

IaC Confluent Cloud AWS Private Linking with Cluster Linking Example

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graph TB
    %% =====
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    %% =====
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    classDef vpcBox fill:#dcfce7,stroke:#16a34a,stroke-width:2px,color:#14532d
    classDef networking fill:#eff6ff,stroke:#2563eb,stroke-width:1.5px,color:#1e3a8a
    classDef dns fill:#ede9fe,stroke:#7c3aed,stroke-width:1.5px,color:#4c1d95
    classDef secrets fill:#fce7f3,stroke:#db2777,stroke-width:1.5px,color:#831843
    classDef tfCloud fill:#f3e8ff,stroke:#9333ea,stroke-width:2px,color:#581c87
    classDef dataFlow fill:#d1fae5,stroke:#059669,stroke-width:1.5px,color:#064e3b
    classDef module fill:#ffedd5,stroke:#ea580c,stroke-width:2px,color:#7c2d12,stroke-dasharray:5

    %% =====
    %% TERRAFORM CLOUD
    %% =====
    subgraph TFC["Terraform Cloud – signalroom org"]
        direction LR
        TFC_WORKSPACE["Workspace  
iac-cc-aws-privatelink-  
cluster-linking-example"]
        TFC_AGENT_POOL["Agent Pool  
signalroom-iac-tfc-agents-pool"]
        TFC_WORKSPACE --- TFC_AGENT_POOL
    end
    TFC_WORKSPACE:::tfCloud
    TFC_AGENT_POOL:::tfCloud

    %% =====
    %% CONFLUENT CLOUD
    %% =====
    subgraph CC["Confluent Cloud"]
        direction TB
```

```

    CC_ENV["Environment: non-prod
Stream Governance: Essentials"]:::confluentCloud

        subgraph CC_SR["Schema Registry"]
            SR_CLUSTER["Schema Registry Cluster
src_api service account
DeveloperRead + DeveloperWrite"]:::confluentCloud
            end

        CC_PLATT["PrivateLink Attachment
AWS region"]:::confluentCloud

        subgraph CC_SANDBOX["Sandbox Cluster - Enterprise / HIGH"]
            direction TB
            SANDBOX_CLUSTER["sandbox_cluster
Enterprise, High Availability"]:::confluentCloud
            SANDBOX_TOPIC["Topic: dev-stock_trades"]:::dataFlow
            SANDBOX_DATAGEN["DataGen Source Connector
STOCK_TRADES to AVRO"]:::dataFlow
            SANDBOX_SA["Service Accounts
app_manager, app_producer
app_consumer, app_connector"]:::confluentCloud
            SANDBOX_DATAGEN -->|produces| SANDBOX_TOPIC
            end

        subgraph CC_SHARED["Shared Cluster - Enterprise / HIGH"]
            direction TB
            SHARED_CLUSTER["shared_cluster
Enterprise, High Availability"]:::confluentCloud
            MIRROR_TOPIC["Mirror Topic
dev-stock_trades"]:::dataFlow
            SHARED_SA["Service Accounts
app_manager, app_consumer"]:::confluentCloud
            end

        subgraph CC_CL["Cluster Linking - Bidirectional"]
            CL_LINK["Bidirectional Cluster Link
sandbox to shared
sandbox_cluster_linking_app_manager
shared_cluster_linking_app_manager"]:::confluentCloud
            end

            CC_ENV --> CC_PLATT
            CC_ENV --> SANDBOX_CLUSTER
            CC_ENV --> SHARED_CLUSTER
            CC_ENV --> SR_CLUSTER
            SANDBOX_TOPIC -->|mirror via cluster link| MIRROR_TOPIC
            CL_LINK --- SANDBOX_CLUSTER
            CL_LINK --- SHARED_CLUSTER
            end

%% =====
%% AWS ACCOUNT
%% =====

```

```
subgraph AWS ["AWS Account"]
    direction TB

        TGW ["Transit Gateway  
Central hub for all VPC routing"]:::networking
        TGW_RT ["TGW Route Table  
Associations + Propagations"]:::networking
        TGW --- TGW_RT

        subgraph SANDBOX_VPC ["module: sandbox_vpc_prvateLink - VPC  
10.0.0.0/20"]
            direction TB
            SBX_SUBNETS ["3x Private Subnets  
across AZs"]:::networking
            SBX_RT ["Route Tables  
to TFC Agent VPC  
to VPN Client VPC  
to VPN VPC, DNS VPC"]:::networking
            SBX_SG ["Security Group  
Ingress: 443, 9092, 53"]:::networking
            SBX_VPCE ["VPC Endpoint  
Interface type, PrivateLink"]:::networking
            SBX_TGW_ATT ["TGW Attachment"]:::networking
            SBX_R53_ASSOC ["PHZ Association"]:::dns
            SBX_PLATTC ["PL Attachment Connection  
confluent_private_link_  
attachment_connection"]:::networking
            SBX_SUBNETS --> SBX_VPCE
            SBX_SG --> SBX_VPCE
        end

        subgraph SHARED_VPC ["module: shared_vpc_prvateLink - VPC  
10.1.0.0/20"]
            direction TB
            SHR_SUBNETS ["3x Private Subnets  
across AZs"]:::networking
            SHR_RT ["Route Tables  
to TFC Agent VPC  
to VPN Client VPC  
to VPN VPC, DNS VPC"]:::networking
            SHR_SG ["Security Group  
Ingress: 443, 9092, 53"]:::networking
            SHR_VPCE ["VPC Endpoint  
Interface type, PrivateLink"]:::networking
            SHR_TGW_ATT ["TGW Attachment"]:::networking
            SHR_R53_ASSOC ["PHZ Association"]:::dns
            SHR_PLATTC ["PL Attachment Connection  
confluent_private_link_  
attachment_connection"]:::networking
            SHR_SUBNETS --> SHR_VPCE
            SHR_SG --> SHR_VPCE
        end

