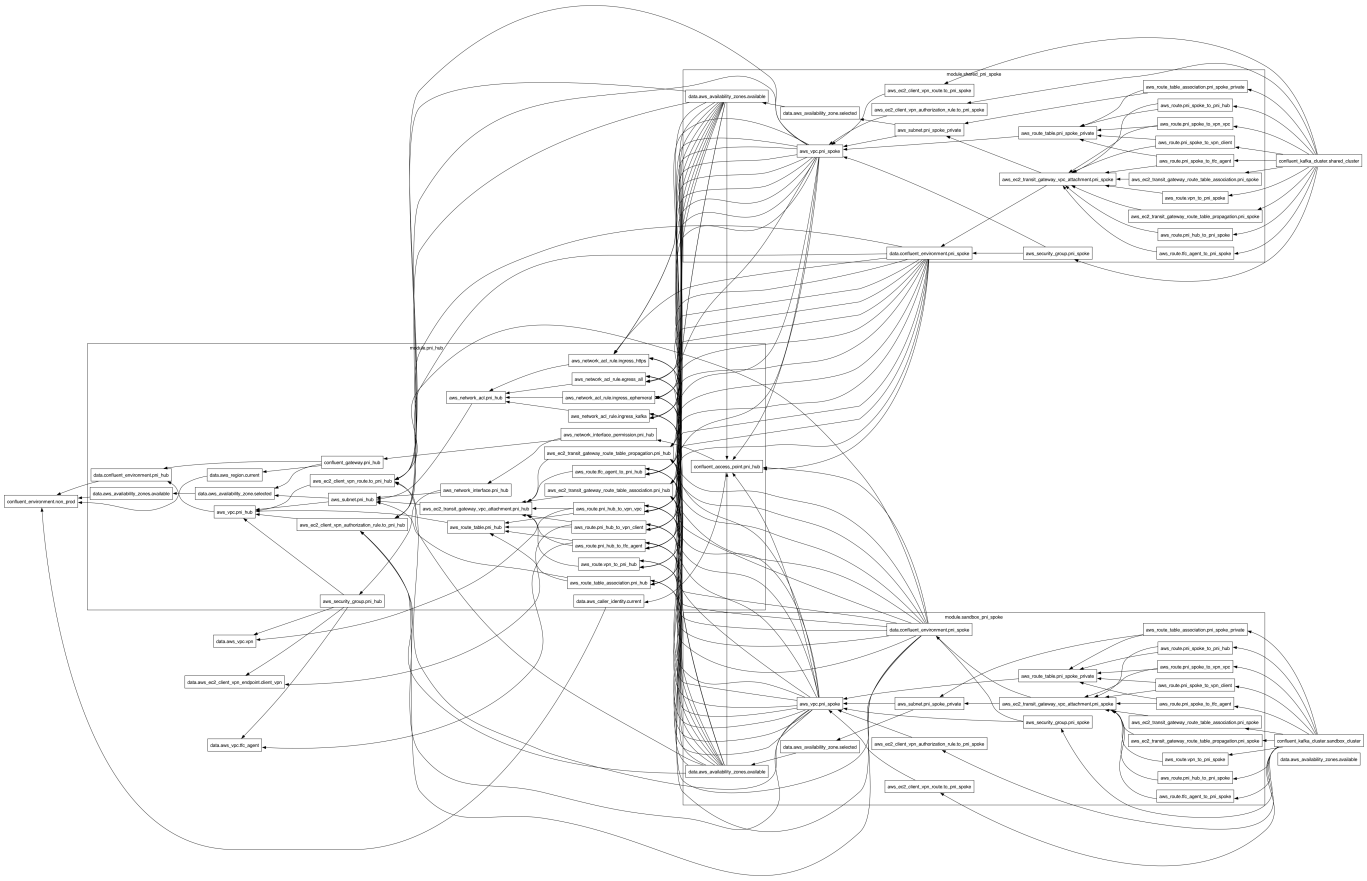
IaC Confluent Cloud AWS Private Network Interface (PNI), Infrastructure and Networking Example



> **Terraform-managed, hub-and-spoke Private Network Interface (PNI) connectivity between AWS VPCs and Confluent Cloud Enterprise Kafka clusters — deployed via Terraform Cloud.**

Overview

This repository provisions a complete, production-grade private networking topology that connects AWS workload VPCs to Confluent Cloud Enterprise Kafka clusters using **Private Network Interface (PNI)** — Confluent's next-generation private connectivity model that replaces PrivateLink with customer-owned ENIs placed directly in your VPCs.

The architecture follows a **Hub-and-Spoke** pattern:

- A **PNI Hub VPC** owns the ENIs registered with Confluent Cloud and serves as the centralized private connectivity anchor.
- **PNI Spoke VPCs** (sandbox, shared) each host a Confluent Cloud Enterprise Kafka cluster and peer connectivity through the hub via AWS Transit Gateway.
- All VPCs are stitched together through an existing **AWS Transit Gateway (TGW)**, enabling a VPN-connected developer/operator to reach Confluent Cloud endpoints without traversing the public internet.

