Solutions Architect Professional

AWS Essentials, Accounts, Networking

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IAM

The policy language

- Provides authorization
- Two parts:
  - **Specification**: *Defining* access policies
  - **Enforcement**: *Evaluating* policies

```
{
  "Statement": [
    {
      "Effect": "Allow",
      "Action": ["s3:Get*", "s3:List*"],
      "Resource": "*"
    }
  ]
}
```


aws

Policy specification basics

- JSON-formatted documents
- Contain a statement (permissions) that specifies:
  - Which actions a principal can perform
  - Which resources can be accessed

```
{
 "Statement":[{
  "Effect":"effect",
  "Principal":"principal",
  "Action":"action",
  "Resource":"arn",
  "Condition":{
   "condition":{
    "key":"value" }
   }
  }
  ]
 }
```

Principal
Action
Resource
Condition

You can have multiple statements and each statement is comprised of PARC

aws

Principal: Examples

- An entity that is allowed or denied access to a resource
- Indicated by an Amazon Resource Name (ARN)
- With IAM policies, the principal element is implicit (i.e., the user, group, or role attached)

Principal
Action
Resource
Condition

```
<!-- Everyone (anonymous users) -->
"Principal":"AWS":"*.*"

<!-- Specific account or accounts -->
"Principal":{"AWS":"arn:aws:iam::123456789012:root" }
"Principal":{"AWS":"123456789012"}

<!-- Individual IAM user -->
"Principal":"AWS":"arn:aws:iam::123456789012:user/username"

<!-- Federated user (using web identity federation) -->
"Principal":{"Federated":"accounts.google.com"}

<!-- Specific role -->
"Principal":{"AWS":"arn:aws:iam::123456789012:role/rolename"}

<!-- Specific service -->
"Principal":{"Service":"ec2.amazonaws.com"}
```

Action: Examples

Principal
Action
Resource
Condition

- Describes the type of access that should be allowed or denied
- You can find actions in the docs or use the policy editor to get a drop-down list
- Statements must include either an `Action` or `NotAction` element

```
<!-- EC2 action -->
"Action":"ec2:StartInstances"

<!-- IAM action -->
"Action":"iam:ChangePassword"

<!- Amazon S3 action -->
"Action":"s3:GetObject"

<!-- Specify multiple values for the Action element-->
"Action":["sqs:SendMessage","sqs:ReceiveMessage"]

<-- Wildcards (* or ?) in the action name. Below covers create/delete/list/update-->
"Action":"iam:*AccessKey*"
```


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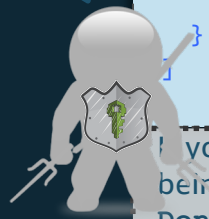
Understanding NotAction

- Lets you specify an exception to a list of actions
- Could result in shorter policies than using `Action` and excludes many actions
- Example: Let's say you want to allow everything but IAM APIs

```
{
  "Version": "2012-10-17",
  "Statement": [ {
      "Effect": "Allow",
      "NotAction": "iam:*",
      "Resource": "*"
    }
  ]
}
```

This is not a **Deny**. A user could still have a separate policy that grants **IAM:***

Is there a difference?



```
{
  "Version": "2012-10-17",
  "Statement": [{
      "Effect": "Allow",
      "Action": "*",
      "Resource": "*"
    },
    {
      "Effect": "Deny",
      "Action": "iam:*",
      "Resource": "*"
    }
  ]
}
```

If you want to prevent the user from ever being able to call IAM APIs, use an explicit **Deny**.

Resource: Examples

- The object or objects being requested
- Statements must include either a `Resource` or a `NotResource` element

```
<-- S3 bucket -->
"Resource":"arn:aws:s3:::my_corporate_bucket/*"

<-- All S3 buckets, except this one -->
"NotResource":"arn:aws:s3:::security_logging_bucket/*"

<-- Amazon SQS queue-->
"Resource":"arn:aws:sqs:us-west-2:123456789012:queue1"

<-- Multiple Amazon DynamoDB tables -->
"Resource":["arn:aws:dynamodb:us-west-2:123456789012:table/books_table",
            "arn:aws:dynamodb:us-west-2:123456789012:table/magazines_table"]

<-- All EC2 instances for an account in a region -->
"Resource": "arn:aws:ec2:us-east-1:123456789012:instance/*"
```

Replace with your account number

Principal
Action
Resource
Condition

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Condition example

Principal
Action
Resource
Condition

What if you wanted to restrict access to a time frame and IP address range?

```
“Condition” : {
   "DateGreaterThan" : {"aws:CurrentTime" : "2017-01-01T11:00:00Z"},
   "DateLessThan": {"aws:CurrentTime" : "2017-12-31T15:00:00Z"},
   "IpAddress" : {"aws:SourceIp" : ["192.0.2.0/24", "203.0.113.0/24"]}
}
```

AND

OR

- Allows a user to access a resource under the following conditions:
  - The time is after 11 a.m. on 01/01/2017 AND
  - The time is before 3 p.m. on 12/31/2017 AND
  - The request comes from an IP address in the 192.0.2.0 /24 OR 203.0.113.0 /24 range
- All of these conditions must be met for the statement to evaluate to TRUE.

Policy variables

`${aws:userid}`

- Predefined variables based on service request context
  - Global keys (`aws:SourceIP`, `aws:MultiFactorAuthPresent`, etc.)
  - Principal-specific keys (`aws:username`, `aws:userid`, `aws:PrincipalType`)
  - Provider-specific keys (`graph.facebook.com:id`, `www.amazon.com:user_id`)
  - SAML keys (`saml:cn`, `saml:edupersonassurance`)
  - See documentation for service-specific variables
- Benefits
  - Simplify policy management
  - Reduce the need for hard-coded, user-specific policies

The anatomy of a policy with variables

```
{
  "Version": "2012-10-17",
  "Statement": [{
     "Effect": "Allow",
     "Action": ["s3:ListBucket"],
     "Resource": ["arn:aws:s3:::myBucket"],
     "Condition":
       {"StringLike":
          {"s3:prefix":["home/${aws:username}/*"]}
        }
    },
    {
      "Effect":"Allow",
      "Action":["s3:*"],
      "Resource": ["arn:aws:s3:::myBucket/home/${aws:username}",
                   "arn:aws:s3:::myBucket/home/${aws:username}/*"]
    }
  ]
}
```

Version is required

Variable in conditions

Variable in resource ARNs

Grants a user access to a home directory in Amazon S3 that can be accessed programmatically

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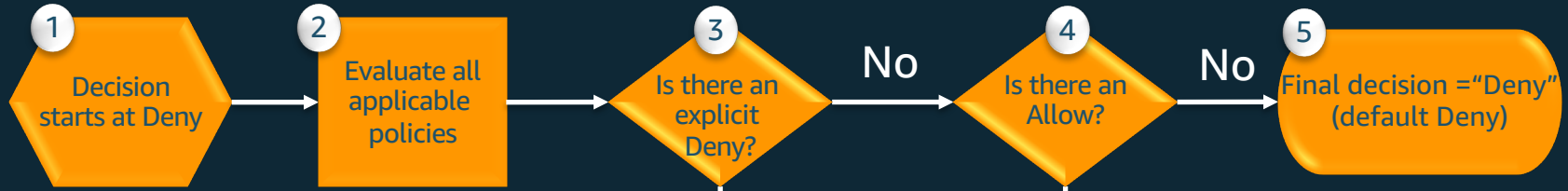
Policy enforcement



- AWS retrieves all policies associated with the user in resource
- Only policies that match the action and conditions are evaluated

- If a policy statement has a Deny, it trumps all other policy statements

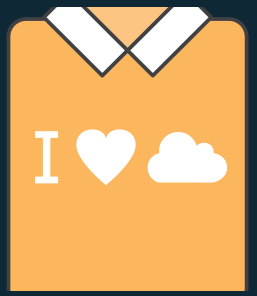
- Access is granted if there is an explicit Allow and no Deny