        TFC_AGENT_VPC ["TFC Agent VPC"]
    
```

```

pre-existing"]:::vpcBox
    VPN_VPC["VPN VPC
pre-existing"]:::vpcBox
    DNS_VPC["DNS VPC
pre-existing"]:::vpcBox

        subgraph R53["Route53 – Centralized DNS"]
            direction TB
            R53_PHZ["Private Hosted Zone
region.aws.private.confluent.cloud"]:::dns
                R53_WILDCARD["Wildcard CNAME
*.dns_domain"]:::dns
                    R53_ZONAL["Zonal CNAMEs
*.az-id.dns_domain"]:::dns
                        R53_RESOLVER["System Resolver Rule
confluent_private domain"]:::dns
                            R53_PHZ --> R53_WILDCARD
                            R53_PHZ --> R53_ZONAL
                        end

            subgraph SM["AWS Secrets Manager"]
                direction LR
                SM_SR["Schema Registry
API credentials"]:::secrets
                    SM_SANDBOX["Sandbox Cluster
manager, consumer, producer"]:::secrets
                        SM_SHARED["Shared Cluster
manager, consumer"]:::secrets
                    end

                SBX_TGW_ATT ---|attach| TGW
                SHR_TGW_ATT ---|attach| TGW
                TFC_AGENT_VPC ---|attach| TGW
                VPN_VPC ---|attach| TGW
                DNS_VPC ---|attach| TGW

                R53_PHZ -.->|associate| TFC_AGENT_VPC
                R53_PHZ -.->|associate| DNS_VPC
                R53_PHZ -.->|associate| VPN_VPC
                R53_PHZ -.->|associate| SBX_R53_ASSOC
                R53_PHZ -.->|associate| SHR_R53_ASSOC

                R53_RESOLVER -.->|rule assoc| TFC_AGENT_VPC
                R53_RESOLVER -.->|rule assoc| DNS_VPC
                R53_RESOLVER -.->|rule assoc| VPN_VPC
                R53_RESOLVER -.->|rule assoc| SANDBOX_VPC
                R53_RESOLVER -.->|rule assoc| SHARED_VPC
            end

            %% =====
            %% CROSS-BOUNDARY CONNECTIONS
            %% =====
            SBX_VPCE ==>|AWS PrivateLink| CC_PLATT
            SHR_VPCE ==>|AWS PrivateLink| CC_PLATT

```

```
SBX_PLATTC -->| registers connection | CC_PLATT
SHR_PLATTC -->| registers connection | CC_PLATT

TFC_AGENT_POOL -->| runs on | TFC_AGENT_VPC

subgraph API_KEY_ROT ["API Key Rotation Module"]
    direction LR
    AKR["iac-confluent-api_key_rotation-tf_module"]
    Auto-rotates keys per day_count schedule"]:::module
    end

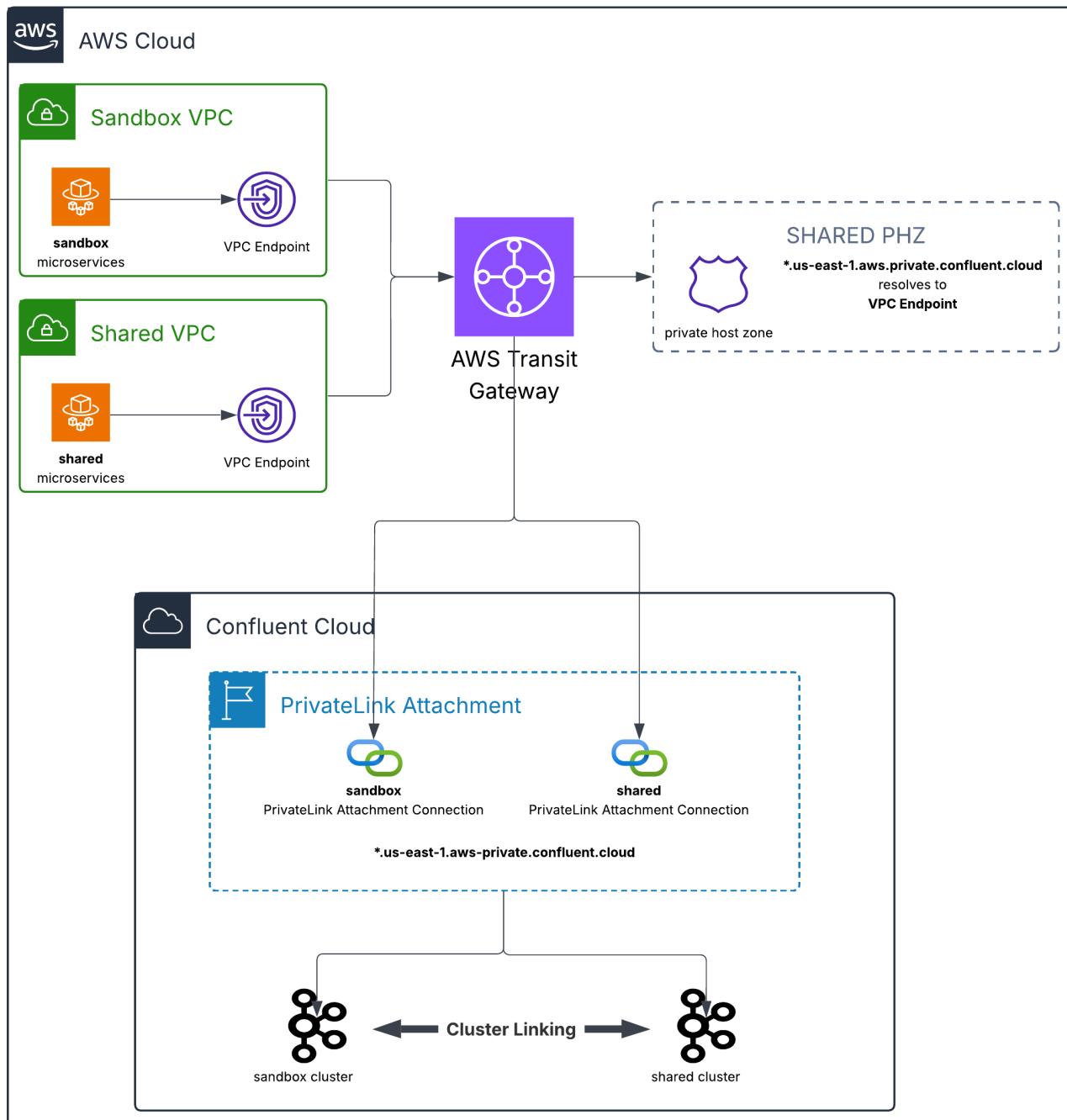
    AKR -->| manages keys for | SANDBOX_SA
    AKR -->| manages keys for | SHARED_SA
    AKR -->| manages keys for | SR_CLUSTER
    AKR -->| manages keys for | CL_LINK