State is managed remotely in **Terraform Cloud** (organization: `signalroom`, workspace: `iac-cc-aws-pni-infrastructure-networking-example`).

Architecture

```
flowchart TD
    subgraph VPN["VPN VPC (existing)"]
        CVE["AWS Client VPN Endpoint"]
    end

    subgraph TFC_AGENT["TFC Agent VPC (existing)"]
        AGENT["Terraform Cloud Agent"]
    end

    TGW["AWS Transit Gateway\n+ Route Table"]

    subgraph PNI_HUB["PNI Hub VPC — 10.3.0.0/20"]
        direction TB
        SG["Security Group\n(ports 443, 9092 ingress only)"]
        NACL["Network ACL\n(443, 9092, ephemeral)"]
        ENI1["ENI — AZ-a"]
        ENI2["ENI — AZ-b"]
        ENI3["ENI — AZ-c"]
        TGW_ATT_HUB["TGW Attachment"]
        GW["confluent_gateway\n(AWS PNI Gateway)"]
        AP["confluent_access_point\n(PNI Access Point)"]
        SG --> ENI1 & ENI2 & ENI3
        ENI1 & ENI2 & ENI3 --> AP
        AP --> GW
    end

    subgraph SANDBOX_SPOKE["Sandbox PNI Spoke VPC — 10.0.0.0/20"]
        TGW_ATT_SB["TGW Attachment"]
        SK_CLUSTER["confluent_kafka_cluster\nsandbox_cluster\n(Enterprise,
HIGH availability)"]
    end

    subgraph SHARED_SPOKE["Shared PNI Spoke VPC — 10.1.0.0/20"]
        TGW_ATT_SH["TGW Attachment"]
        SH_CLUSTER["confluent_kafka_cluster\nshared_cluster\n(Enterprise,
HIGH availability)"]
    end

    subgraph CONFLUENT_CLOUD["Confluent Cloud"]
        ENV["Environment: non-prod\n(Stream Governance: ESSENTIALS)"]
        GW --> ENV
        SK_CLUSTER --> ENV
        SH_CLUSTER --> ENV
    end

    CVE -->|"routes via TGW"| TGW
```

```
    AGENT -->|"routes via TGW"| TGW
    TGW <-->|"attach + propagate"| TGW_ATT_HUB
    TGW <-->|"attach + propagate"| TGW_ATT_SB
    TGW <-->|"attach + propagate"| TGW_ATT_SH
    TGW_ATT_HUB --> PNI_HUB
    TGW_ATT_SB --> SANDBOX_SPOKE
    TGW_ATT_SH --> SHARED_SPOKE
```

Module Structure

```
.
├── main.tf                          # Root: environment, cluster
resources, module calls
├── data.tf                          # Data sources: VPCs, VPN endpoint,
AZs
├── variables.tf                     # Root-level input variables
├── outputs.tf                       # PNI gateway & access point IDs
├── versions.tf                      # Provider version pins (AWS 6.33,
Confluent 2.62, TFE 0.73)
├── provider.tf                      # Provider configuration
├── deploy.sh                        # Bootstrap / teardown script (AWS
SSO + TF env vars)
└── modules/
    ├── aws-vpc-confluent-pni-hub/   # PNI Hub module
    │   ├── setup-confluent-pni-hub.tf            # Gateway, access point,
VPC, subnets, ENIs, SG
    │   ├── setup-aws-vpc-tgw-private_routing.tf  # TGW attachment,
associations, routes
    │   ├── setup-aws-vpc-security_group_rules.tf # NACL rules
    │   ├── setup-aws-network-permissions.tf      # ENI permissions for
Confluent's AWS account
    │   ├── data.tf                               # Module-level data
sources
    │   ├── variables.tf                          # Module inputs
    │   ├── outputs.tf                            # Gateway/access point
IDs exposed to root
    │   └── versions.tf                           # Module provider
constraints
    └── aws-vpc-confluent-pni-spoke/              # PNI Spoke module
(sandbox, shared)
        ├── main.tf
        ├── data.tf
        ├── variables.tf
        ├── outputs.tf
        └── versions.tf
```

Prerequisites

Requirement	Detail
Terraform	`>= 1.5.0`
Terraform Cloud	Organization `signalroom`, workspace pre-created
AWS account	SSO profile with sufficient IAM permissions (VPC, TGW, ENI, Client VPN)
Confluent Cloud account	API key/secret with environment-level admin
Existing AWS Transit Gateway	TGW ID + associated Route Table ID
Existing VPN VPC	VPC ID, route table IDs, Client VPN endpoint ID, target subnet IDs
Existing TFC Agent VPC	VPC ID + route table IDs

Configuration

All sensitive values are passed as environment variables (never stored in `.tfvars`). The `deploy.sh` script handles setting `TF_VAR_*` exports automatically after AWS SSO authentication.