- By default, an implicit (default) Deny is returned

Federation

Identity federation benefits

Users



Before: Unique credentials

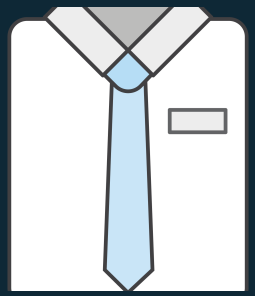
After: **Single sign-on (SSO)**

Security

Long-term access keys

Temporary security credentials

Compliance



One-off

Aligned with internal controls

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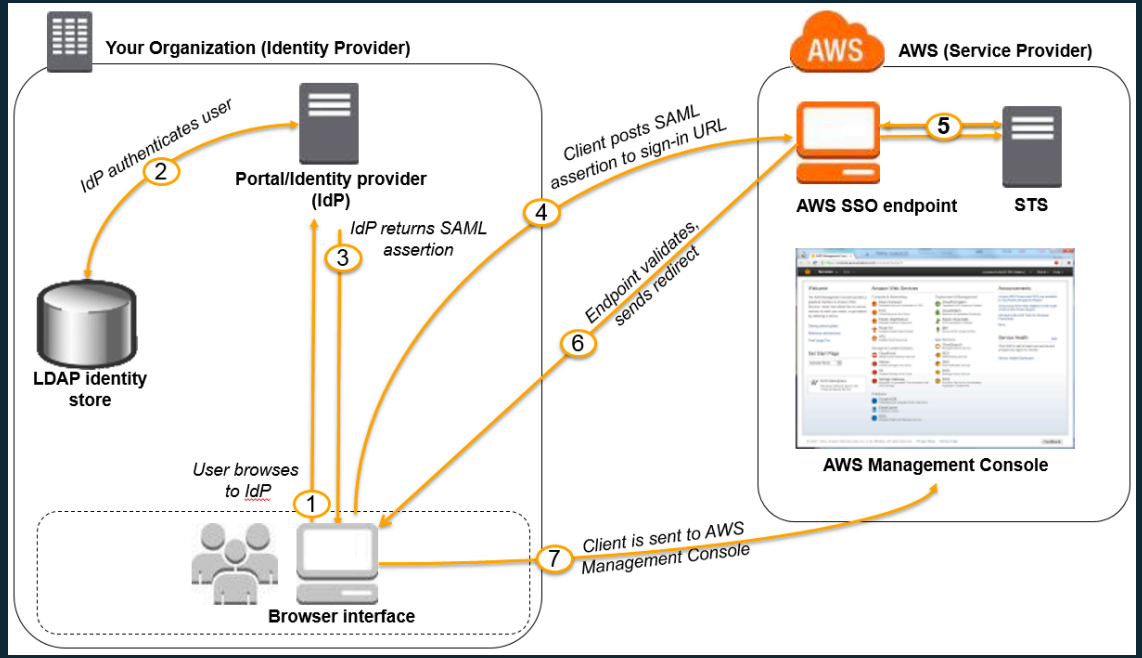
SAML 2.0 Federation

Example SAML 2.0 Providers

AD FS okta SECUREAUTH Auth0 Azure Active Directory SailPoint



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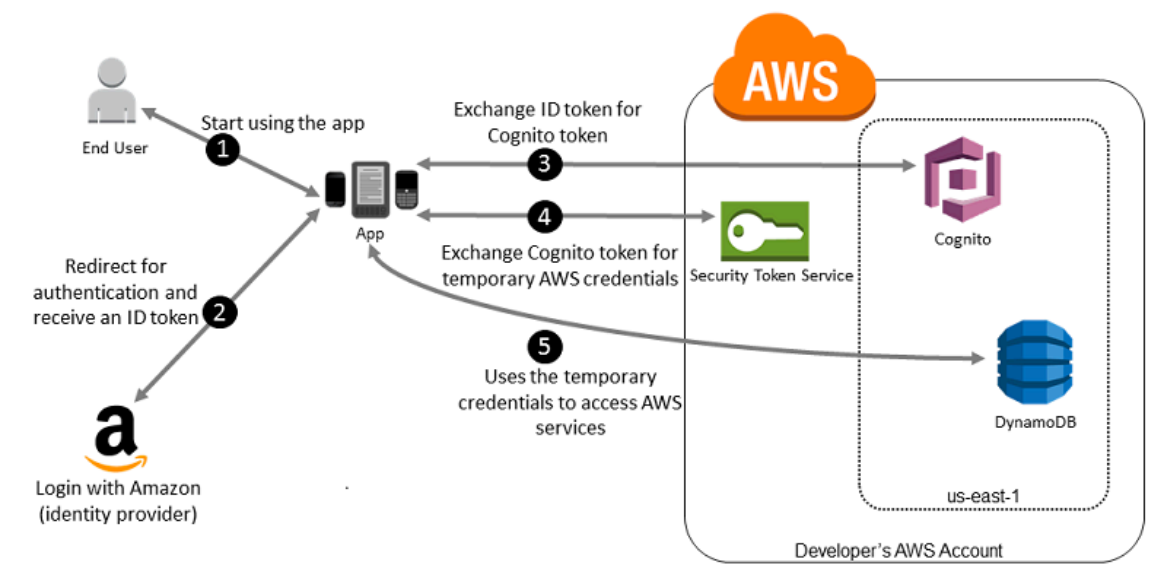
Web Identity Federation (OpenID Connect)



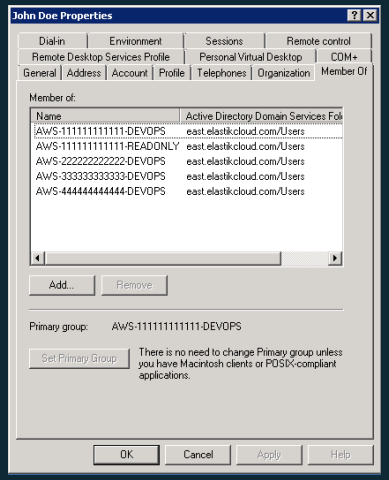
Example OIDC Providers

Federation patterns

Model 1: Direct federation (fine-grained)

Description: One LDAP group per AWS account + role combination; naming convention for maintainable IdP rules

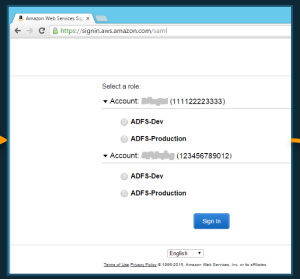
Enterprise (identity provider)



Post the SAML assertion to sign-in; includes all roles in all accounts that user is authorized to assume

AWS (service provider)

AWS sign-in

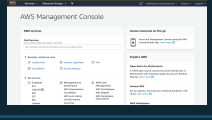


User selects the target account and role

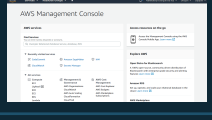
User redirected to target account + role

AWS STS returns temporary credentials using AssumeRoleWithSAML

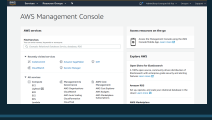
Account 1111111111



Account 2222222222



Account 3333333333

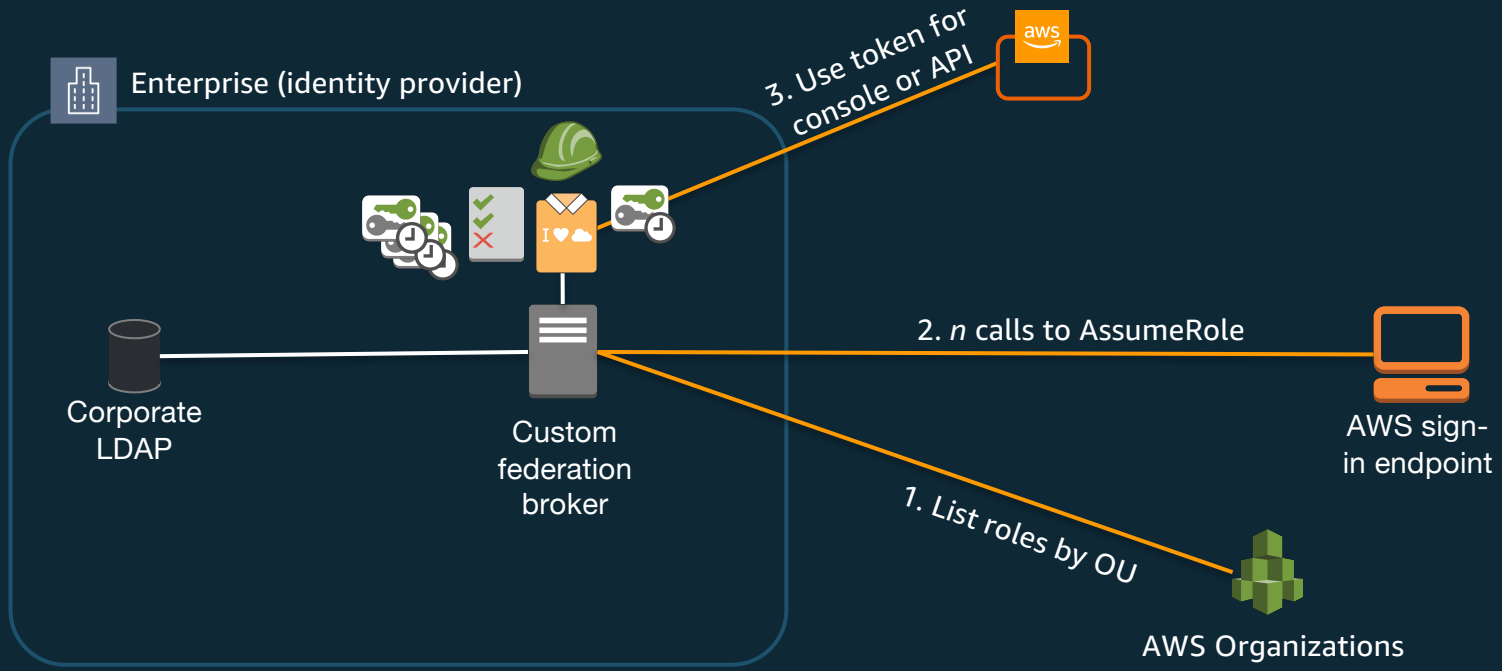


NOTE: Trusted automation system creates and updates roles in all accounts, e.g., account vending machine