    AKR -->| stores credentials | SM
```

This repository provides **production-grade Terraform infrastructure-as-code** that implements a **secure, multi-network Confluent Cloud architecture**. It demonstrates **AWS PrivateLink connectivity from a single Confluent Cloud environment to multiple AWS VPCs**, enabling private, network-isolated access without exposing traffic to the public internet.

The solution also showcases **in-region Cluster Linking between two Confluent Cloud Kafka clusters**, enabling **low-latency, fully managed data replication** across teams, lines of business, or isolated environments (for example, development, staging, and production) within the same AWS region.

Cluster Linking maintains an **in-sync mirror of selected topics** on the consuming cluster. This isolation allows consuming teams to independently scale **large numbers of consumers, stream processing applications, and downstream sinks** without impacting the producing cluster. From the producer's perspective, the load is equivalent to **a single additional consumer**, regardless of downstream scale.



Access control and ownership remain cleanly separated: the producing team grants **scoped read credentials** to approved topics, while the consuming team **creates, owns, monitors, and manages the cluster link**. This pattern enables secure, scalable data sharing with clear operational boundaries and minimal coupling.

Below is the Terraform resource visualization of the infrastructure that's created:

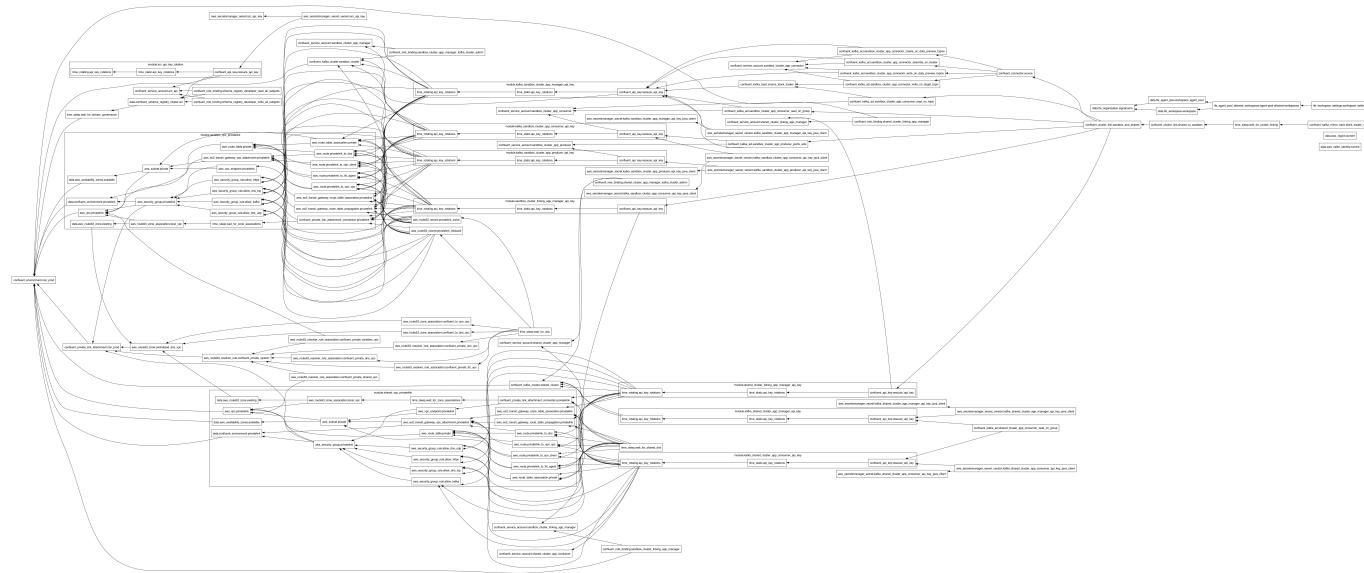


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1.0 Prerequisites

This project assumes you have the following prerequisites in place:

- Client VPN, Centralized DNS Server, and Transit Gateway
- Terraform Cloud Agent

1.1 Client VPN, Centralized DNS Server, and Transit Gateway

