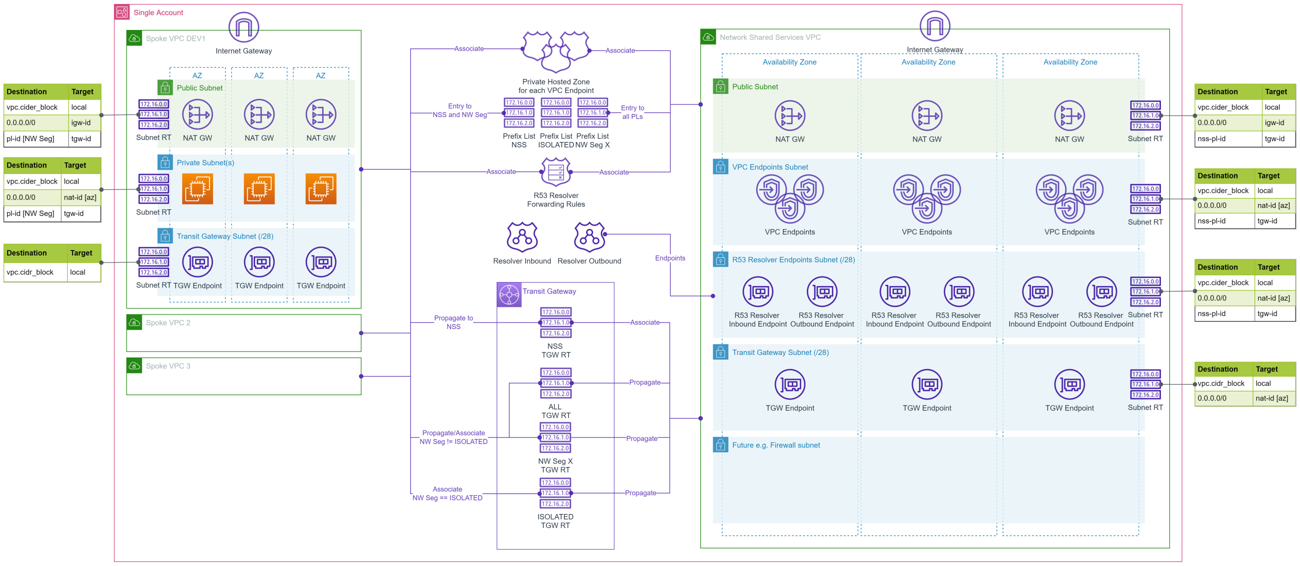
- Provision Network Shared Services (NSS) VPC in the *Network* account with
  - Network Segments for VPC to VPC connectivity.
  - Organization, Organization Units (OUs), or Accounts level sharing of NSS resources.
- Provision zero or more of the following supported NSS
  - Centralized VPC private endpoints for one or more supported AWS services.
  - Centralized hybrid DNS.



- Provision spoke VPCs in AWS account, with which sharing is enabled, along with
  - Network segment based VPC to VPC connectivity.
  - Connectivity to zero or more provisioned NSS.



As a side-effect, these modules support provisioning the complete solution in a single AWS account as well.



Features

The solution has following features:

- Create Network Shared Services (NSS) VPC in the target (*Network or single*) AWS Account.
- Enable sharing and connectivity at Organization, Organization Units (OUs), or Accounts level for the provisioned NSS resources.
  - If shared at the Organization level then all accounts in the Organization can use NSS.
  - If shared with a list of OUs then all accounts in those OUs can use NSS.
  - If shared with a list of accounts then only those accounts can use NSS.

- Create zero or more of the following supported NSS.
    - Centralized VPC private endpoints for one or more supported AWS services.
    - Centralized hybrid DNS.
- Create spoke VPCs in an AWS account, with which sharing is enabled, along with
    - Network segment based VPC to VPC connectivity across the accounts.
    - Connectivity to zero or more provisioned NSS.
- For the NSS VPC
    - Create zero or more network segments for VPC to VPC connectivity.
        - By default two network segments "ALL" and "ISOLATED" are always created.
    - For the single account setup, disable sharing but continue to support connectivity.
    - Define CIDRs for the VPC and subnets or let the module calculate the CIDRs.
    - Use Prefix-list or super net CIDR blocks for subnet routing.
    - For NSS egress, create NAT GW in single AZ or all AZs.
- For the centralized VPC private endpoints NSS
    - Optionally enable VPC flow logs at subnet or individual AWS service level.
        - Log to Amazon CloudWatch or Amazon S3
        - Optionally encrypt the logs using a provided or generated KMS key.
        - Use a provided IAM role or create an IAM role for the Amazon CloudWatch or Amazon S3 logging.
        - Filter, aggregate, format, and partition logs based on the destination.
- For the centralized hybrid DNS NSS
    - Optionally create Route 53 resolver inbound endpoints for the provided on-premises CIDRs.
    - Optionally create Route 53 resolver outbound endpoints and Route 53 resolver forwarding rules for the provided on-premises domain names and DNS resolver IP addresses.
- For the spoke VPC
    - If no network segment is requested then connect to the "ISOLATED" network segment.
    - if the requested network segment is not supported then connect to the "ISOLATED" network segment.
    - "ISOLATED" network segment provides connectivity to NSS VPC only.
    - Enable connectivity to zero, all, or selected VPC private endpoints.
- Uniformly name and tag the provisioned resources.

Prerequisites

- The target AWS Account(s) (e.g. Tooling, Network, and spoke VPC accounts) and AWS Region are identified.
- The AWS User/Role executing the Terraform scripts must have permissions to provision the bootstrap resources in the `tooling` account and `Terraformer` IAM role in other accounts.