IdP maps group **AWS-111111111111-RoleName** to **arn:aws:iam::111111111111:role/RoleName**

Model 2: Direct federation (coarse-grained)

Description: One LDAP group per AWS Organizations OU + role combination; custom or third-party API-aware broker

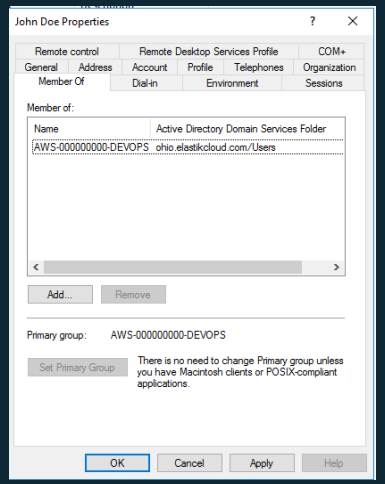


Custom broker maps LDAP group membership to *n* roles based on rules

Model 3: Hub-and-spoke

Description: Federate into AWS jump account, then make AuthZ decision and assume second role in target account

Enterprise (identity provider)



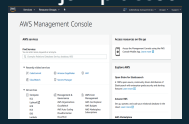
Authenticate to directory; IdP returns authorized roles in AWS IAM jump account

User selects role; AssumeRoleWithSAML returns token in jump account

AWS (service provider)

AWS sign-in

Account 000000000
IAM jump account

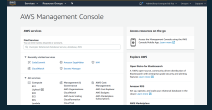


User calls AssumeRole to get token from target account using cross-account roles

STS

User redirected to target account

Account 1111111111



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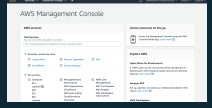

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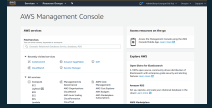

NOTE: Trusted automation system creates and updates roles in all accounts, e.g., account vending machine

Custom logic or policy in your control plane determines which roles can be assumed

Model 4: No federation; native IAM + automation

Description: Manage entitlements with IAM users, groups, and roles; consider SSO and token vending solution

- A unique IAM user object for every authorized AWS user
  - Consider commercial SSO/password synchronization solutions
- Vault credentials for non-humans, JIT access from code
  - Use Amazon EC2 instance profile/execution roles when available (AWS Lambda)
- Password expiration and complexity policies enforced
- Users mapped to IAM groups by job function
- Groups granted minimal AWS control plane and resource access
- Token vending solution layered on for higher-privileged operations

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Summary

	Direct federation (fine-grained)	Direct federation (coarse-grained)	Hub-and-spoke	Native IAM
Audit complexity	Low	Medium	**High**	**High**
Joiners, leavers, and movers complexity	Low	Low	Medium	**High**
Scalability	Highly scalable	Highly scalable	**Hard to scale**	**Hard to scale**
Developer impact	Low	Low	**High**	**Medium**
Impact on directory ops	**High**	Medium	Low	Very low
Impact on IdP ops	Low	**Medium**	Low	N/A
Permissions granularity	Fine	**Coarse**	**Coarse**	Fine
Custom code required	Low	**High**	**Medium**	**Medium**

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AWS Organizations

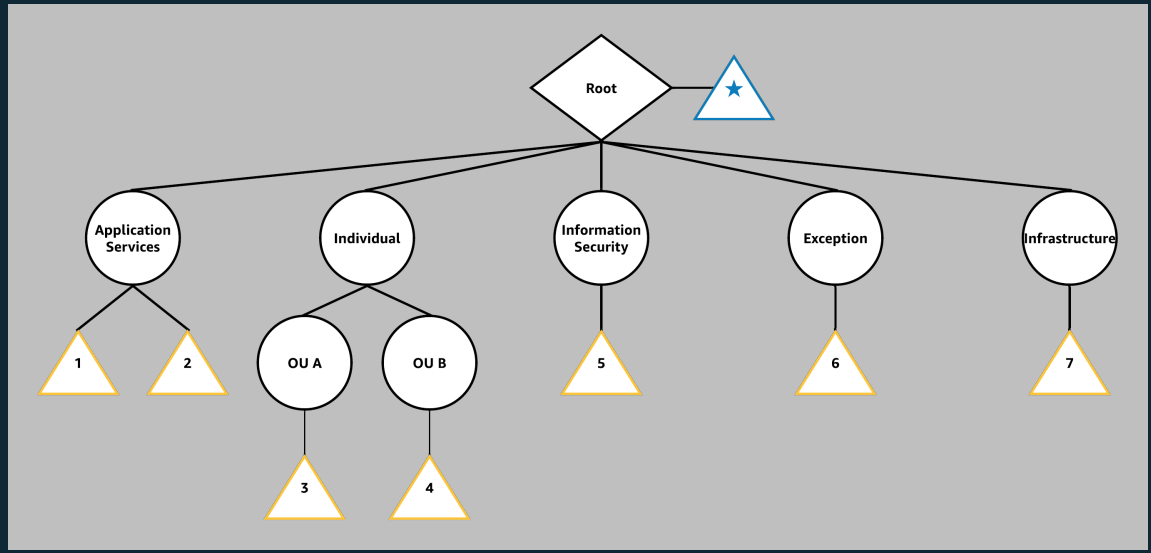
Service Control Policies (SCPs)

Define the maximum available permissions for IAM entities in an account

SCPs do not grant permission

Attach SCPs to the organization root, OUs, and individual accounts

SCPs attached to the root and OUs apply to all OUs and accounts inside of them



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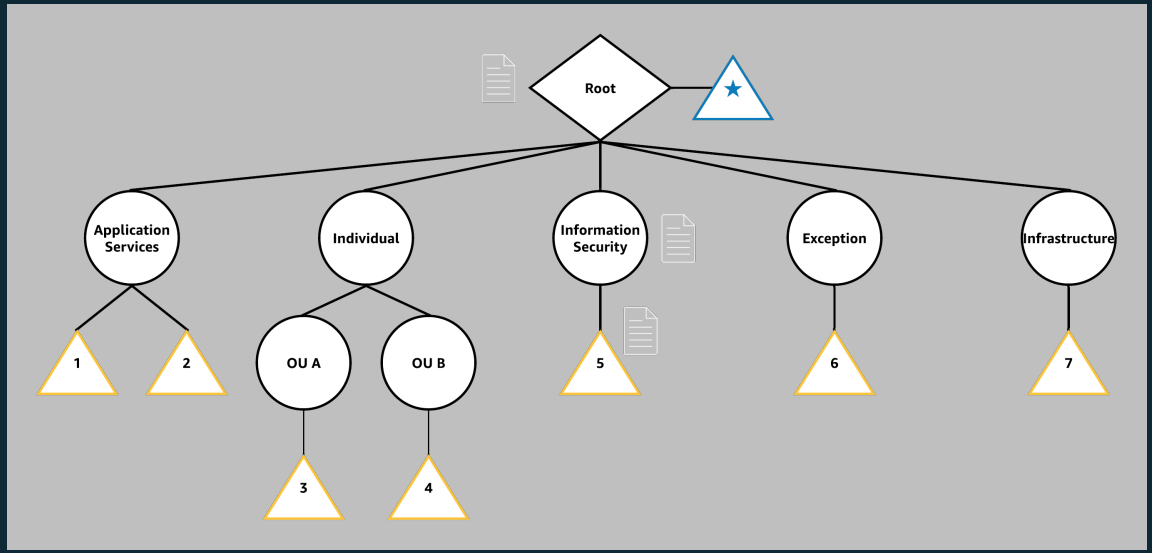

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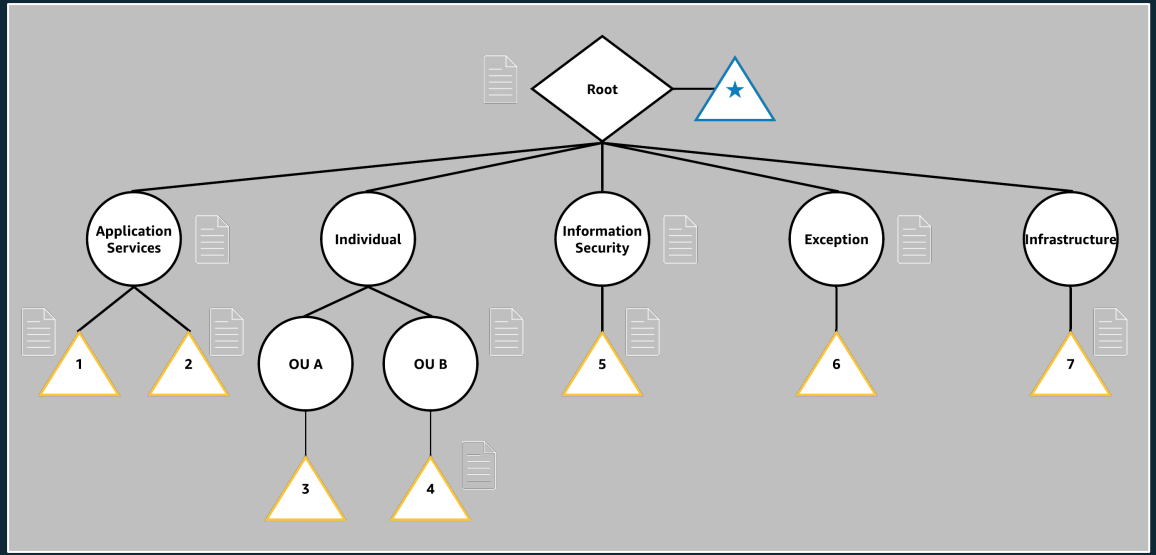

