Enterprise AWS VPC Design & Implementation Document

Project Objective

Design and implement a **scalable, production-ready AWS VPC** that:

- Uses **multiple subnet sizes** based on workload demand
- Implements **correct routing and controlled internet access**
- Follows **enterprise CIDR planning best practices**
- Is **secure, expandable, auditable**, and suitable for long-term growth

1. Business Scenario

The organization is building a **shared cloud network platform** to host:

- Admin & operational services (bastion, ops tooling)
- Internet-facing edge and load balancers
- Web application tiers
- Backend application services
- Internal platforms and container workloads
- Large shared internal services

The network **must be designed once** and support **years of growth** without re-CIDR or re-architecture.

2. CIDR & Capacity Planning Strategy

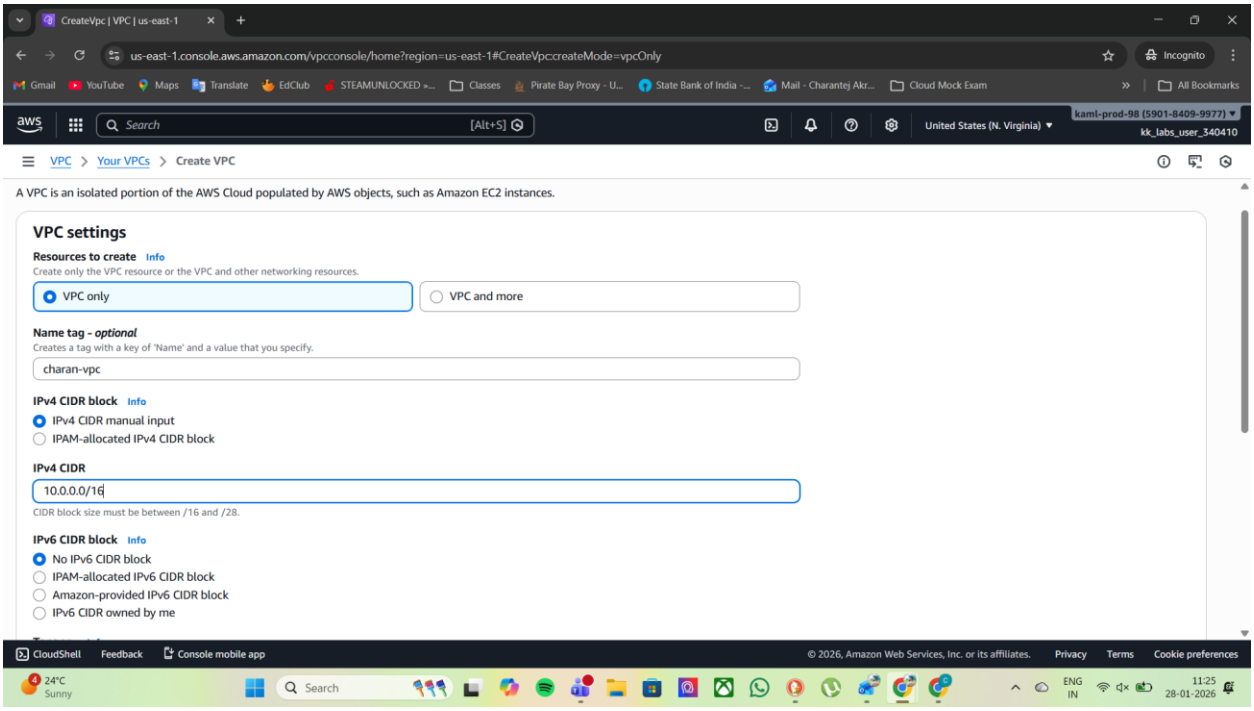
2.1 Why a /16 VPC CIDR

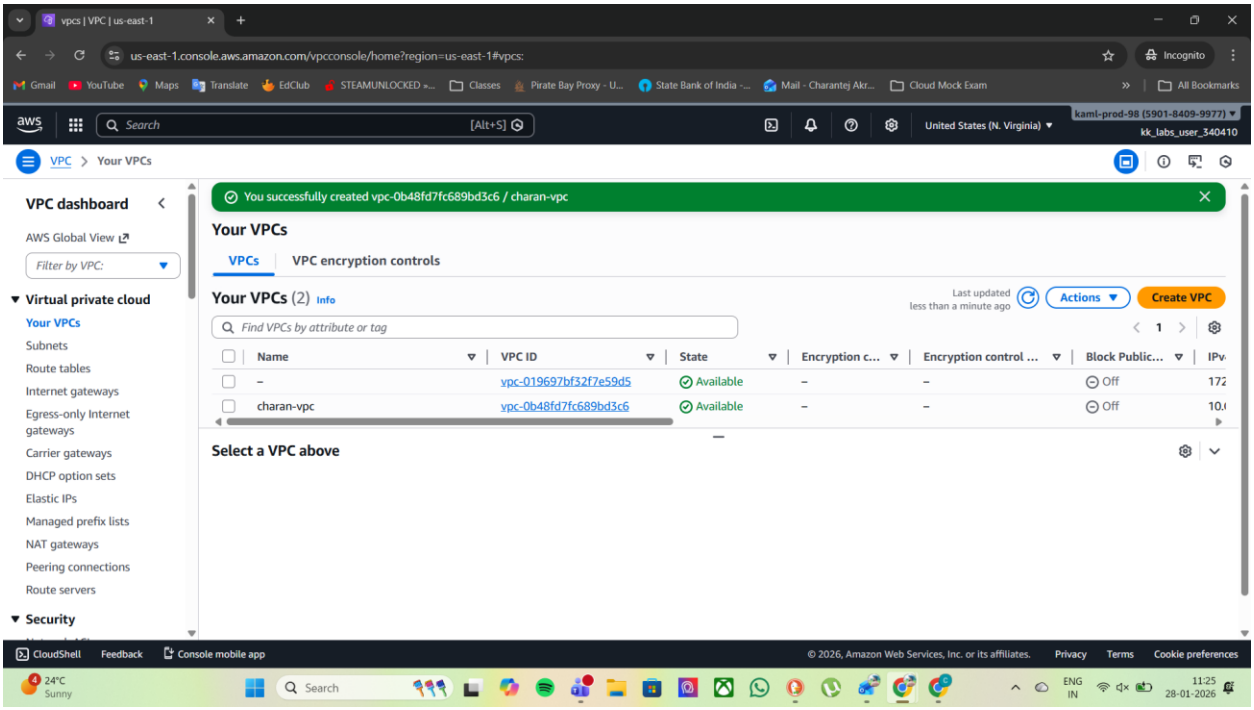
- Provides **65,536 IP addresses**
- Supports **large uneven subnet allocations**
- Allows **future subnet additions** without redesign
- Aligns with **AWS enterprise best practices**

Selected VPC CIDR

`10.0.0.0/16`

This CIDR provides a clean, private RFC1918 address space with predictable subnet boundaries.





3. Subnet Design Principles

Key Rules Applied

- Allocate **largest subnets first**
- Respect **binary CIDR boundaries**
- Ensure **no overlaps**
- Keep design **human-readable and auditable**

Failure to follow these rules results in:

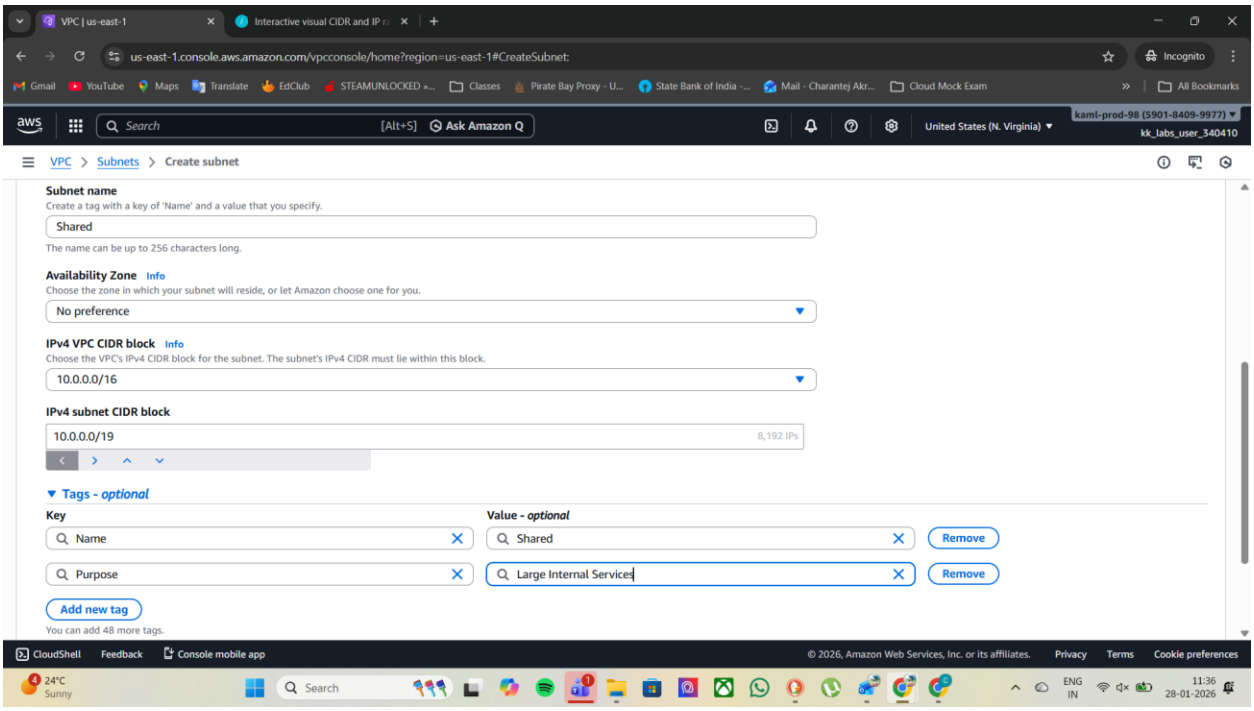
- Invalid CIDR blocks
- AWS rejection
- Broken routing and expansion limits