```
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graph TD
    subgraph USERS ["👤 Remote Users"]
        VPNClient["VPN Client  
(OpenVPN/AWS Client)"]
        end

        subgraph AWS ["☁ AWS Cloud"]
            subgraph VPN_VPC ["Client VPN VPC  
var.vpn_vpc_cidr"]
                VPNEndpoint["AWS Client VPN  
Endpoint"]
                VPNSubnets["VPN Subnets  
(Multi-AZ)"]
                VPNSG["Security Group  
client-vpn-sg"]
                VPNResolver["Route53 Outbound  
Resolver Endpoint"]
                VPNEndpoint --> VPNSubnets
                VPNSubnets --> VPNSG
                VPNSubnets --> VPNResolver
            end

            subgraph TGW ["Transit Gateway  
signalroom-tgw"]
                TGWCore["TGW Core  
ASN: 64512"]
                TGWRouteTable["Custom Route  
Tables"]
                TGWCore --> TGWRouteTable
            end
        end
    end
```

```
    subgraph DNS_VPC ["DNS VPC (Centralized)
var.dns_vpc_cidr"]
    R53Inbound ["Route53 Inbound
Resolver Endpoint"]
    R53PHZ ["Private Hosted Zones
*.aws.confluent.cloud"]
    R53Inbound --> R53PHZ
end

    subgraph TFC_VPC ["TFC Agent VPC
var.tfc_agent_vpc_cidr"]
    TFCAgent ["Terraform Cloud
Agent"]
end

    subgraph WORKLOAD_VPCs ["Workload VPCs"]
        subgraph WL1 ["Workload VPC 1"]
            VPCE1 ["VPC Endpoint
(PrivateLink)"]
        end
        subgraph WL2 ["Workload VPC N..."]
            VPCEN ["VPC Endpoint
(PrivateLink)"]
        end
    end

    ACM ["ACM Certificates
(Server & Client)"]
    CWLogs ["CloudWatch Logs
VPN & Flow Logs"]
end

    subgraph CONFLUENT ["Confluent Cloud"]
        PrivateLinkService ["PrivateLink Service
Endpoint"]
        Kafka ["Kafka Cluster
(Private)"]
        PrivateLinkService --> Kafka
    end

%% Connections
VPNClient -->|"Mutual TLS
Authentication" | VPNEndpoint
ACM -.->|"Certificate Auth" | VPNEndpoint

VPN_VPC -->|"TGW Attachment" | TGW
DNS_VPC -->|"TGW Attachment" | TGW
TFC_VPC -->|"TGW Attachment" | TGW
WL1 -->|"TGW Attachment" | TGW
WL2 -->|"TGW Attachment" | TGW

VPNResolver -->|"DNS Forwarding
Rule" | R53Inbound
R53PHZ -->|"Returns Private"
```

```
Endpoint IPs" | VPCE1
```

```
VPCE1 -->|"AWS PrivateLink"| PrivateLinkService
VPCEN -->|"AWS PrivateLink"| PrivateLinkService
```

```
VPNEndpoint -.->|"Logs"| CWLogs
TGW -.->|"Flow Logs"| CWLogs
```

```
%% Styling
```

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classDef vpcStyle fill:#e8f0fe,stroke:#1a73e8,stroke-width:2px
classDef tgwStyle fill:#fef7e0,stroke:#f9ab00,stroke-width:3px
classDef dnsStyle fill:#e6f4ea,stroke:#34a853,stroke-width:2px
classDef confluentStyle fill:#f3e8fd,stroke:#9334e6,stroke-width:2px
classDef serviceStyle fill:#fff,stroke:#5f6368,stroke-width:1px

class USERS userStyle
class VPN_VPC,TFC_VPC,WORKLOAD_VPCs,WL1,WL2 vpcStyle
class TGW tgwStyle
class DNS_VPC dnsStyle
class CONFLUENT confluentStyle
```

1.1.1 Key Features Required for Confluent PrivateLink to Work

1.1.1.1 Hub-and-Spoke Network Architecture via Transit Gateway

- Transit Gateway serves as the central routing hub connecting all VPCs
- Disabled default route table association/propagation for explicit routing control
- DNS support enabled on the TGW (`dns_support = "enable"`)
- Custom route tables for fine-grained traffic control between VPCs

1.1.1.2 Centralized DNS Resolution (Critical for PrivateLink)

- **Dedicated DNS VPC** with Route53 Inbound Resolver endpoints
- **Private Hosted Zones** for `*.aws.confluent.cloud` domain
- DNS forwarding rules route Confluent queries from all VPCs to the central DNS VPC
- Route53 Outbound Resolver in VPN VPC forwards to DNS VPC resolver IPs

1.1.1.3 DNS Forwarding Chain (as documented in your outputs)

1. Client queries `lkc-xxxxx.us-east-1.aws.private.confluent.cloud`
2. VPN VPC's default DNS forwards to Route53 Outbound Resolver
3. Outbound Resolver forwards to DNS VPC Inbound Resolver
4. DNS VPC checks Private Hosted Zones → returns VPC Endpoint private IPs