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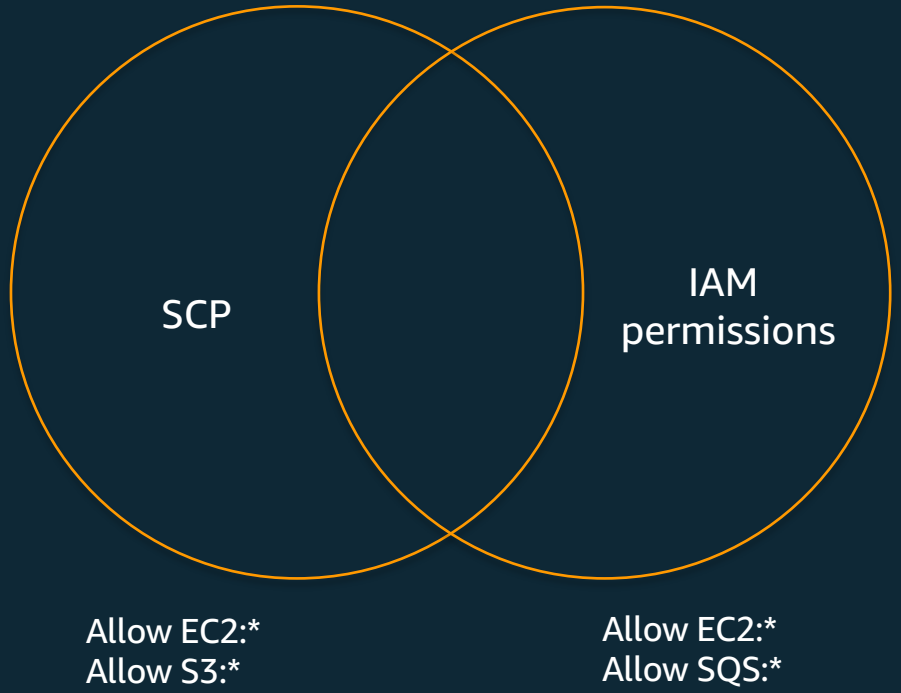

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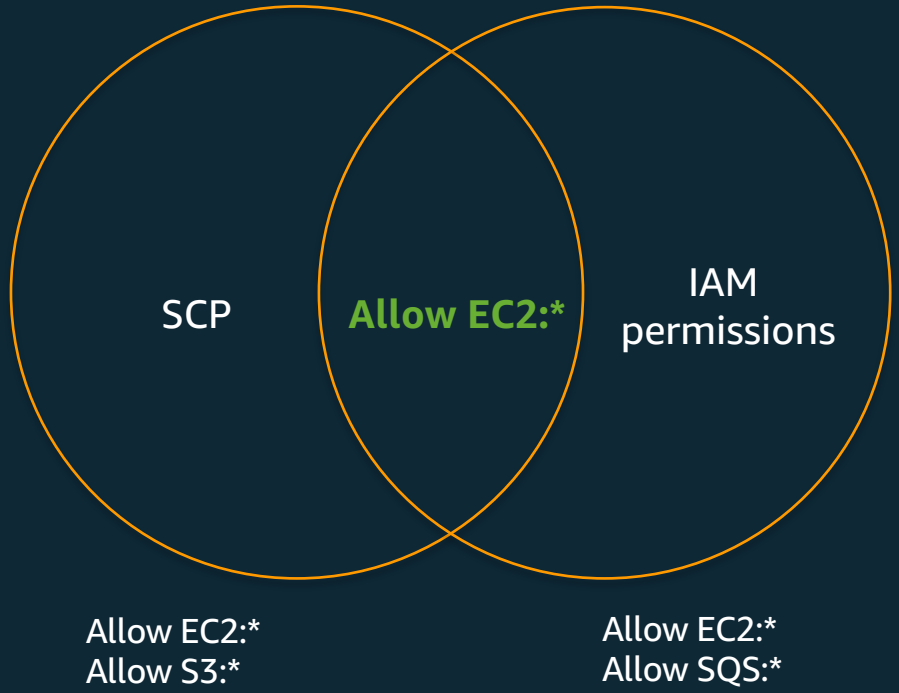

Authoring SCPs

Whitelist - only allow specific actions[1]

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Effect": "Allow",
              "Action": [
                "ec2:*", "ds:*", "s3:*"
              ],
              "Resource": "*"
    }
  ]
}
```

Blacklist – block specific actions[2]

```
{
  "Version": "2012-10-17",
  "Statement": [
        {
      "Effect": "Deny",
      "Action": [
        "organizations:LeaveOrganization",
        "ec2:TerminateInstances"
      ],
      "Resource": "*"
    }
  ]
}
```

1. Resource/conditionals supported on Deny statements only

2. Requires an Allow: * policy to avoid denying all services

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Authoring SCPs

Deny access to AWS based on the requested region

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Sid": "DenyAllOutsideEU",
      "Effect": "Deny",
      "NotAction": [
        "iam:*","organizations:*","route53:*",
        "cloudfront:*", "support:*"
      ],
      "Resource": "*",
      "Condition": {
        "StringNotEquals": {
          "aws:RequestedRegion": [
            "eu-central-1","eu-west-1"
          ]
        }
      }
    }
  ]
}
```

Authoring SCPs

Deny access to AWS based on the requested region

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
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      "NotAction": [
        "iam:*","organizations:*","route53:*",
        "cloudfront:*", "support:*"
      ],
      "Resource": "*",
      "Condition": {
        "StringNotEquals": {
          "aws:RequestedRegion": [
            "eu-central-1","eu-west-1"
          ]
        }
      }
    }
  ]
}
```

Authoring SCPs

Deny access to AWS based on the requested region

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
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      "Effect": "Deny",
      "NotAction": [
        "iam:*","organizations:*","route53:*",
        "cloudfront:*", "support:*"
      ],
      "Resource": "*",
      "Condition": {
        "StringNotEquals": {
          "aws:RequestedRegion": [
            "eu-central-1","eu-west-1"
          ]
        }
      }
    }
  ]
}
```

Prevent IAM principals from making changes to a common administrative IAM role

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Sid": "DenyAccessToASpecificRole",
      "Effect": "Deny",
      "Action": [
        "iam:AttachRolePolicy", "iam:DeleteRole",
        "iam:DeleteRolePermissionsBoundary",
        "iam:DeleteRolePolicy", "iam:DetachRolePolicy",
        "iam:PutRolePermissionsBoundary",
        "iam:PutRolePolicy", "iam:UpdateRole",
        "iam:UpdateAssumeRolePolicy",
        "iam:UpdateRoleDescription"
      ],
      "Resource": [
        "arn:aws:iam::*:role/AWS-ADMINISTRATOR-ROLE"
      ]
    }
  ]
}
```

Authoring SCPs

Deny access to AWS based on the requested region

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Sid": "DenyAllOutsideEU",
      "Effect": "Deny",
      "NotAction": [
        "iam:*","organizations:*","route53:*",
        "cloudfront:*", "support:*"
      ],
      "Resource": "*",
      "Condition": {
        "StringNotEquals": {
          "aws:RequestedRegion": [
            "eu-central-1","eu-west-1"
          ]
        }
      }
    }
  ]
}
```

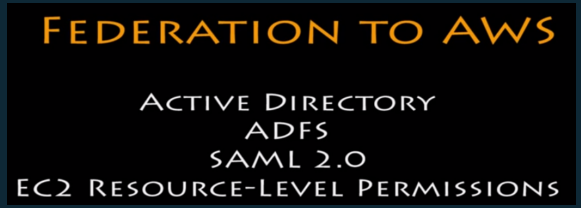
Prevent IAM principals from making changes to a common administrative IAM role

```
{
  "Version": "2012-10-17",
  "Statement": [
    {
      "Sid": "DenyAccessToASpecificRole",
      "Effect": "Deny",
      "Action": [
        "iam:AttachRolePolicy", "iam:DeleteRole",
        "iam:DeleteRolePermissionsBoundary",
        "iam:DeleteRolePolicy", "iam:DetachRolePolicy",
        "iam:PutRolePermissionsBoundary",
        "iam:PutRolePolicy", "iam:UpdateRole",
        "iam:UpdateAssumeRolePolicy",
        "iam:UpdateRoleDescription"
      ],
      "Resource": [
        "arn:aws:iam::*:role/AWS-ADMINISTRATOR-ROLE"
      ]
    }
  ]
}
```