4. Subnet CIDR Allocation (6 Unequal Subnets)

4.1 Subnet Allocation Table

Subnet Name	Purpose	Required IPs	CIDR	Address Range
Shared	Large Internal Services	~8,192	/19	10.0.0.0 – 10.0.31.255
Platform	Containers / Tools	~4,096	/20	10.0.32.0 – 10.0.47.255
App	Application Tier	~2,048	/21	10.0.48.0 – 10.0.55.255
Web	Web Tier	~1,024	/22	10.0.56.0 – 10.0.59.255
Edge	Ingress / Load Balancers	~512	/23	10.0.60.0 – 10.0.61.255
Admin	Bastion / Ops	~256	/24	10.0.62.0 – 10.0.62.255

Remaining space (10.0.63.0 – 10.0.255.255) is **reserved for future growth**.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VPC > Subnets > Create subnet
Subnet name
Create a tag with a key of 'Name' and a value that you specify.
Shared
The name can be up to 256 characters long.
Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference
IPv4 VPC CIDR block Info
Choose the VPC's IPv4 CIDR block for the subnet. The subnet's IPv4 CIDR must lie within this block.
10.0.0.0/16
IPv4 subnet CIDR block
10.0.0.0/19
8,192 IPs
Tags - optional
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Value - optional
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Remove