Key Input Variables

Variable	Description
`tgw_id`	Existing Transit Gateway ID
`tgw_rt_id`	Transit Gateway Route Table ID
`vpn_vpc_id`	VPN VPC ID
`vpn_vpc_rt_ids`	Comma-separated VPN VPC route table IDs
`vpn_endpoint_id`	AWS Client VPN Endpoint ID
`vpn_target_subnet_ids`	Comma-separated VPN associated subnet IDs
`tfc_agent_vpc_id`	Terraform Cloud Agent VPC ID
`tfc_agent_vpc_rt_ids`	Comma-separated TFC Agent VPC route table IDs
`eni_number_per_subnet`	Number of ENIs per subnet (default: `17`)
`aws_region`	AWS region for all resources

CIDR Allocations

Network	CIDR
PNI Hub VPC	`10.3.0.0/20`
Sandbox Spoke VPC	`10.0.0.0/20`
Shared Spoke VPC	`10.1.0.0/20`

All VPCs use 3 subnets across 3 AZs with `/4` new bits of sub-netting.

Deployment

Create

```
./deploy.sh create \
  --profile=<SSO_PROFILE_NAME> \
  --confluent-api-key=<CONFLUENT_API_KEY> \
  --confluent-api-secret=<CONFLUENT_API_SECRET> \
  --tfe-token=<TFE_TOKEN> \
  --tgw-id=<TGW_ID> \
  --tgw-rt-id=<TGW_RT_ID> \
  --tfc-agent-vpc-id=<TFC_AGENT_VPC_ID> \
  --tfc-agent-vpc-rt-ids=<TFC_AGENT_VPC_RT_IDs> \
  --vpn-vpc-id=<VPN_VPC_ID> \
  --vpn-vpc-rt-ids=<VPN_VPC_RT_IDs> \
  --vpn-endpoint-id=<VPN_ENDPOINT_ID> \
  --vpn-target-subnet-ids=<VPN_TARGET_SUBNET_IDs> \
  --pni-hub-vpc-cidr=<PNI_HUB_VPC_CIDR>
```

The script will:

1. Authenticate to AWS SSO and export temporary credentials.
2. Export all `TF_VAR_*` environment variables.
3. Run `terraform init`, `terraform plan`, prompt for confirmation, then `terraform apply`.
4. Generate a Terraform graph visualization at `docs/images/terraform-visualization.png`.

Destroy

```
./deploy.sh destroy \
  --profile=<SSO_PROFILE_NAME> \
  # ... (same arguments as create)
```

Destroy runs `terraform destroy -auto-approve` and regenerates the visualization.

Outputs

Output	Description
`confluent_pni_hub_gateway_id`	ID of the `confluent_gateway` resource (PNI Hub)
`confluent_pni_hub_access_point_id`	ID of the `confluent_access_point` resource

Security Design

Security Group (PNI ENIs): Ingress-only on ports `443` (HTTPS/REST/Schema Registry) and `9092` (Kafka), sourced from the PNI Hub VPC CIDR, TFC Agent VPC CIDR, VPN VPC CIDR, and Client VPN CIDR. **No egress rules are defined**, which causes Terraform to revoke AWS's default `0.0.0.0/0` egress — intentionally mirroring PrivateLink's unidirectional behavior and preventing Confluent-initiated connections into the customer network.

Network ACL: Allows TCP ingress on `443`, `9092`, and ephemeral ports `1024–65535`. Allows all egress.

ENI Permissions: `aws_network_interface_permission` grants Confluent's AWS account `INSTANCE-ATTACH` permission on each customer-owned ENI. This is the core PNI handshake — Confluent attaches its broker VMs to your ENIs without your traffic ever leaving the AWS backbone.

How PNI Differs from PrivateLink

Aspect	PrivateLink	PNI
ENI ownership	Confluent's account	**Customer's account**
DNS	Requires PHZ + VPC associations	Confluent manages DNS
Connectivity model	VPC Interface Endpoint	ENIs registered via `confluent_access_point`
Egress control	Unidirectional by design	Explicit empty egress on SG required
Port 53 (DNS) rules	Required in SG	**Not needed**

Provider Versions

Provider	Version
`hashicorp/aws`	`6.33.0` (root) / `>= 6.2.0` (modules)
`confluentinc/confluent`	`2.62.0` (root) / `>= 2.40.0` (modules)
`hashicorp/time`	`~> 0.13.1`
`hashicorp/tfe`	`~> 0.73.0`

Related Resources

- Confluent Cloud Private Network Interface (PNI)
- Confluent Terraform Provider
- AWS Transit Gateway
- AWS Client VPN

References

- Confluent PNI Documentation
- Confluent PNI FAQ
- AWS Multi-VPC ENI Attachment
- confluent_gateway Terraform resource
- confluent_access_point Terraform resource