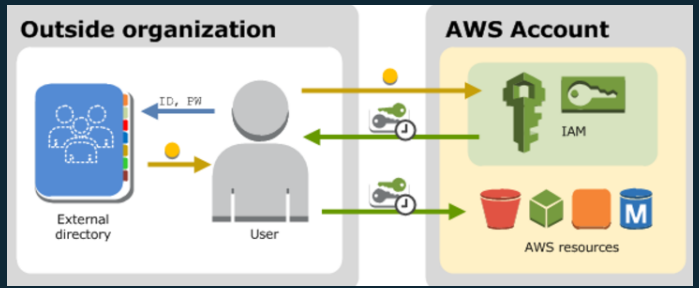
Best Practice #1

Use Federated Access from Outside of AWS

Use the same identity management system you use for everything else in your organization.



https://aws.amazon.com/iam/details/manage-federation/



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Best Practice #2

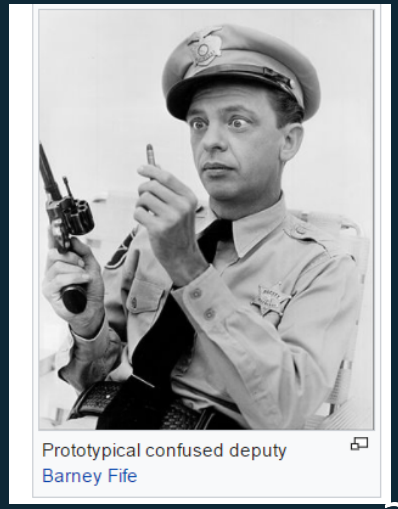
Use IAM roles not accounts

IAM access keys are just waiting to be leaked

Examples:

Cross-account roles, instance roles, etc.…

When using IAM cross-account roles don't forget about the confused deputy problem: https://en.wikipedia.org/wiki/Confused_deputy_problem



aws

Best Practice #3

Rotate all IAM access and secret access keys on a regular basis

Set a policy for how often

Policy can vary based on situation

Wait to see how hard it is to actually accomplish

https://aws.amazon.com/blogs/security/how-to-rotate-access-keys-for-iam-users/

aws

Best Practice #4

Don't leak your AWS access keys

Pushing Access Keys to GitHub is a common accident

What to Do If You Inadvertently Expose an AWS Access Key
https://aws.amazon.com/blogs/security/what-to-do-if-you-inadvertently-expose-an-aws-access-key/

https://wptavern.com/ryan-hellyers-aws-nightmare-leaked-access-keys-result-in-a-6000-bill-overnight

Ryan Hellyer's AWS Nightmare: Leaked Access Keys Result in a $6,000 Bill Overnight

Sarah Gooding September 26, 2014 26

WordPress developer Ryan Hellyer had always wanted to open source his website. As a strong supporter of open source software and an avid plugin developer, he enjoys sharing his code and learning from others. This desire

aws

Best Practice #5

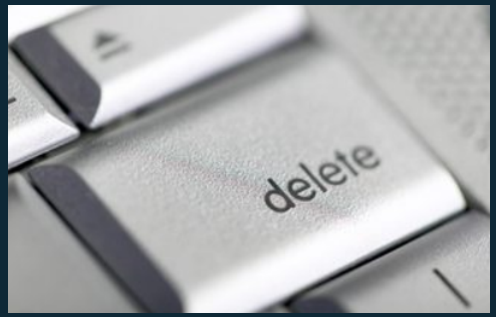
Delete Stale or Unused Access Keys

If an IAM access key is not being used, delete it

More complicated deleting root access keys

Create a policy around aging of stale or unused
    90 day? 365 day?

Look at AWS method ***generate-credential-report***



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Best Practice #6

Set IAM Password Policies

Account by Account setting

Nine Password Policy Options

- Minimum password length
- Require at least one uppercase letter
- Require at least one lowercase letter
- Require at least one number
- Require at least one nonalphanumeric character
- Allow users to change their own password
- Enable password expiration
- Prevent password reuse
- Password expiration requires administrator reset

http://docs.aws.amazon.com/IAM/latest/UserGuide/id_credentials_passwords_account-policy.html

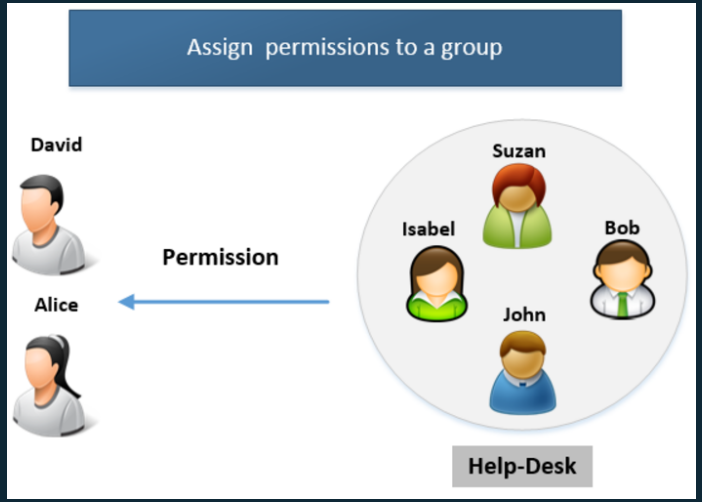
Best Practice #7

Do not grant permissions to IAM users,
grant to IAM groups and assign users to groups

Managing user permissions is complex

Control permissions on groups

Assign users to groups



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Best Practice #8

Find unused IAM accounts

Attack surface that doesn’t need to be there

User left organization? Is a default password still on the account?

Set your organizational policy on how long is unused or stale

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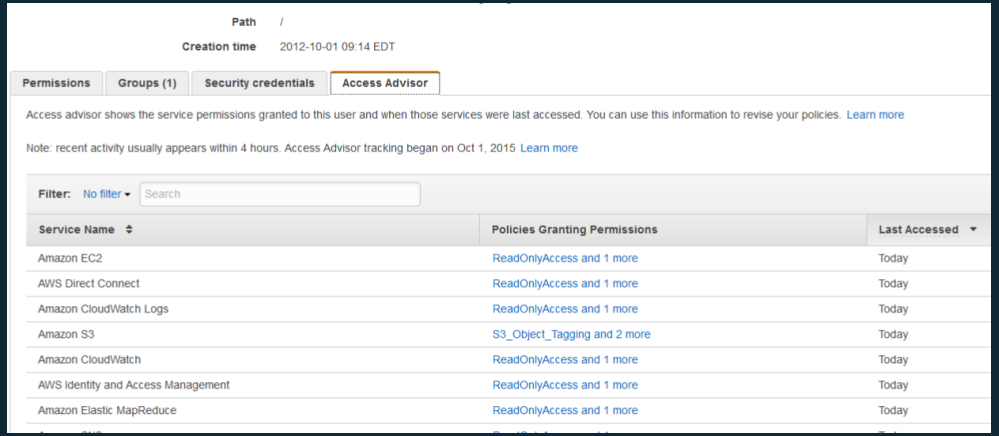
Best Practice #9

Find accounts with permissions they don't actually need

Principle of least privileges

Use IAM Access Advisor tab

Revoke what you don’t need



Best Practice #10

Monitor All IAM Activity

AWS CloudTrail records each time the AWS API is called

- Currently supports most AWS services
- You have to enable it in every account/region

Conveniently everything in AWS goes through the API

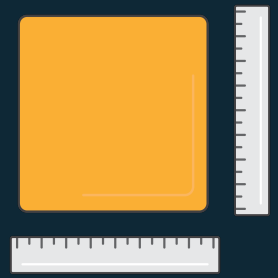
- Even actions in the AWS Management Console go through the API

CloudTrail writes files into an Amazon S3 bucket

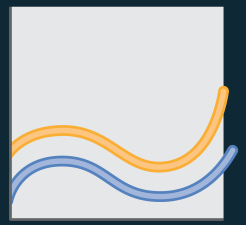
- Near real-time (every five minutes)
- Files are in JSON format