Purpose
Large Internal Services
Remove
Add new tag
You can add 48 more tags.
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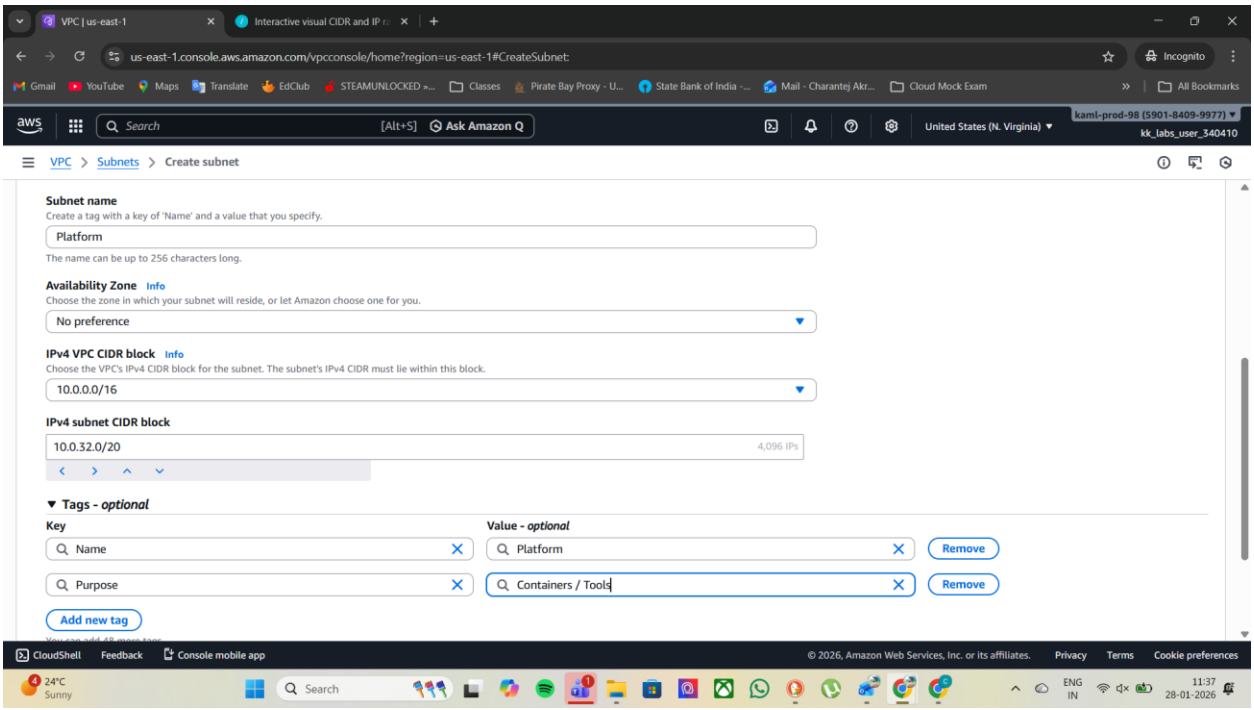
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VPC > Subnets > Create subnet
Subnet name
Create a tag with a key of 'Name' and a value that you specify.
Platform
The name can be up to 256 characters long.
Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference
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10.0.0.0/16
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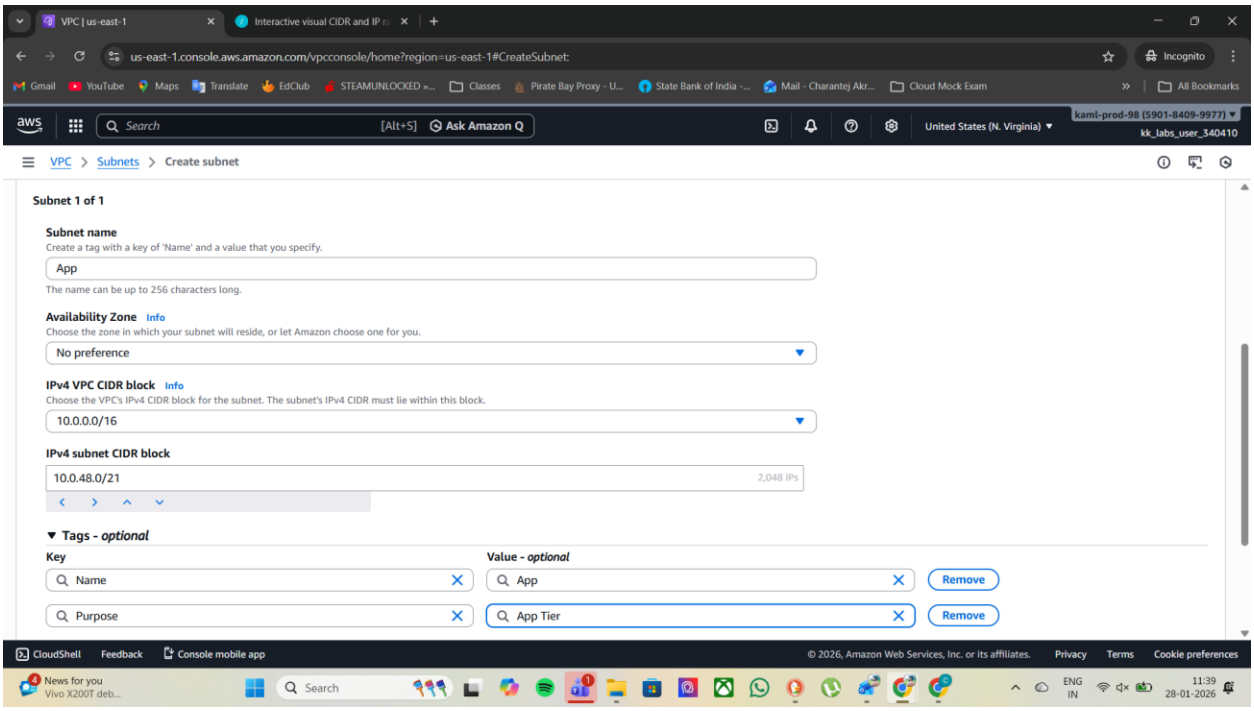
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Subnet 1 of 1
Subnet name
Create a tag with a key of 'Name' and a value that you specify.
App
The name can be up to 256 characters long.
Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference
IPv4 VPC CIDR block Info
Choose the VPC's IPv4 CIDR block for the subnet. The subnet's IPv4 CIDR must lie within this block.
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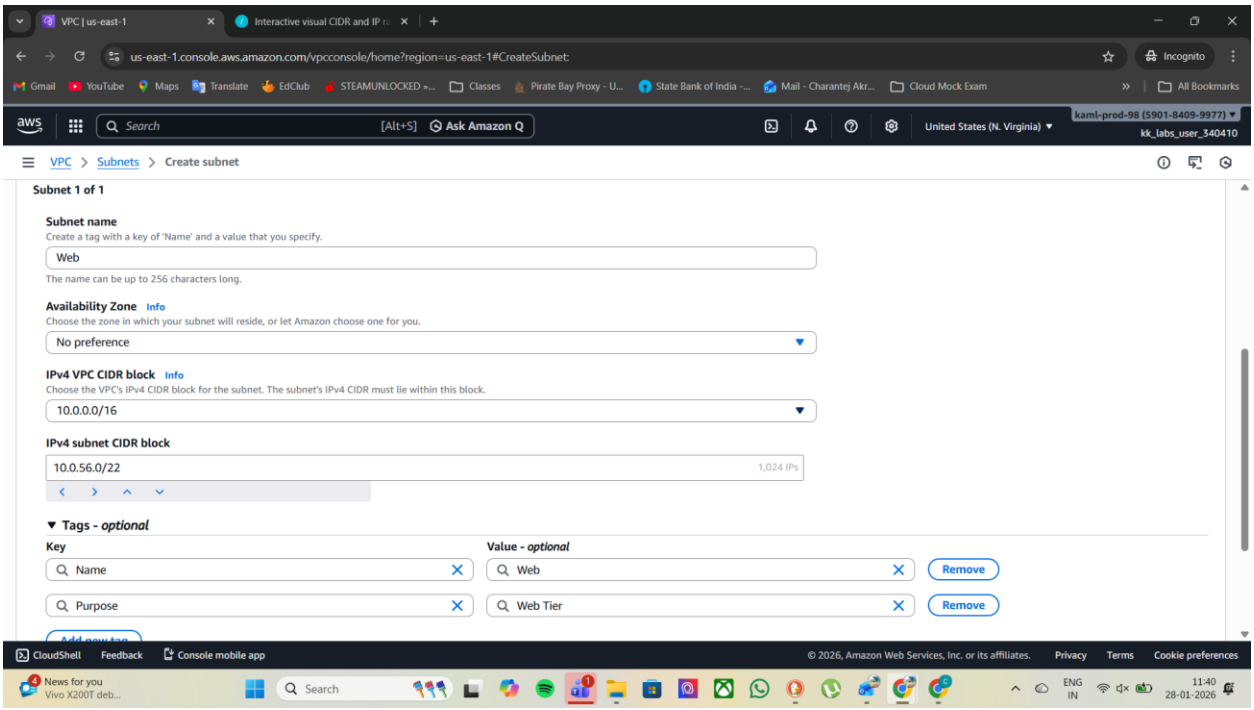
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VPC > Subnets > Create subnet