1.1.1.4 VPC Endpoints (AWS PrivateLink)

- VPC Endpoints in workload VPCs connecting to Confluent's PrivateLink service

- Security groups allowing traffic from authorized sources (VPN clients, TFC agents)

1.1.1.5 Client VPN Integration

- Mutual TLS authentication using ACM certificates (server + client)
- Split tunnel configuration for routing only Confluent traffic through VPN
- Authorization rules controlling which CIDRs VPN clients can access
- Routes added to VPN endpoint for all workload VPC CIDRs via Transit Gateway

1.1.1.6 Cross-VPC Routing

- TGW attachments for: VPN VPC, DNS VPC, TFC Agent VPC, and all Workload VPCs
- Route tables in each VPC with routes to other VPCs via TGW
- Workload VPC CIDRs aggregated and distributed to VPN client routes

1.1.1.7 Security & Observability

- Dedicated security groups per component (VPN endpoint, etc.)
- VPC Flow Logs and TGW Flow Logs to CloudWatch
- VPN connection logging for audit trails
- IAM roles with least-privilege for flow log delivery

1.2 Terraform Cloud Agent

```
%%{init: {'theme': 'base', 'themeVariables': { 'primaryColor': '#1a73e8', 'primaryTextColor': '#fff', 'primaryBorderColor': '#1557b0', 'lineColor': '#5f6368', 'secondaryColor': '#34a853', 'tertiaryColor': '#fbcc04'}}}%%

flowchart TB
    subgraph TERRAFORM_CLOUD["▲ Terraform Cloud (HCP)"]
        TFC["Terraform Cloud API & Workspaces"]
        AgentPool["Agent Pool (signalroom)"]
        end

        subgraph AWS ["▲ AWS Cloud"]
            subgraph TFC_AGENT_VPC["TFC Agent VPC var.vpc_cidr"]
                subgraph PUBLIC_SUBNETS ["Public Subnets (Multi-AZ)"]
                    IGW["Internet Gateway"]
                    NAT1["NAT Gateway AZ-1"]
                    NAT2["NAT Gateway AZ-2"]
                end

                subgraph PRIVATE_SUBNETS ["Private Subnets (Multi-AZ)"]
                    subgraph ECS ["ECS Fargate Cluster"]
                        ...
                    end
                end
            end
        end
    end
```

```
    TFCAgent1["TFC Agent
Container"]
    TFCAgent2["TFC Agent
Container"]
end

    subgraph AWS_ENDPOINTS ["AWS VPC Endpoints"]
        VPCE_SM["Secrets Manager
Endpoint"]
        VPCE_CW["CloudWatch Logs
Endpoint"]
        VPCE_ECR["ECR API/DKR
Endpoints"]
        VPCE_S3["S3 Gateway
Endpoint"]
    end

    CONFLUENT_SG["Confluent PrivateLink
Security Group"]
end

    DHCP ["DHCP Options
(Custom DNS)"]
    TFC_AGENT_SG["TFC Agent
Security Group"]
end

    subgraph TGW ["Transit Gateway
signalroom-tgw"]
        TGWCore ["TGW Core"]
        TGWRT ["Route Table"]
    end

    subgraph DNS_VPC ["DNS VPC (Centralized)
var.dns_vpc_cidr"]
        R53Inbound ["Route53 Inbound
Resolver"]
        PHZ ["Private Hosted Zones
*.aws.confluent.cloud"]
    end

    subgraph CLIENT_VPN_VPC ["Client VPN VPC
var.client_vpn_vpc_cidr"]
        VPNEndpoint ["Client VPN
Endpoint"]
    end

    subgraph WORKLOAD_VPCs ["Workload VPCs
(Confluent PrivateLink)"]
        subgraph WL1 ["Workload VPC 1"]
            VPCE1 ["PrivateLink
Endpoint"]
        end
        subgraph WL2 ["Workload VPC N"]

```

```

    VPCEN["PrivateLink
Endpoint"]
        end
    end

        SecretsManager["AWS Secrets Manager
(TFC Agent Token)"]
            CloudWatch["CloudWatch Logs"]
            ECR_Registry["ECR Registry
(hashicorp/tfc-agent)"]
        end

    subgraph CONFLUENT["Confluent Cloud"]
        PrivateLinkSvc["PrivateLink
Service"]
            Kafka["Kafka Cluster
(Private)"]
        end

    %% External Connections
    TFC <-->|"HTTPS/443
via NAT" | TFCAgent1
    TFC <-->|"HTTPS/443
via NAT" | TFCAgent2
    AgentPool -->|"Agent Registration" | TFCAgent1

    %% Internal VPC Connections
    TFCAgent1 --> TFC_AGENT_SG
    TFCAgent2 --> TFC_AGENT_SG
    TFCAgent1 --> VPCE_SM
    TFCAgent2 --> VPCE_CW

    VPCE_SM -->|"Private DNS" | SecretsManager
    VPCE_CW -->|"Private DNS" | CloudWatch
    VPCE_ECR -->|"Private DNS" | ECR_Registry

    NAT1 --> IGW
    NAT2 --> IGW
    TFCAgent1 -->|"0.0.0.0/0" | NAT1
    TFCAgent2 -->|"0.0.0.0/0" | NAT2

    %% DHCP & DNS Flow
    DHCP -->|"DNS Servers:
VPC + Centralized" | TFCAgent1
    TFCAgent1 -->|"DNS Query:
*.confluent.cloud" | R53Inbound

    %% Transit Gateway Connections
    TFC_AGENT_VPC -->|"TGW Attachment" | TGW
    DNS_VPC -->|"TGW Attachment" | TGW
    CLIENT_VPN_VPC -->|"TGW Attachment" | TGW
    WL1 -->|"TGW Attachment" | TGW
    WL2 -->|"TGW Attachment" | TGW