Cost Optimization

The Five Pillars of Cost Optimization



Right Sizing Your Instances



Increase Elasticity

Pick the Right Pricing Model

Match Usage to Storage Class

Mechanisms for Optimisation

aws

Pillar 1:
Right Sizing

Cheapest Instance / Best Performance
Monitor Usage

Right Sizing example

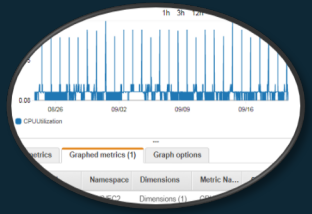
m4.4xlarge
$0.80 per hr

1. Migrate/provision & Run

2. Check (CPU, RAM, network, disc)

m4.large
$0.10 per hr

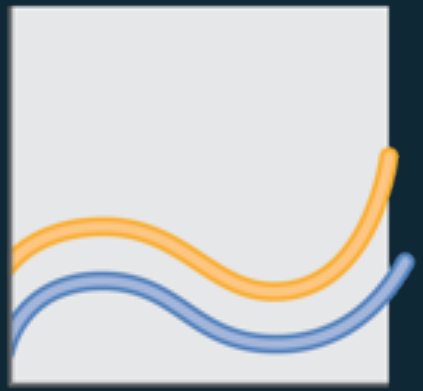
3. Right Size



4. Review Performance

87% Saving

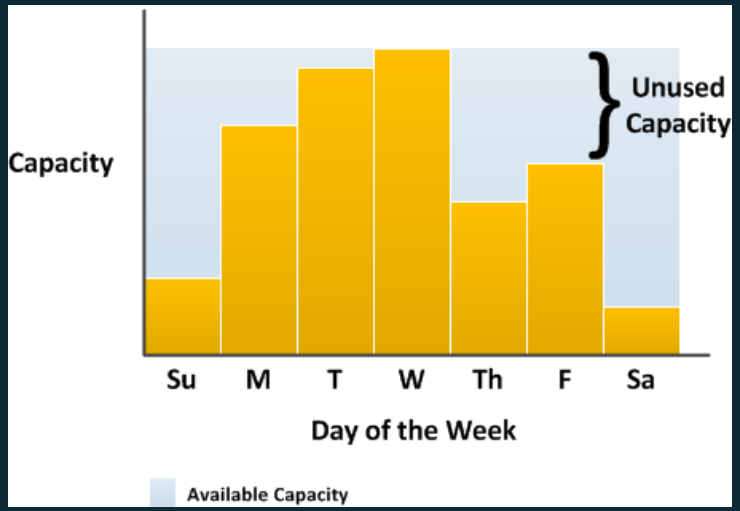
5. Save!



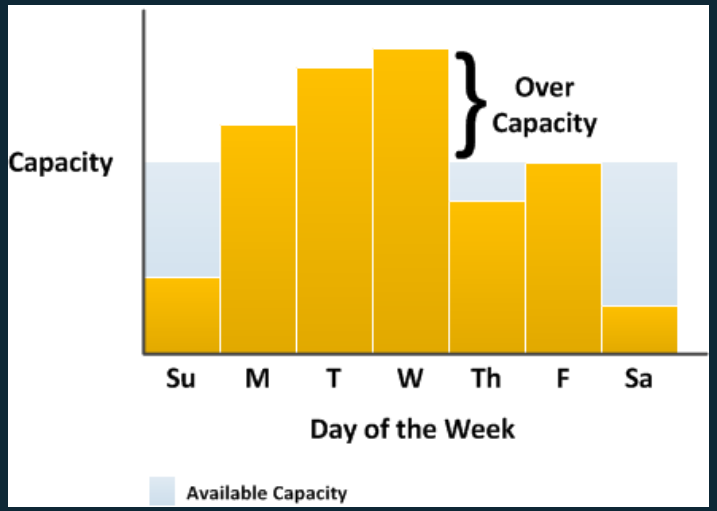
Pillar 2:
Increase Elasticity
Autoscaling

aws

Traditional approaches to capacity management



Build to peak load

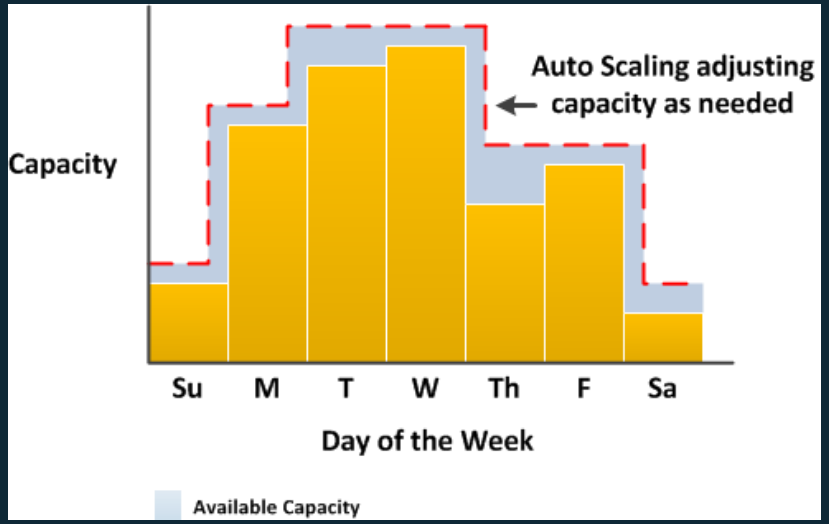


Build to average load

Lower over-provisioning via elasticity

Auto Scaling allows you to:

- React dynamically to changes in load
- Schedule regular workloads
- Optimise your instance usage
- Reduce over-provisioning
- Complimentary service!



Pillar 3:
Leveraging the Right Pricing Model

Reserved Instances
EC2 Spot
On-Demand

aws

What are Reserved Instances (RIs)?

- Discount for commitment
- Expires after 1 hour
- Doesn’t map directly to an Instance

Up to 75% Savings

aws

EC2 Spot provides incredible savings for the right workloads

Up to 90% Savings

Spot can be used for

- Stateless
- Fault-tolerant
- Big data
- Containers
- CI/CD
- Web servers
- High Performance Compute
- Dev/Test
- See https://amzn.to/2wKNIT1

aws

Pillar 4:
Leveraging the Right Storage Class

Elastic Block Storage
Simple Storage Service

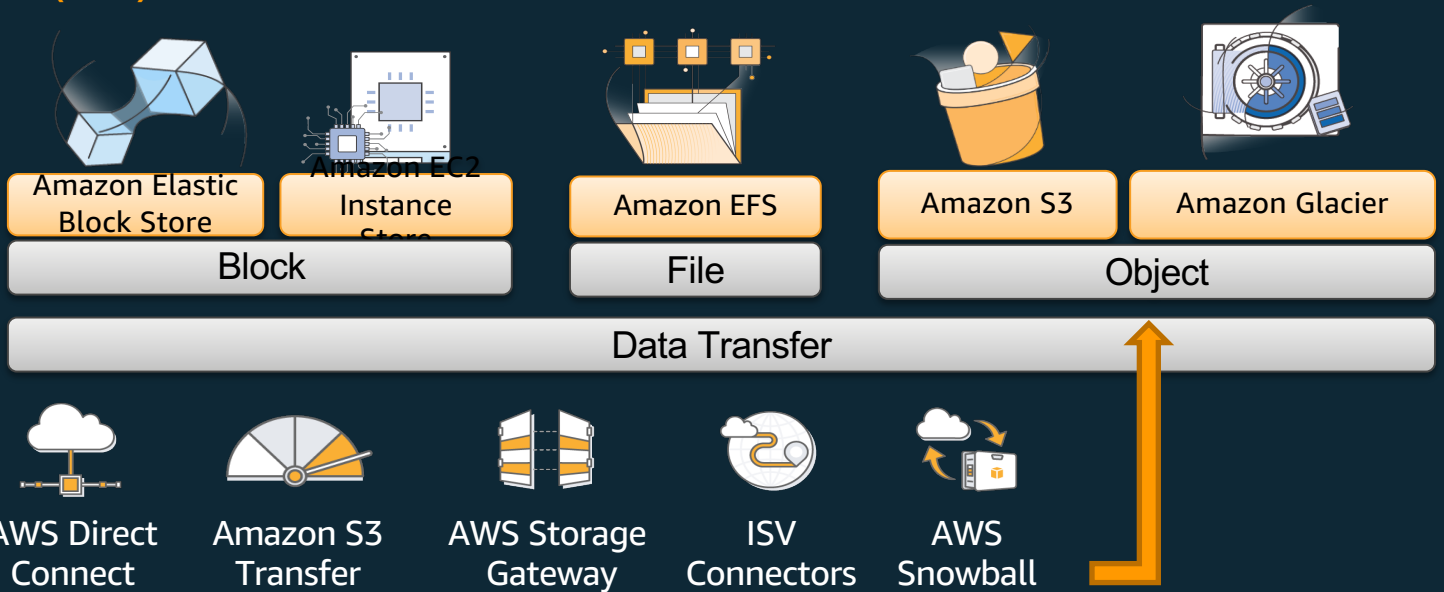
aws

Amazon Storage Classes/Platforms

- Server/Instance Storage
- Local Filesystems
- Networked Volumes (EBS)

- Distributed Filesystem

- Object Storage
- Backup Target – Snapshots,…

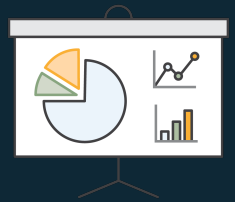


Pillar 5:
Mechanisms for Cost Optimization

aws

Summary of Mechanisms for Optimisation

Define, agree, and enforce cost allocation tagging



Define metrics, set targets, and review

Enable teams to architect for cost

Assign optimization responsibility

aws

Networking

Basics quiz

What is the minimum and maximum size for a VPC CIDR?

A. /24 -- /8

B. /32 -- /16

C. /28 -- /16

D. /28 -- /8

Basics quiz

What is the minimum and maximum size for a VPC CIDR?