Subnet 1 of 1
Subnet name
Create a tag with a key of 'Name' and a value that you specify.
Web
The name can be up to 256 characters long.
Availability Zone Info
Choose the zone in which your subnet will reside, or let Amazon choose one for you.
No preference
IPv4 VPC CIDR block Info
Choose the VPC's IPv4 CIDR block for the subnet. The subnet's IPv4 CIDR must lie within this block.
10.0.0.0/16
IPv4 subnet CIDR block
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1,024 IPs
Tags - optional
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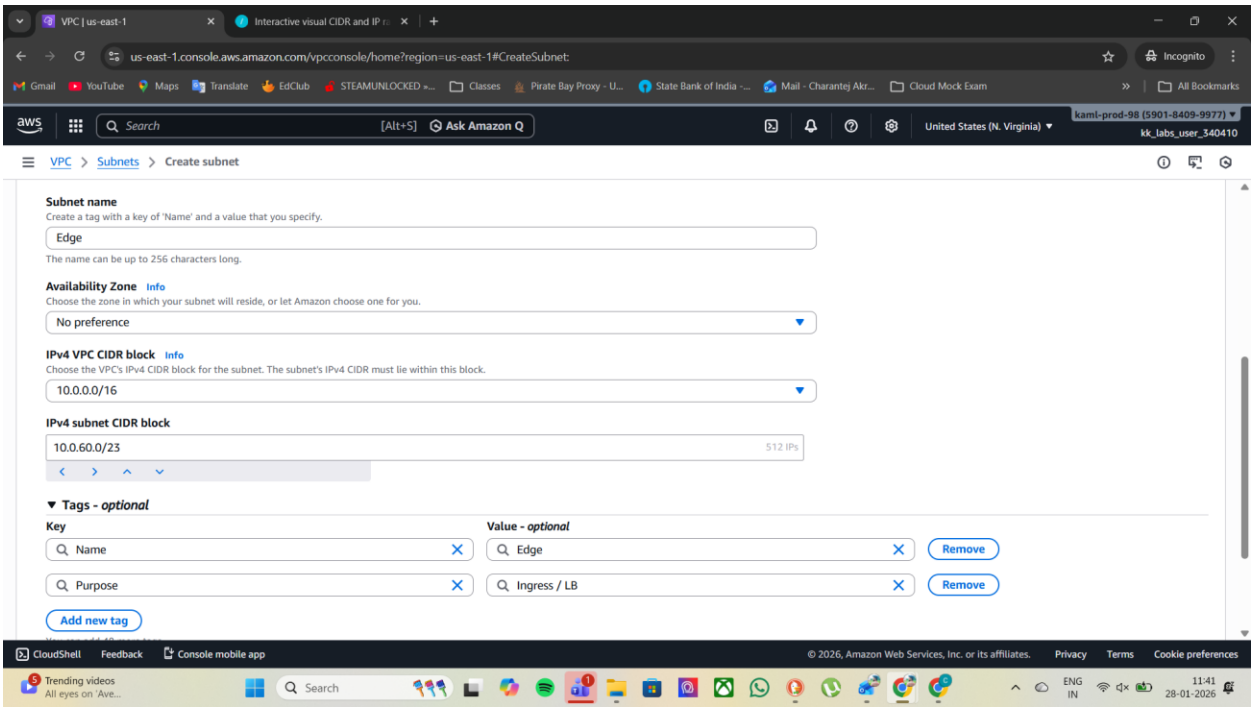
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Create a tag with a key of 'Name' and a value that you specify.
Edge
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Availability Zone Info
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No preference
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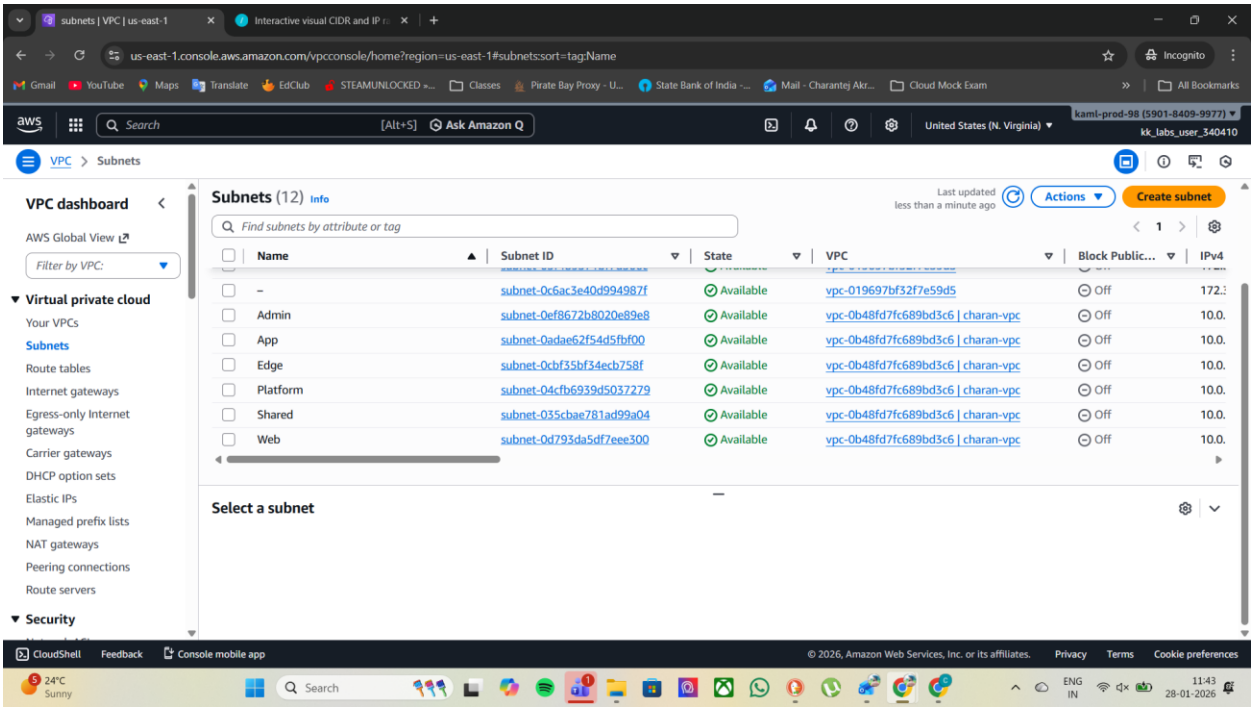
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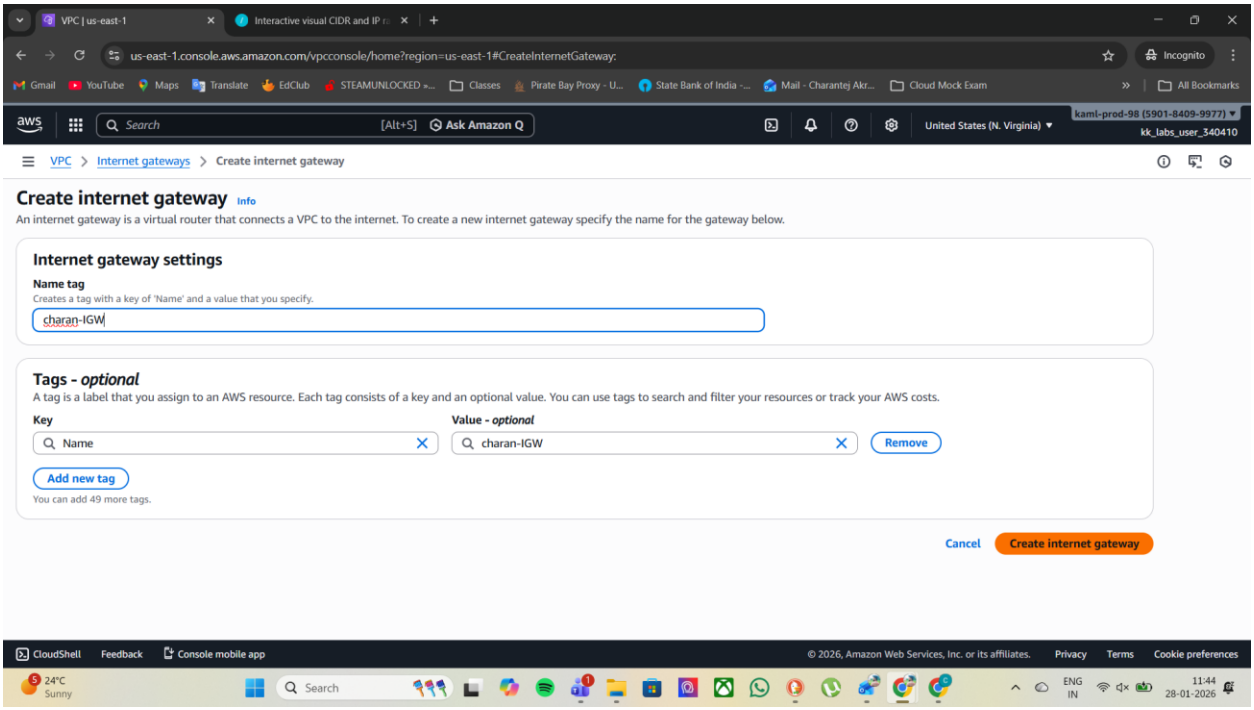
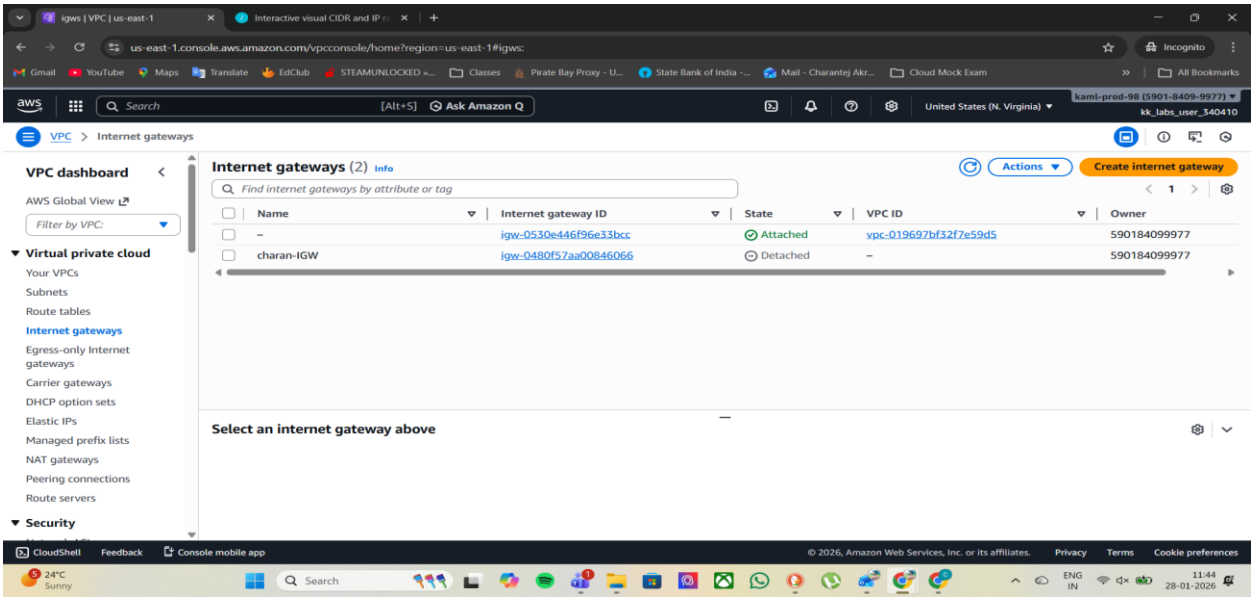
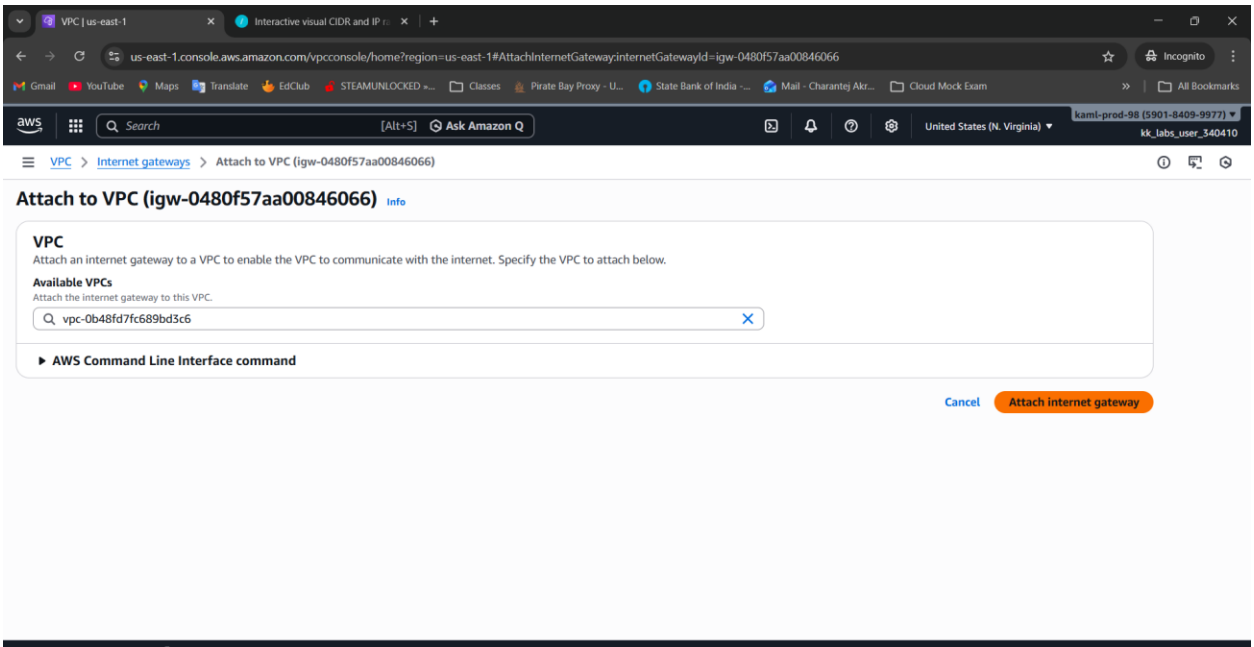
5. Internet Gateway Design