```

```

%% Route Propagation
TGWCore --> TGWRT

%% DNS Resolution
R53Inbound --> PHZ
PHZ -->|"Returns Private IPs" | VPCE1

%% PrivateLink Connections
VPCE1 -->|"AWS PrivateLink" | PrivateLinkSvc
VPCEN -->|"AWS PrivateLink" | PrivateLinkSvc
PrivateLinkSvc --> Kafka

%% TFC Agent to Workload VPCs
TFC_AGENT_SG -->|"HTTPS/443
Kafka/9092" | CONFLUENT_SG
CONFLUENT_SG -->|"via TGW" | VPCE1
CONFLUENT_SG -->|"via TGW" | VPCEN

%% Styling
classDef tfcStyle fill:#5c4ee5,stroke:#3d32a8,stroke-
width:2px,color:#fff
classDef vpcStyle fill:#e8f0fe,stroke:#1a73e8,stroke-width:2px
classDef tgwStyle fill:#fef7e0,stroke:#f9ab00,stroke-width:3px
classDef dnsStyle fill:#e6f4ea,stroke:#34a853,stroke-width:2px
classDef confluentStyle fill:#f3e8fd,stroke:#9334e6,stroke-width:2px
classDef endpointStyle fill:#fce8e6,stroke:#ea4335,stroke-width:1px
classDef ecsStyle fill:#fff3e0,stroke:#ff9800,stroke-width:2px

class TERRAFORM_CLOUD tfcStyle
class TFC_AGENT_VPC,CLIENT_VPN_VPC,WORKLOAD_VPCs,WL1,WL2 vpcStyle
class TGW tgwStyle
class DNS_VPC dnsStyle
class CONFLUENT confluentStyle
class AWS_ENDPOINTS,VPCE_SM,VPCE_CW,VPCE_ECR,VPCE_S3 endpointStyle
class ECS ecsStyle

```

1.2.1 Key Features Required for Confluent PrivateLink to Work (TFC Agent Configuration)

1.2.1.1 Custom DHCP Options for DNS Resolution

- DHCP Options Set configured with **dual DNS servers**: VPC default DNS (`cidrhost(vpc_cidr, 2)`) AND centralized DNS VPC resolver IPs
- Region-aware domain name configuration (`ec2.internal` for us-east-1, `{region}.compute.internal` for others)
- Associates TFC Agent VPC with custom DHCP options to route Confluent domain queries to the central DNS infrastructure

1.2.1.2 Transit Gateway Connectivity

- TFC Agent VPC attached to shared Transit Gateway with DNS support enabled
- Explicit route table association and route propagation (not using TGW defaults)

- Routes added from private subnets to: DNS VPC, Client VPN VPC, and all Workload VPCs containing PrivateLink endpoints
- Flattened route map pattern (`for_each`) ensures routes are created for every workload VPC CIDR

1.2.1.3 Security Group Configuration for Kafka/PrivateLink Traffic

- **TFC Agent Security Group** with egress rules for:
 - HTTPS (443) and Kafka (9092) to each workload VPC CIDR
 - DNS (UDP/TCP 53) to DNS VPC CIDR specifically
 - General HTTPS/HTTP for Terraform Cloud API and package downloads
- **Confluent PrivateLink Security Group** allowing inbound from TFC Agent SG on ports 443 and 9092

1.2.1.4 AWS VPC Endpoints for Private Service Access

- **Interface endpoints** with private DNS enabled for: Secrets Manager, CloudWatch Logs, ECR API, ECR DKR
- **S3 Gateway endpoint** (required for ECR image layer pulls)
- Dedicated security group for VPC endpoints allowing HTTPS from within VPC
- Eliminates NAT Gateway dependency for AWS service calls

1.2.1.5 ECS Fargate Deployment Pattern

- TFC Agents run in private subnets with `assign_public_ip = false`
- NAT Gateways per AZ for outbound internet (Terraform Cloud API communication)
- Agent token stored in Secrets Manager, fetched via VPC Endpoint
- Container health checks and deployment circuit breaker for reliability

1.2.1.6 IAM Permissions for Infrastructure Management

- Task role with Transit Gateway, VPC, Route53 Resolver, and Client VPN management permissions
- Execution role with Secrets Manager access for agent token retrieval
- KMS permissions scoped to Secrets Manager service for encryption/decryption

1.2.1.7 Network Architecture Summary

- **Hub-and-spoke model:** TGW connects TFC Agent VPC → DNS VPC → Workload VPCs
- **DNS resolution chain:** TFC Agent → Custom DHCP → Centralized DNS VPC → Private Hosted Zones → PrivateLink Endpoint IPs
- **Traffic flow:** TFC Agent → TGW → Workload VPC → PrivateLink Endpoint → Confluent Cloud Kafka

2.0 Project's Architecture Overview

2.1 Key Features Required for Confluent PrivateLink to Work (Confluent Cloud Configuration)

2.1.1 Confluent Private Link Attachment (Environment-Level)

- Single `confluent_private_link_attachment` resource created at the environment level for AWS region
- Provides the `vpc_endpoint_service_name` that AWS VPC Endpoints connect to
- Provides the `dns_domain` (e.g., `*.aws.private.confluent.cloud`) for DNS configuration
- Multiple VPCs can share the same PrivateLink attachment via separate VPC Endpoints