A. /24 -- /8

B. /32 -- /16

C. /28 -- /16

D. /28 -- /8

Basics quiz

/16 = 65,536 addresses
/17 = 32, 728
/18 = 16,384
/19 = 8,192
/20 = 4,096
/21 = 2,048
/22 = 1,024
/23 = 512
/24 = 256
/25 = 128
/26 = 64
/27 = 32
/28 = 16

5 reserved IPs per range
+0 = Network
+1 = Gateway
+2 = DNS
+3 = Reserved
N-1 = Broadcast

Basics quiz

How many additional CIDR ranges can be assigned to a VPC?

A. 1

B. 2

C. 3

D. 4

E. 5

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Basics quiz

How many additional CIDR ranges can be assigned to a VPC?

A. 1

B. 2

C. 3

D. 4

E. 5

Basics quiz

You may have 1 primary CIDR block and
up to 4 additional CIDR blocks assigned to a VPC

You should avoid overlapping IP addresses

VPC Firewall

Security Group

- Stateful
- Only specify allow rules
- Default = deny all

- If traffic is allowed out, the return traffic is automatically allowed back in

- Can reference other SGs

NACL

- Stateless
- Can allow or deny
- Default = allow all

- Have to worry about ephemeral ports

- Rules processed in order

aws

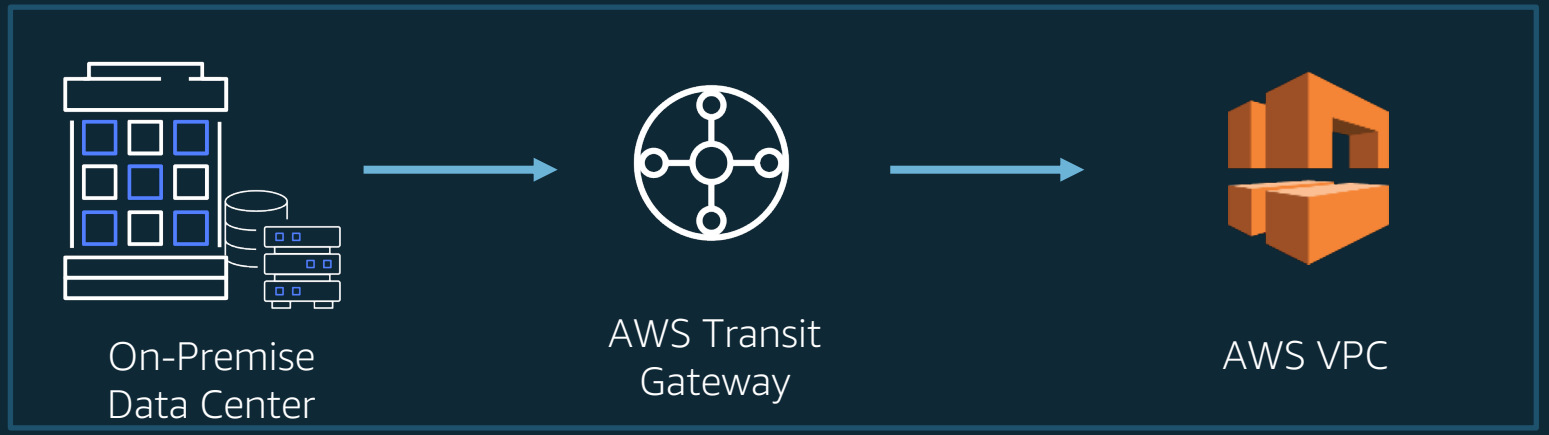
VPC Connectivity Options

- IGW — Make a subnet public by routing to IGW
- NAT GW — Enable private instances to connect to the internet
- Egress-only IGW — Like NAT GW for IPv6
- VPG — Site-to-Site VPN
- Peering — Connect 2 VPCs to each other
- ClassicLink — Enable EC2-Classic instances to connect to VPC
- VPC Endpoint — Private connectivity between VPC and AWS Service
- Outposts LGW — Route to network where Outposts resides
- Middleware — Intercept traffic with an appliance (ie. Filtering, DLP)
- TGW — Let’s talk about it…

aws

AWS Transit Gateway

Easily interconnect thousands of VPCs and on-premise networks



AWS Transit Gateway: Key features

Centralized routing polices across VPCs and on-prem

Scales to support thousands of VPCs across multi-accounts

Increase connectivity throughput with multi-vpn connections

Flexible segmentation and routing rules

Horizontally scalable

Simplified management

AWS Transit Gateway: Benefits

 **Simplified Networking**	• Centrally interconnect multiple VPCs across accounts • One central connection point for VPN and Direct Connect • Reduce or eliminate need for peer to peer networking • Increase VPN throughput via ECMP routing (50 Gbps+)
 **Global Connectivity**	• Peer AWS Transit Gateway across regions • Leverage the AWS Global Network for low latency cross-region connectivity • Regional construct reduces blast radius
 **Easy manageability**	• Reduces time to configure on premise connectivity to AWS • Easily monitor and manage from a central point • Integrated with CloudWatch and VPC Flow Logs • Leverage existing VPC security groups and network access control lists

Use Case – Interconnecting Geographically Dispersed On-Premise and VPC resources

- Customer with multiple VPCs
- Build applications that span a large number of VPCs
- Share network services (DNS, Active Directory, FW, IDS)
- Reduce management overhead

Use Case – Edge Consolidation

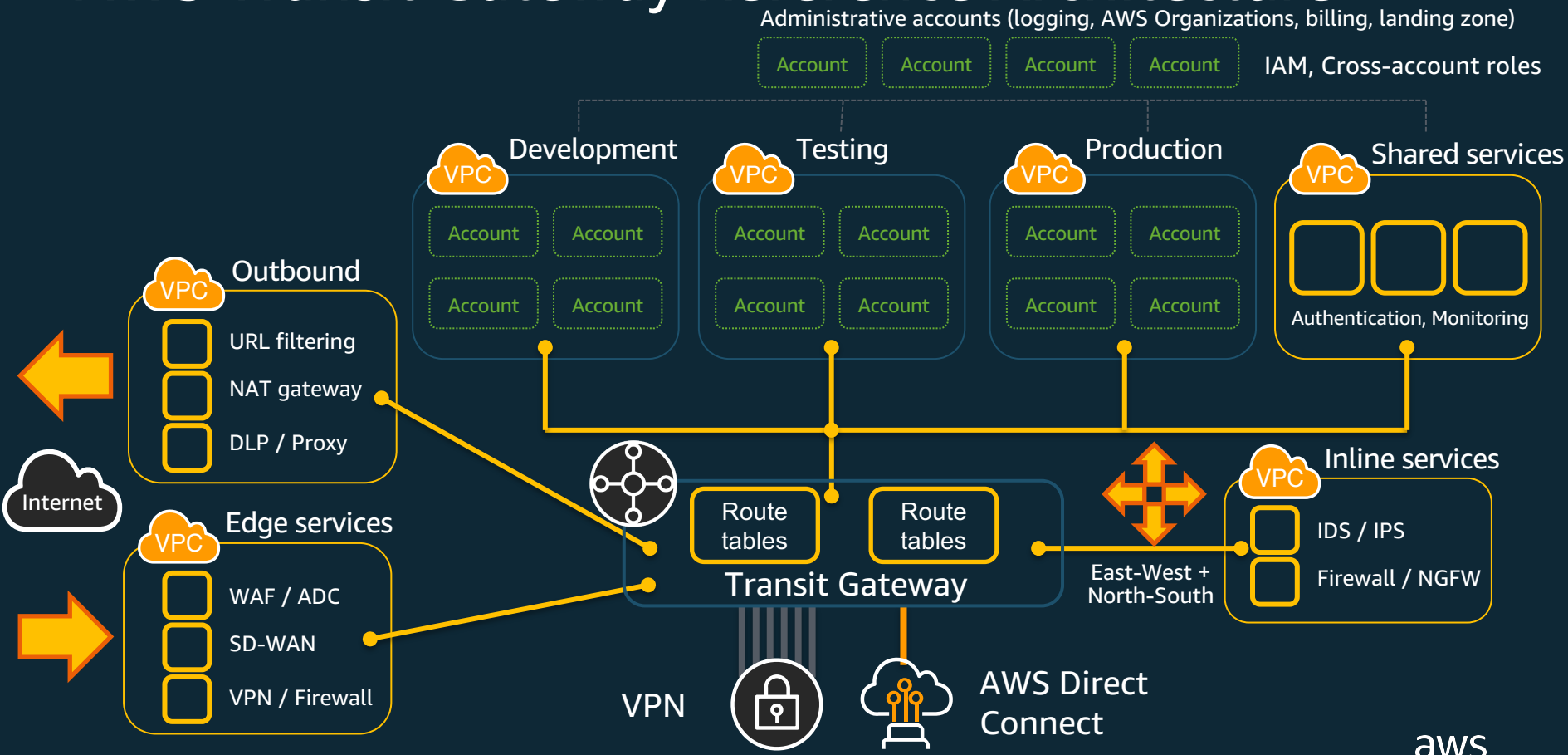
- Share a common VPN or Direct Connect Gateway (DXGW) across all VPCs
- Reduce time to connect on premise resources to multiple VPCs
- No additional customer network changes required when adding a VPC to AWS Transit Gateway