5.1 Internet Gateway (IGW)

- A **single Internet Gateway** is created
- Attached directly to the VPC
- Enables internet routing **only where explicitly allowed**



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Attach to VPC (igw-0480f57aa00846066) Info
VPC
Attach an internet gateway to a VPC to enable the VPC to communicate with the internet. Specify the VPC to attach below.
Available VPCs
Attach the internet gateway to this VPC.
vpc-0b48fd7fc689bd3c6
AWS Command Line Interface command
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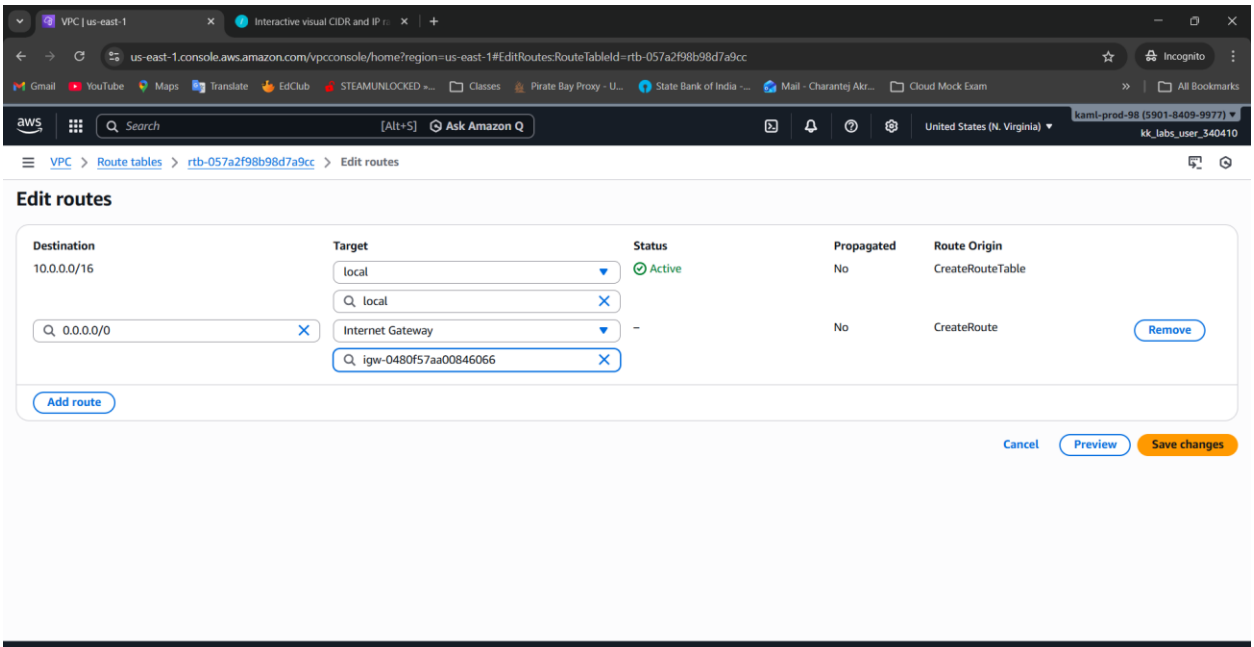
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VPC
Route tables
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Internet Gateway
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Add route
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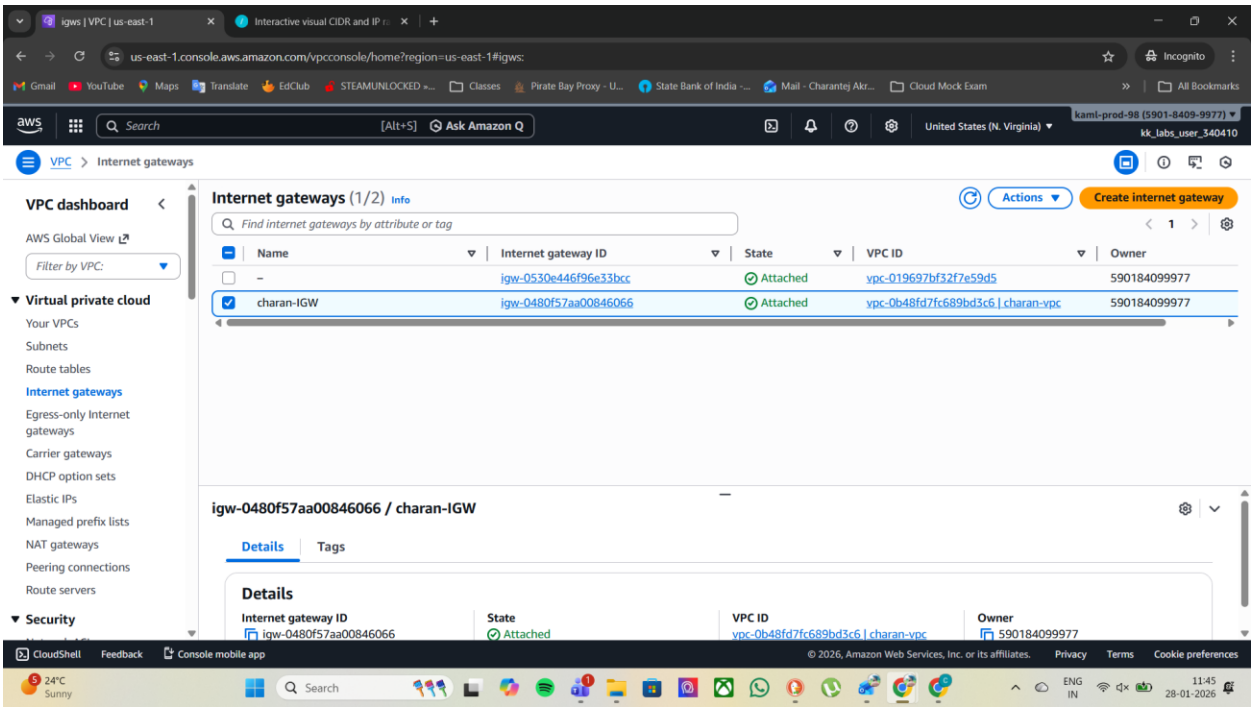
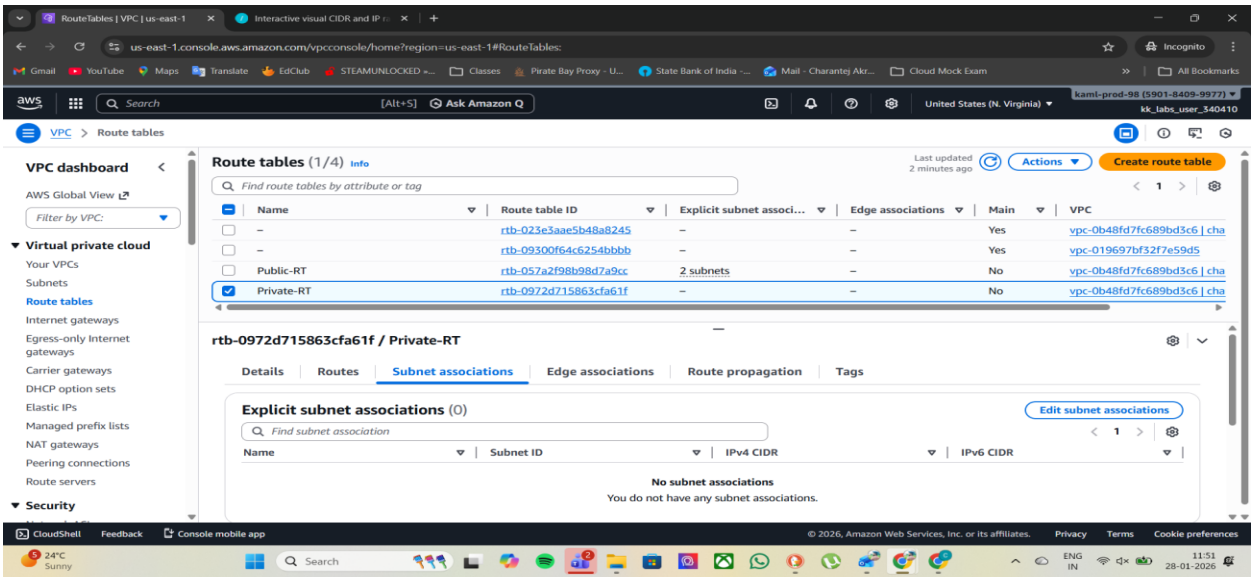


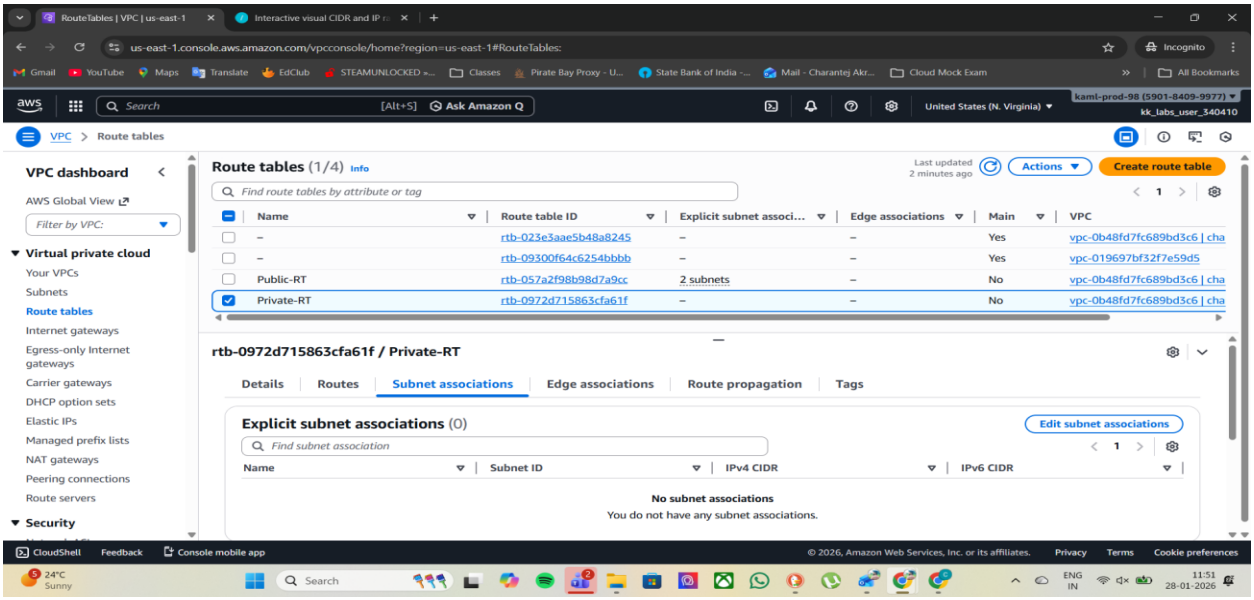
6. Route Table Architecture (Enterprise Model)

6.1 Route Tables Created

Route Table	Associated Subnets	Routes
Public-RT	Admin, Edge	10.0.0.0/16 → local0.0.0.0/0 → IGW
Private-RT	Web, App, Platform, Shared	10.0.0.0/16 → local

No NAT Gateway is used intentionally to **fully isolate private subnets**.