- For the Multi-Account environment, the master account for the AWS Organization must have enabled sharing in the AWS Resource Access Manager (RAM).
  - e.g. `aws ram enable-sharing-with-aws-organization`
- The Terraform CLI (`version = ">= 1.3.9"`) is installed.
- Terraform backend provider and state locking providers are identified and bootstrapped in the *Tooling* account.
  - A bootstrap module/example is provided that provisions an Amazon S3 bucket for Terraform state storage and Amazon DynamoDB table for Terraform state locking.
    - The Amazon S3 bucket name must be globally unique.
- *Terraformer* IAM role is bootstrapped in each of the target AWS account.
  - A bootstrap module/example is provided that provisions the *Terraformer* role in target AWS accounts.
- Uniform resource tagging scheme is identified.
  - The examples use only two tags: `Env` and `Project`

Usage

- Use the modules via GitHub source or copy the needed module into your repository.
- Incorporate the module in your network CI/CD pipeline as appropriate.
- This solution uses external module terraform-aws-vpc to provision the Amazon VPC.
- This solution uses external module aws-tf-kms to provision AWS KMS Key, if encrypted flow logs are enabled for VPC endpoints without providing an existing `kms_alias`.

Quotas

The following table lists the default quotas relevant to this solution. Most of these quotas can be increased on request.

Service	**Quota**	**Adjustable**	**Comments**
VPCs per Region	5	Yes	100s of VPC per Region are possible
Subnets per VPC	200	Yes	More subnets mean smaller IP ranges per subnet
Route tables per VPC	200	Yes	This solution uses one route table per subnet
Routes per route table	50	Yes	Prefix-list is used for routes. Entries in the prefix-list count towards this limit. Suggest using `super_net_cidr_blocks` feature of the solution

Service	Quota	Adjustable	Comments
IPv4 CIDR blocks per VPC	5	Yes	Up to total 50. This solution supports one CIDR block per VPC
IPv6 CIDR blocks per VPC	5	No	Not supported by this solution
EIP per Region	5	Yes	One EIP is used by each NAT GW in this solution
Internet GW per Region	5	Yes	One IGW per VPC
NAT GW per AZ	5	Yes	This solution provision max one NAT GW per AZ
Prefix lists per Region	100	Yes	This solution uses (number of nw segments+1) prefix-lists. Minimum 3.
References to a prefix list per resource type	5000	Yes	This solution references nw segment prefix-list in subnet route tables
VPC endpoints per VPC	50	Yes	Combined quota for interface and Gateway endpoints in a VPC.
Transit gateways per account	5	Yes	This solution uses one TGW
TGW route tables per TGW	20	Yes	This solution uses (number of nw segments+1) TGW route tables. Minimum 3.
Attachments per TGW	5000	No	Each connected VPC uses one attachment
Max bandwidth per VPC attachment to TGW	up to 50 Gbps	No	
Private Hosted zones	500 per account	Yes	This solution creates one PHZ per VPC endpoint
VPC associations per private hosted zone	300	Yes	In this solution each spoke VPC that uses a centralized VPC endpoint uses one association

Service	Quota	Adjustable	Comments
R53 resolver endpoints per Region	4 per account	Yes	This solution creates 2 resolver endpoints
IP addresses per R53 resolver endpoint	6	Yes	This solution creates one ip address per AZ in NSS VPC
QPS per IP address per R53 endpoint	10000~		QPS varies based on query
IP addresses per R53 rule	6	Yes	Each on-premises DNS resolver endpoint uses one IP address
VPC associations per R53 rule	2000	Yes	In this solution each spoke VPC may use one association

Future Enhancements

This solution will be enhanced in future to improve currently supported NSS and include more NSS as following:

- Improve centralized hybrid DNS with optional
  - Route 53 DNS Firewall
  - DNS query logs
  - DNS QPS alarm
- Support flow logs for all NSS and spoke VPCs/Subnet(s).
- Support multiple secondary CIDRs and connectivity for spoke VPCs.
- Centralized egress to internet with optional
  - AWS Network Firewall inspection
  - Gateway load balancer and security appliance inspection
- Improve VPC-to-VPC connectivity with optional
  - On-premises connectivity via VPN or Direct Connect Gateway
  - AWS Network Firewall inspection
  - Gateway load balancer and security appliance inspection
- Centralized ingress from internet with optional
  - AWS Network Firewall inspection
  - Gateway load balancer and security appliance inspection

References

- AWS Whitepapers
  - Building a Scalable and Secure Multi-VPC AWS Network Infrastructure
- AWS Blogs
  - Centralize access using VPC interface endpoints to access AWS services across multiple VPCs
  - Integrating AWS Transit Gateway with AWS PrivateLink and Amazon Route 53 Resolver
  - Simplify DNS management in a multi-account environment with Route 53 Resolver
- AWS Documentation
  - AWS services that integrate with AWS PrivateLink
  - Amazon VPC quotas
  - Quotas for your transit gateways
  - Amazon Route 53 Quotas
- AWS Open Source Projects
  - aws-ia/terraform-aws-vpc
  - aws-samples/aws-tf-kms
  - aws-ia/terraform-aws-network-hubandspoke
  - aws-samples/vpc-endpoint-sharing
  - aws-samples/hub-and-spoke-with-inspection-vpc-terraform
  - aws-samples/aws-network-hub-for-terraform

Security

See CONTRIBUTING for more information.

License

This library is licensed under the MIT-0 License. See the LICENSE file.