Use Case – Digital security and threat intelligence

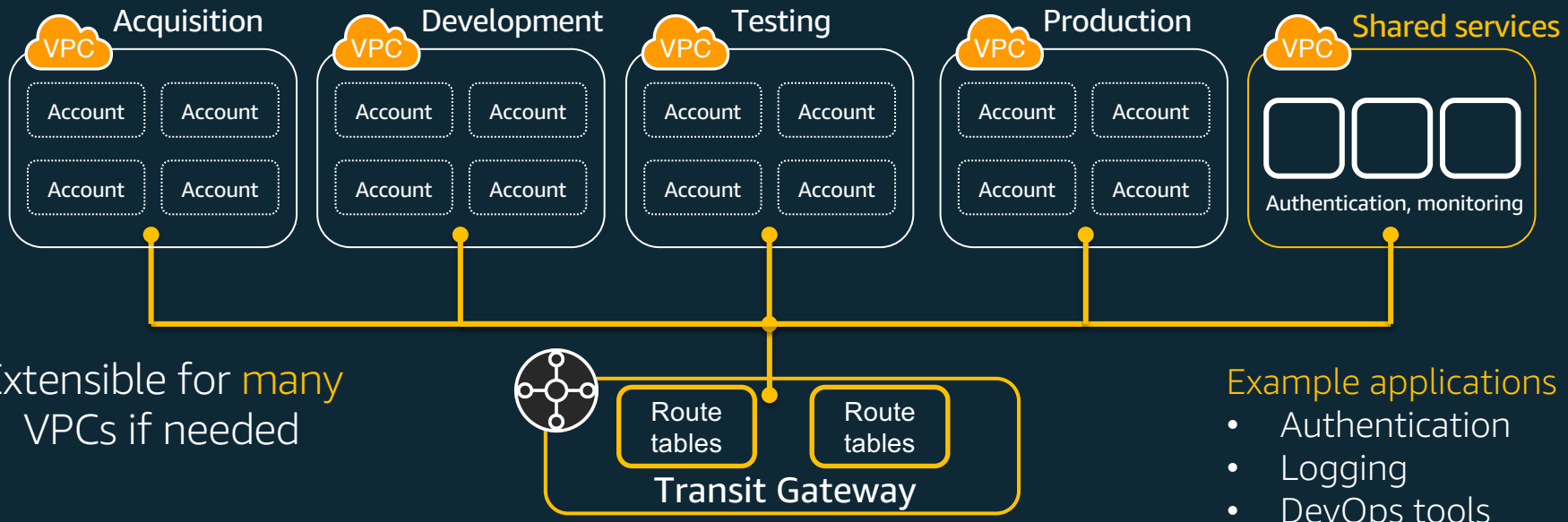
- Shared VPC hosts security tools
- Firewall as a service
- Web application Firewall (WAF), Data Loss Prevention (DLP), Intrusion Detection / Protection (IDS/IPS),
- Scales out over native AWS Service

How Does It Work

AWS Transit Gateway Reference Architecture



Shared Services with AWS Transit Gateway



Extensible for many VPCs if needed

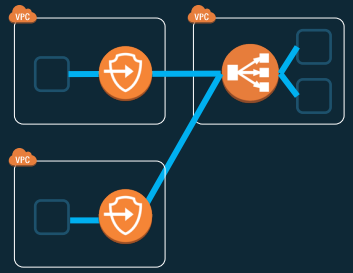
Example applications

- Authentication
- Logging
- DevOps tools
- Security resources

Works with flat or isolated segmentation

Using AWS Transit Gateway and PrivateLink

AWS PrivateLink



- One-to-many connectivity
- Highly scalable
- Supports overlapping CIDRs
- Uses Elastic Load Balancing
- Load balancing and hourly endpoint costs

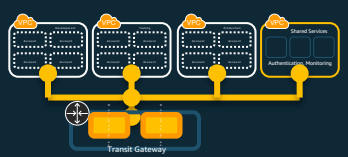
Scope: Application shared services

Trust model: No mutual trust

Dependencies: Load balancing and application architecture

Scale: Thousands of spoke VPCs

AWS Transit Gateway



- Many-to-Many or one-to-many with route tables
- Highly scalable
- Hourly per AZ endpoint costs

Scope: Network shared services to many VPCs

Trust model: Per VPC trust, centralized control

Dependencies: Centralized control of the Transit Gateway

Scale: Thousands of spoke VPCs

aws

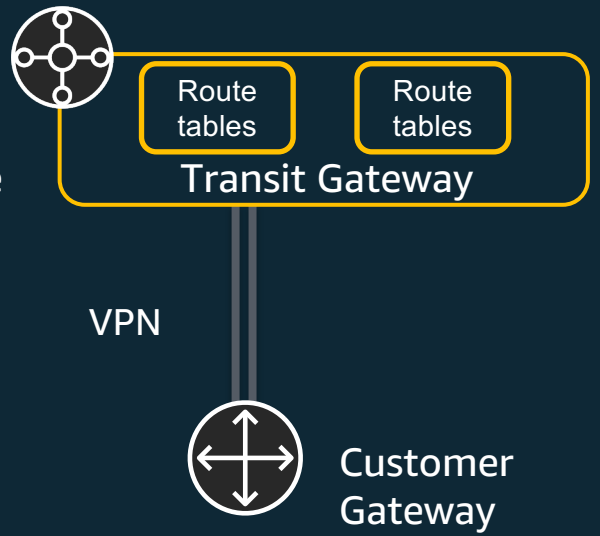
VPN With Transit Gateway

Consolidate VPN at the Transit Gateway (TGW)

- VPN acts similar to the Virtual Private Gateway (VGW)
  - Bandwidth, configuration, APIs, cost, and experience
  - VPN is attached to a TGW instead of a VGW
  - Same 1.25 gbps bandwidth per tunnel applies

Encryption to the edge of many VPCs

- Traffic is encrypted until it's inside the VPC
- Does not natively encrypt traffic between VPCs
  - Inter-region VPC peering does



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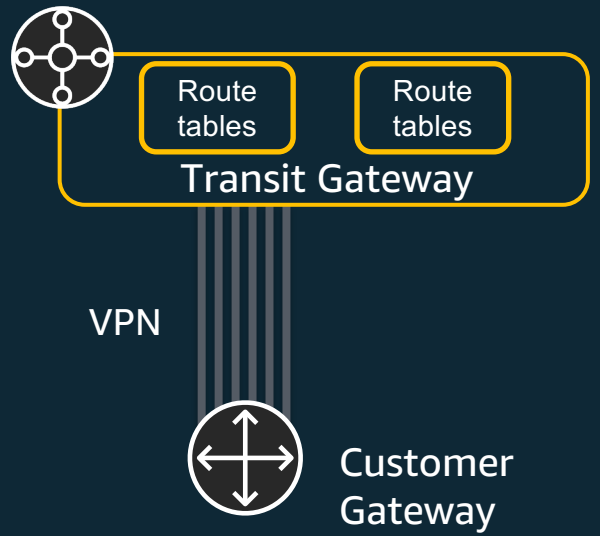
VPN with Transit Gateway: Add more bandwidth

Support for spreading traffic across many tunnels
- Equal Cost Multi-Path (ECMP) support with BGP multi-path
- Tested up to 50 Gbps of traffic
- Split traffic into smaller flows, multi-part uploads, etc.

Check your on-premises configuration
- Multi-path BGP
- ECMP support, amount of equal paths, reverse-path forwarding/spoofing checks
- Only supported with BGP, not static routing



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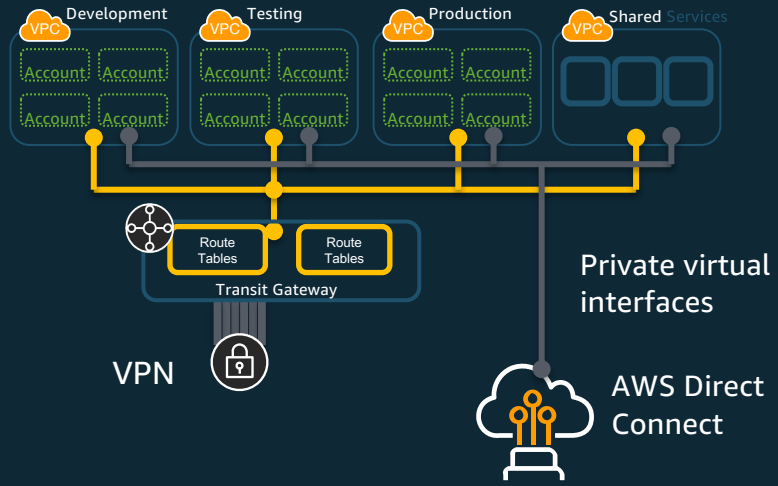
AWS Direct Connect and Transit Gateway

Use Direct Connect in parallel



Use VPN over a Direct Connect public virtual interface (VIF)