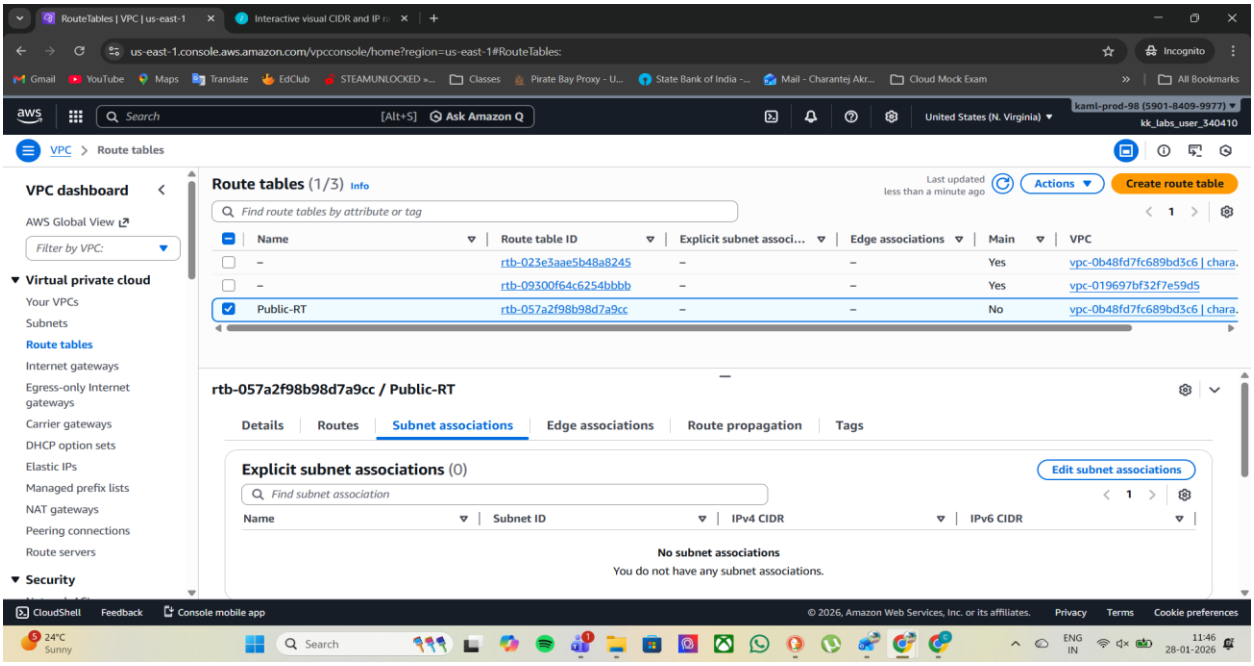
7. Route Table Associations

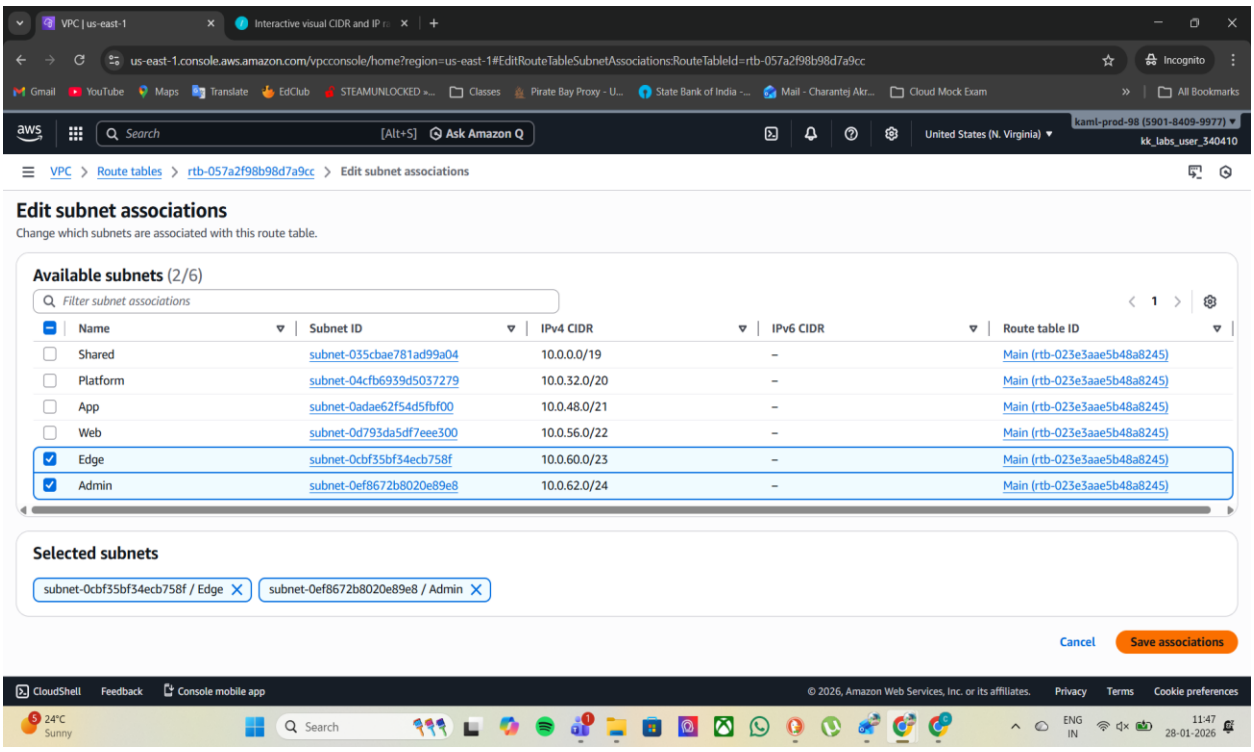
Explicit Associations

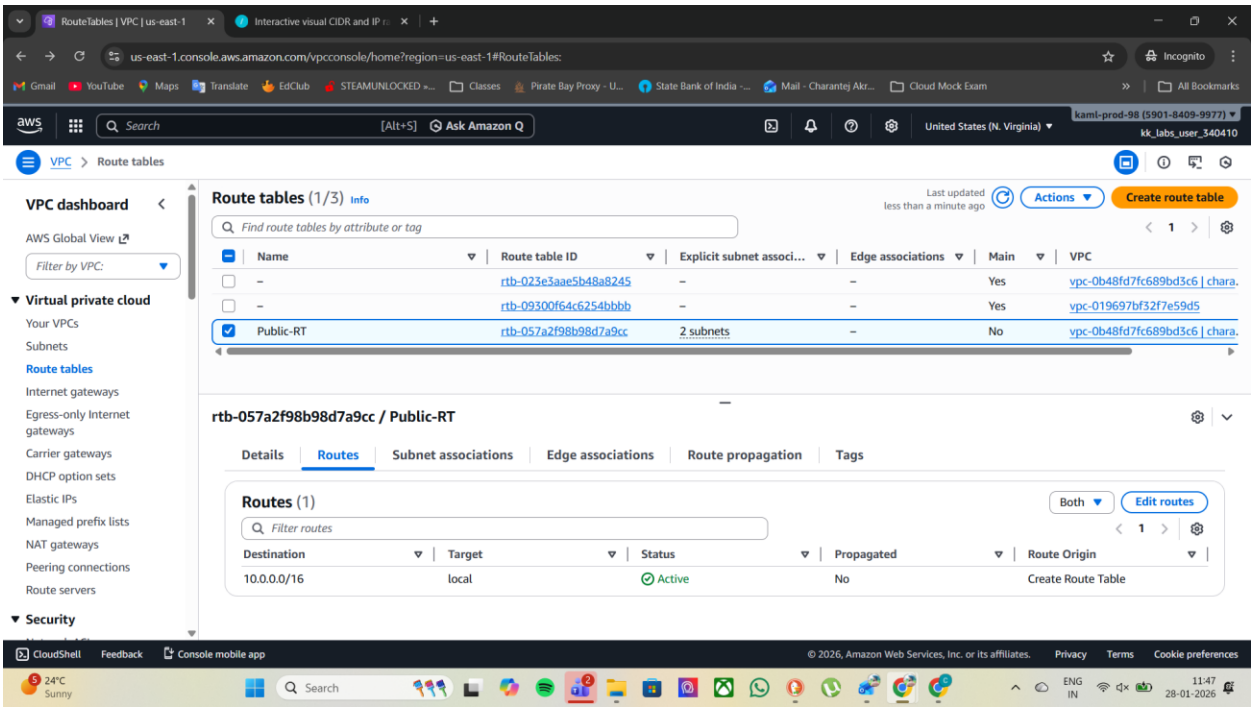
- **Admin subnet → Public-RT**
- **Edge subnet → Public-RT**
- **Web, App, Platform, Shared → Private-RT**