2.1.2 AWS VPC Endpoint Configuration

- Interface VPC Endpoints (`vpc_endpoint_type = "Interface"`) in each workload VPC
- **Critical:** `private_dns_enabled = false` — DNS handled via centralized Private Hosted Zones instead
- Security groups allowing inbound on ports 443 (HTTPS), 9092 (Kafka), and 53 (DNS) from TFC Agent VPC, VPN VPC, VPN Client CIDR, and local VPC CIDR
- Endpoints deployed across multiple AZs (3 subnets) for high availability

2.1.3 Confluent Private Link Attachment Connection

- `confluent_private_link_attachment_connection` links the AWS VPC Endpoint ID to the Confluent PrivateLink attachment
- Creates the bidirectional connection between AWS and Confluent Cloud
- Depends on Route53 zone associations being complete first (`time_sleep` for propagation)

2.1.4 Centralized Private Hosted Zone (PHZ) Strategy

- Single PHZ created for the Confluent DNS domain, associated with **all VPCs** that need access
- **Zonal CNAME records:** `*.{availability-zone-id}.{dns_domain}` → AZ-specific VPC Endpoint DNS
- **Wildcard CNAME record:** `*.{dns_domain}` → Primary VPC Endpoint DNS

2.1.5 Route53 SYSTEM Resolver Rule

- `rule_type = "SYSTEM"` tells Route53 to use Private Hosted Zones for the Confluent domain
- Rule associated with every VPC that needs Confluent access

2.1.6 Transit Gateway Routing

- Each PrivateLink VPC attached to TGW with DNS support enabled
- Route table association AND route propagation configured
- Routes added from PrivateLink VPCs back to all consumer VPCs

2.1.7 Multi-Cluster Architecture with Cluster Linking

- Two Enterprise Kafka clusters (Sandbox and Shared) in the same environment
- Bidirectional Cluster Link with mirror topics for data replication

2.1.8 Service Account & API Key Management

- Separate service accounts per role with API key rotation

- ACLs granting specific permissions per service account
- API keys stored in AWS Secrets Manager

2.1.9 DNS Propagation Timing

- `time_sleep` resources ensuring DNS propagates before dependent resources (1-2 minutes)

2.1.10 Schema Registry Integration

- Stream Governance (Essentials) enabled at environment level with AVRO support

3.0 Let's Get Started

3.1 Deploy the Infrastructure

The `deploy.sh` script handles authentication and Terraform execution:

```
./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-cidr=<TFC_AGENT_VPC_CIDR> \
--dns-vpc-id=<DNS_VPC_ID> \
--vpn-vpc-id=<VPN_VPC_ID> \
--vpn-vpc-cidr=<VPN_VPC_CIDR> \
--vpn-client-vpc-cidr=<VPN_CLIENT_VPC_CIDR> \
[--dns-vpc-cidr=<DNS_VPC_CIDR>]          # Default: 10.255.0.0/24
[--day-count=<DAY_COUNT>]                  # Default: 30 (API key rotation
interval)
```

Handling DNS Resolution Errors: If you encounter DNS resolution errors during the apply process, simply re-run the `deploy.sh` script with the `create` command.

Cluster Linking Error:

```
| Error: error creating Cluster Link: 400 Bad Request: A cluster link
| already exists with the provided link name: Cluster Link
| _fA8DRTZSvGrLkTur7e8-Q already exists.
|
|   with confluent_cluster_link.shared_to_sandbox,
|   on setup-confluent-cluster_linking.tf line 113, in resource
| "confluent_cluster_link" "shared_to_sandbox":
|   113: resource "confluent_cluster_link" "shared_to_sandbox" {
```

If you see the above error, it indicates that the previous failed attempt left the cluster link in place. To resolve, delete the existing cluster link via the Confluent CLI:

```
confluent kafka link delete bidirectional_between_sandbox_and_shared --cluster <SANDBOX_CLUSTER_ID> --environment <NON_PROD_ENV_ID> --force
```

Then re-run the `deploy.sh` script with the `create` command.

3.2 Teardown the Infrastructure

```
./deploy.sh destroy \
--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-cidr=<TFC_AGENT_VPC_CIDR> \
--dns-vpc-id=<DNS_VPC_ID> \
--vpn-vpc-id=<VPN_VPC_ID> \
--vpn-vpc-cidr=<VPN_VPC_CIDR> \
--vpn-client-vpc-cidr=<VPN_CLIENT_VPC_CIDR>
```

Handling Cluster Link Deletion Error(s):

If you encounter a Cluster Link deletion error during the destroy process, you may see an error message similar to the following:

```
| Error: error deleting Cluster Link "lkc-m1ox27/bidirectional_between_sandbox_and_shared": 401 Unauthorized: Not authorized: the authenticated user didn't have the right access to the resource: Cluster authorization failed.
```

Navigate to the Terraform directory:

```
cd terraform
```

Remove the unreachable resources from the Terraform state:

```
terraform state rm 'confluent_cluster_link.sandbox_and_shared'  
terraform state rm 'confluent_cluster_link.shared_to_sandbox'
```

Navigate back to the root directory:

```
cd ..
```

Rerun the `deploy.sh` script with the `destroy` command.