Validation Rule

- No subnet uses the **main route table unintentionally**



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Actions
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Main
VPC
– rtb-023e3aae5b48a8245 – – Yes vpc-0b48fd7fc689bd3c6 | chara.
– rtb-09300f64c6254bbbb – – Yes vpc-019697bf32f7e59d5
Public-RT rtb-057a2f98b98d7a9cc 2 subnets – No vpc-0b48fd7fc689bd3c6 | chara.
rtb-057a2f98b98d7a9cc / Public-RT
Details Routes Subnet associations Edge associations Route propagation Tags
Routes (1)
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Target
Status
Propagated
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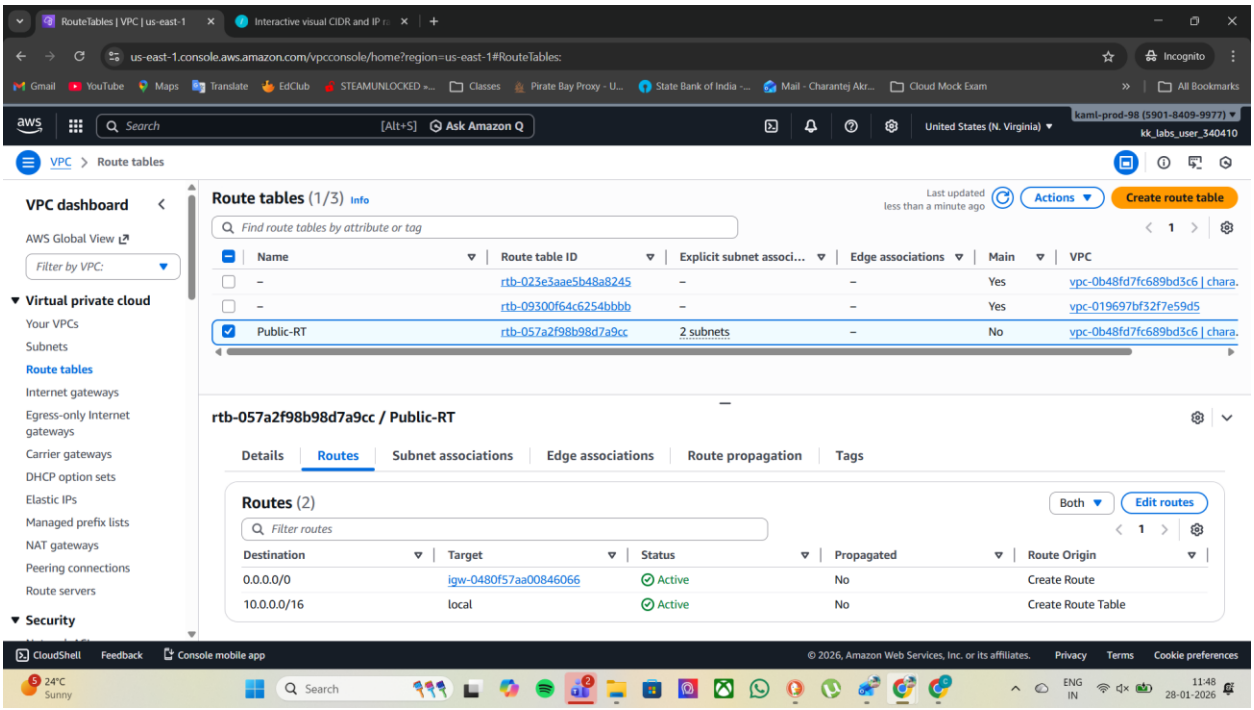
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Subnets
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VPC
– rtb-023e3aae5b48a8245 – – Yes vpc-0b48fd7fc689bd3c6 | chara.
– rtb-09300f64c6254bbbb – – Yes vpc-019697bf32f7e59d5
Public-RT rtb-057a2f98b98d7a9cc 2 subnets – No vpc-0b48fd7fc689bd3c6 | chara.
rtb-057a2f98b98d7a9cc / Public-RT
Details Routes Subnet associations Edge associations Route propagation Tags
Routes (2)
Both
Edit routes
Filter routes
Destination
Target
Status
Propagated
Route Origin
0.0.0.0/0 igw-0480f57aa00846066 Active No Create Route
10.0.0.0/16 local Active No Create Route Table
CloudShell Feedback Console mobile app
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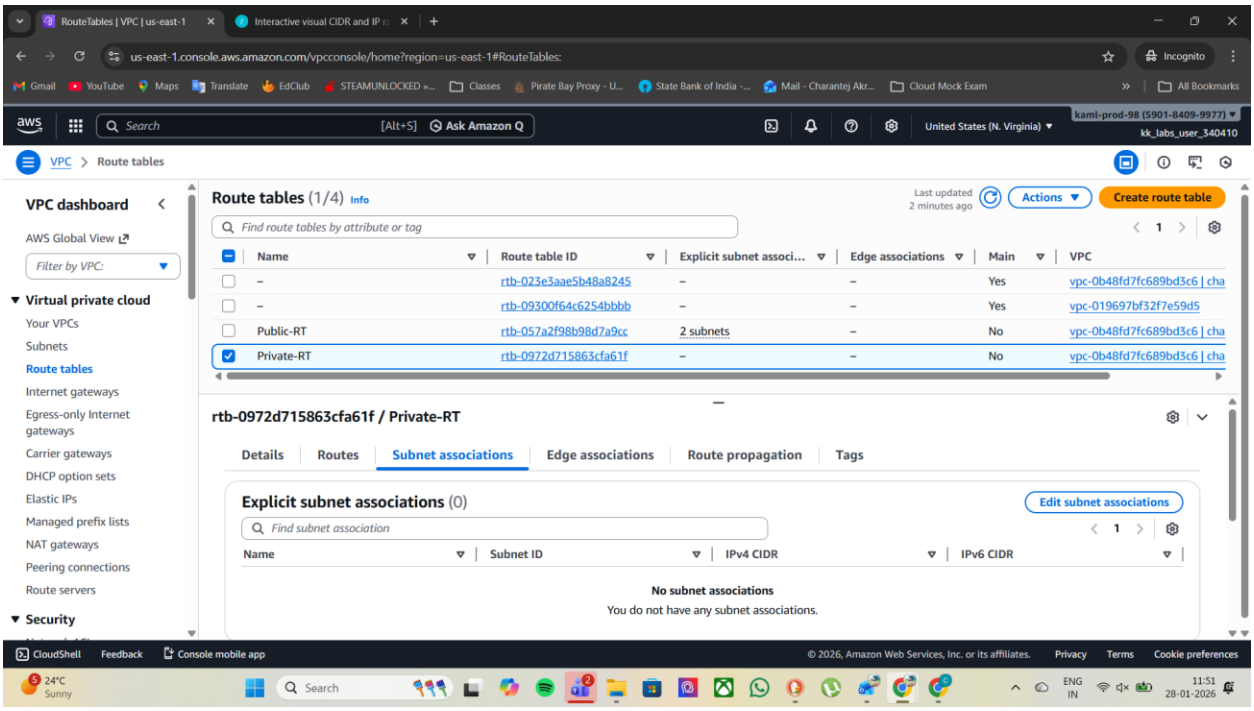
RouteTables | VPC | us-east-1
Interactive visual CIDR and IP
us-east-1.console.aws.amazon.com/vpcconsole/home?region=us-east-1#RouteTables:
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VPC > Route tables
VPC dashboard
AWS Global View
Filter by VPC:
Virtual private cloud
Your VPCs
Subnets
Route tables
Internet gateways
Egress-only Internet gateways
Carrier gateways
DHCP option sets
Elastic IPs
Managed prefix lists
NAT gateways
Peering connections
Route servers
Security
Route tables (1/4) Info
Last updated 2 minutes ago
Actions
Create route table
Find route tables by attribute or tag
Name
Route table ID
Explicit subnet associ...
Edge associations
Main
VPC
rtb-023e3aae5b48a8245
rtb-09300f64c6254bbbb
Public-RT
rtb-057a2f98b98d7a9cc
2 subnets
Private-RT
rtb-0972d715863cfa61f
rtb-0972d715863cfa61f / Private-RT
Details
Routes
Subnet associations
Edge associations
Route propagation
Tags
Explicit subnet associations (0)
Edit subnet associations
Find subnet association
Subnet ID
IPv4 CIDR
IPv6 CIDR
No subnet associations
You do not have any subnet associations.
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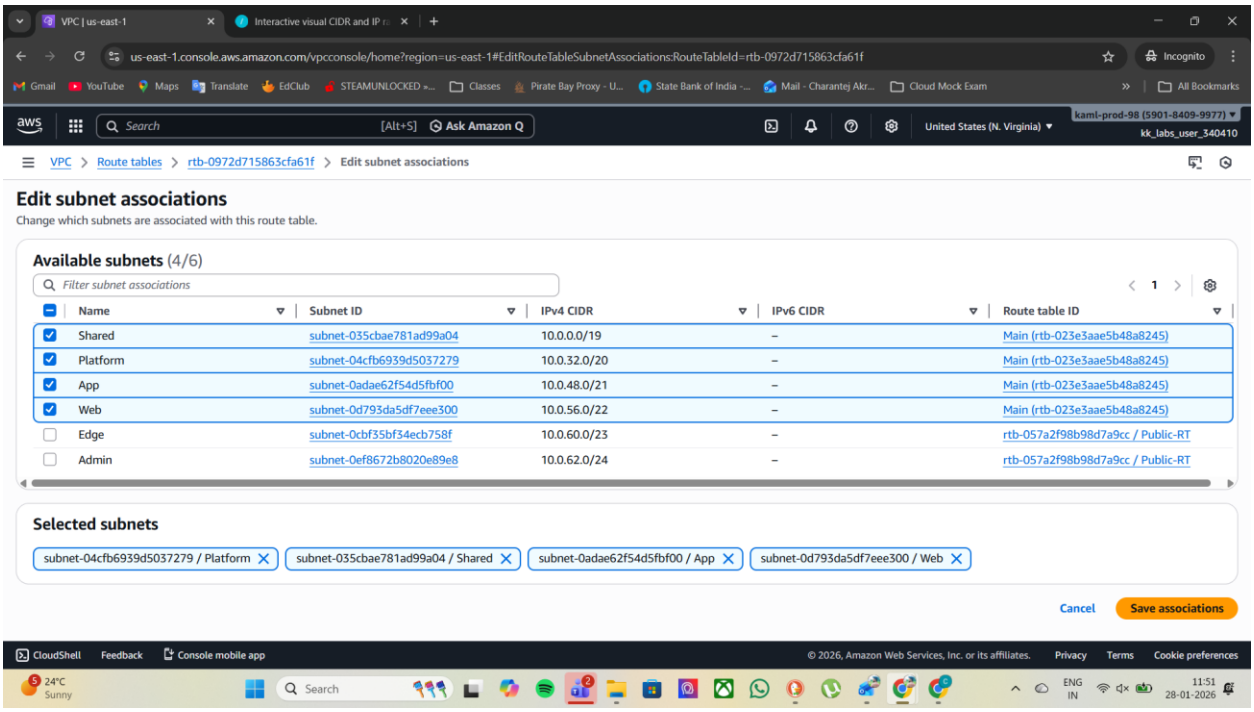
VPC | us-east-1
Interactive visual CIDR and IP
us-east-1.console.aws.amazon.com/vpcconsole/home?region=us-east-1#EditRouteTableSubnetAssociations:RouteTableId=rtb-0972d715863cfa61f
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kk_labs_user_340410