Handling DNS Resolution Errors:

If you encounter DNS resolution errors during the destroy process, you may see error messages similar to the following:

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#dev-  
stock_trades#LITERAL#User:sa-81j9gv0##DESCRIBE#ALLOW": Delete  
"https://lkc-y08xyo.us-east-  
1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?  
host=%2A&operation=DESCRIBE&pattern_type=LITERAL&permission=ALLOW&principal  
=User%3Asa-81j9gv0&resource_name=dev-stock_trades&resource_type=TOPIC":  
dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such  
host  
|  
  
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#dev-  
stock_trades#LITERAL#User:sa-zmrv663##READ#ALLOW": Delete "https://lkc-  
y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-  
y08xyo/acls?  
host=%2A&operation=READ&pattern_type=LITERAL&permission=ALLOW&principal=Us  
er%3Asa-zmrv663&resource_name=dev-stock_trades&resource_type=TOPIC": dial  
tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host  
|  
  
| Error: error deleting Kafka ACLs "lkc-  
y08xyo/GROUP#sandbox_aws_privatelink_example_#LITERAL#User:sa-  
zmrv663##READ#ALLOW": Delete "https://lkc-y08xyo.us-east-  
1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?  
host=%2A&operation=READ&pattern_type=LITERAL&permission=ALLOW&principal=Us  
er%3Asa-  
zmrv663&resource_name=sandbox_aws_privatelink_example_&resource_type=GROUP  
": dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no  
such host
```

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#sandbox_aws_privatetlink_example_#LITERAL#User:sa-w7xq219##*#WRITE#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?host=%2A&operation=WRITE&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-w7xq219&resource_name=sandbox_aws_privatetlink_example_&resource_type=TOPIC": dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host
```

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/CLUSTER#kafka-cluster#LITERAL#User:sa-w7xq219##*#DESCRIBE#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?host=%2A&operation=DESCRIBE&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-w7xq219&resource_name=kafka-cluster&resource_type=CLUSTER": dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host
```

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#dev-stock_trades#LITERAL#User:sa-w7xq219##*#WRITE#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?host=%2A&operation=WRITE&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-w7xq219&resource_name=dev-stock_trades&resource_type=TOPIC": dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host
```

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#sandbox_aws_privatetlink_example_#LITERAL#User:sa-w7xq219##*#CREATE#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?host=%2A&operation=CREATE&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-w7xq219&resource_name=sandbox_aws_privatetlink_example_&resource_type=TOPIC": dial tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host
```

```
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#dev-
```

```
stock_trades#LITERAL#User:sa-81j9gv0##READ#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?  
host=%2A&operation=READ&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-81j9gv0&resource_name=dev-stock_trades&resource_type=TOPIC": dial  
tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host  
  
| Error: error deleting Kafka ACLs "lkc-y08xyo/TOPIC#dev-  
stock_trades#LITERAL#User:sa-81j9gv0##WRITE#ALLOW": Delete "https://lkc-y08xyo.us-east-1.aws.private.confluent.cloud:443/kafka/v3/clusters/lkc-y08xyo/acls?  
host=%2A&operation=WRITE&pattern_type=LITERAL&permission=ALLOW&principal=User%3Asa-81j9gv0&resource_name=dev-stock_trades&resource_type=TOPIC": dial  
tcp: lookup lkc-y08xyo.us-east-1.aws.private.confluent.cloud: no such host  
  
Operation failed: failed running terraform apply (exit 1)
```

Navigate to the Terraform directory:

```
cd terraform
```

Remove the unreachable resources from the Terraform state:

```
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_connector_describe_on_cluster'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_connector_write_on_target_topic'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_connector_create_on_data_preview_topics'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_connector_write_on_data_preview_topics'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_producer_prefix_acls["DESCRIBE"]'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_producer_prefix_acls["READ"]'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_producer_prefix_acls["WRITE"]'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_consumer_read_on_topic'  
terraform state rm  
'confluent_kafka_acl.sandbox_cluster_app_consumer_read_on_group'  
terraform state rm 'confluent_kafka_topic.source_stock_trades'
```

Navigate back to the root directory:

```
cd ..
```

Rerun the `deploy.sh` script with the `destroy` command.

4.0 Resources

4.1 Terminology

- **PHZ:** Private Hosted Zone - AWS Route 53 Private Hosted Zone is a DNS service that allows you to create and manage private DNS zones within your VPCs.
- **TFC:** Terraform Cloud - A service that provides infrastructure automation using Terraform.
- **VPC:** Virtual Private Cloud - A virtual network dedicated to your AWS account.
- **AWS:** Amazon Web Services - A comprehensive cloud computing platform provided by Amazon.
- **CC:** Confluent Cloud - A fully managed event streaming platform based on Apache Kafka.
- **PL:** PrivateLink - An AWS service that enables private connectivity between VPCs and services.
- **IaC:** Infrastructure as Code - The practice of managing and provisioning computing infrastructure through machine-readable definition files.

4.2 Related Documentation

- [AWS PrivateLink Overview in Confluent Cloud](#)
- [Use AWS PrivateLink for Serverless Products on Confluent Cloud](#)
- [GitHub Sample Project for Confluent Terraform Provider PrivateLink Attachment](#)
- [Geo-replication with Cluster Linking on Confluent Cloud](#)
- [Use the Confluent Cloud Console with Private Networking](#)
- [IP Filtering on Confluent Cloud](#)
- [AWS/Azure PrivateLink Networking Course](#)
- [Hands On: Configuring a PrivateLink Cluster](#)