VPC > Route tables > rtb-0972d715863cfa61f > Edit subnet associations
Edit subnet associations
Change which subnets are associated with this route table.
Available subnets (4/6)
Filter subnet associations
Name
Subnet ID
IPv4 CIDR
IPv6 CIDR
Route table ID
Shared
subnet-035cbae781ad99a04
10.0.0.0/19
Main (rtb-023e3aae5b48a8245)
Platform
subnet-04cfb6939d5037279
10.0.32.0/20
App
subnet-0adae62f54d5fbf00
10.0.48.0/21
Web
subnet-0d793da5df7eee300
10.0.56.0/22
Edge
subnet-0cbf35bf34ecb758f
10.0.60.0/23
rtb-057a2f98b98d7a9cc / Public-RT
Admin
subnet-0ef8672b8020e89e8
10.0.62.0/24
Selected subnets
subnet-04cfb6939d5037279 / Platform
subnet-035cbae781ad99a04 / Shared
subnet-0adae62f54d5fbf00 / App
subnet-0d793da5df7eee300 / Web
Cancel
Save associations
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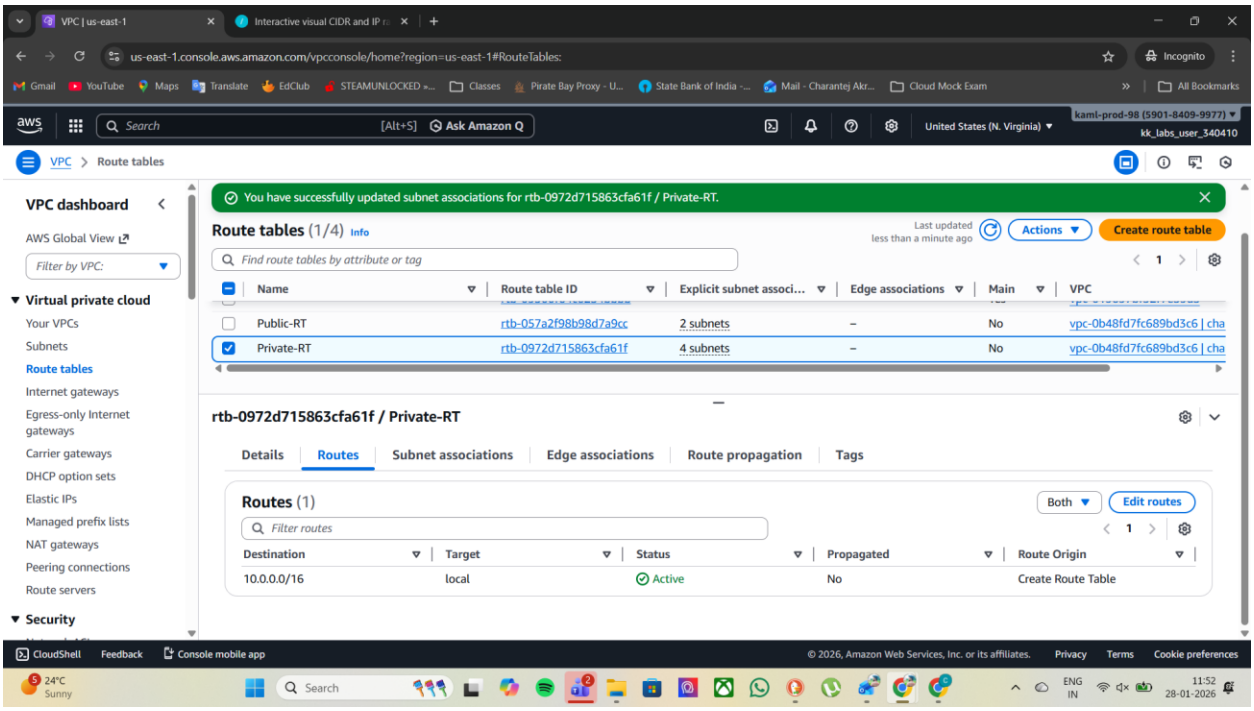
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VPC > Route tables
VPC dashboard
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Filter by VPC:
Virtual private cloud
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Subnets
Route tables
Internet gateways
Egress-only Internet gateways
Carrier gateways
DHCP option sets
Elastic IPs
Managed prefix lists
NAT gateways
Peering connections
Route servers
Security
You have successfully updated subnet associations for rtb-0972d715863cfa61f / Private-RT.
Route tables (1/4) Info
Last updated less than a minute ago
Actions
Create route table
Find route tables by attribute or tag
Name
Route table ID
Explicit subnet associ...
Edge associations
Main
VPC
Public-RT
rtb-057a2f98b98d7a9cc
2 subnets
–
No
vpc-0b48fd7fc689bd3c6 | cha
Private-RT
rtb-0972d715863cfa61f
4 subnets
–
No
vpc-0b48fd7fc689bd3c6 | cha
rtb-0972d715863cfa61f / Private-RT
Details
Routes
Subnet associations
Edge associations
Route propagation
Tags
Routes (1)
Both
Edit routes
Filter routes
Destination
Target
Status
Propagated
Route Origin
10.0.0.0/16
local
Active
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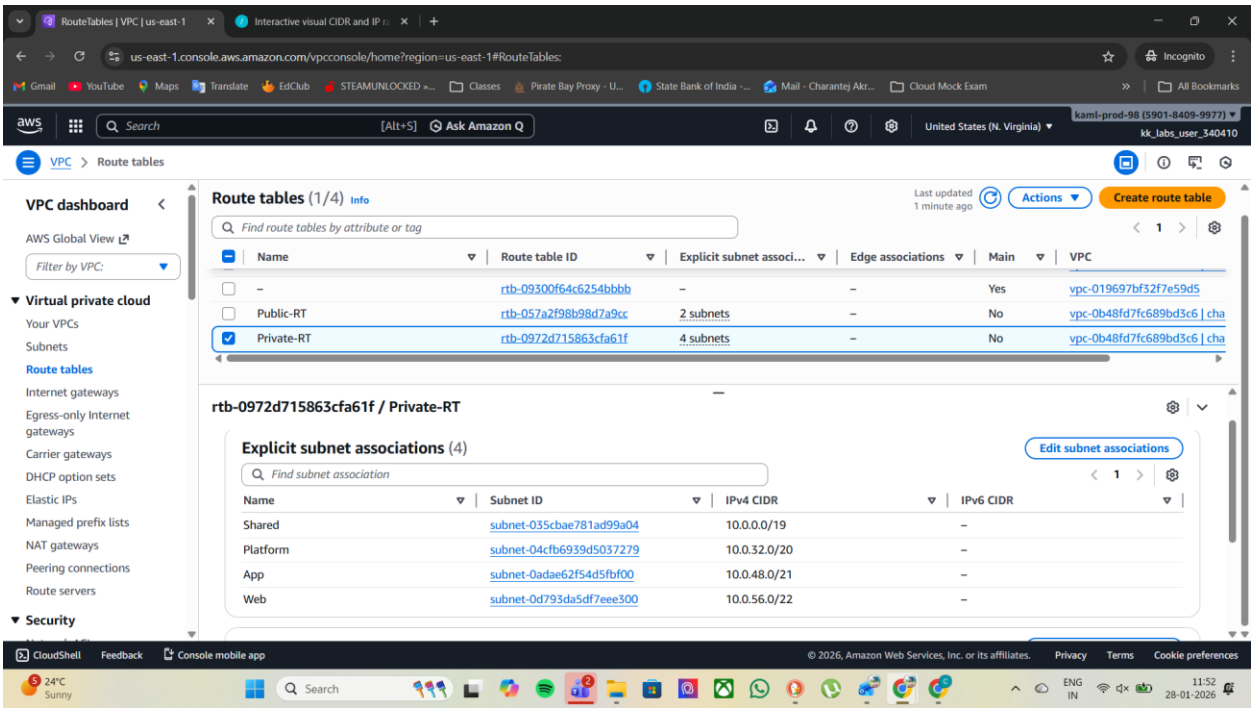
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NAT gateways
Peering connections
Route servers
Security
Route tables (1/4) Info
Last updated 1 minute ago
Actions
Create route table
Find route tables by attribute or tag
Name
Route table ID
Explicit subnet associ...
Edge associations
Main
VPC
–
rtb-09300f64c6254bbbb
–
–
Yes
vpc-019697bf32f7e59d5
Public-RT
rtb-057a2f98b98d7a9cc
2 subnets
–
No
vpc-0b48fd7fc689bd3c6 | cha
Private-RT
rtb-0972d715863cfa61f
4 subnets
–
No
vpc-0b48fd7fc689bd3c6 | cha
rtb-0972d715863cfa61f / Private-RT
Explicit subnet associations (4)
Edit subnet associations
Find subnet association
Name
Subnet ID
IPv4 CIDR
IPv6 CIDR
Shared
subnet-035cbae781ad99a04
10.0.0.0/19
–
Platform
subnet-04cfb6939d5037279
10.0.32.0/20
–
App
subnet-0adae62f54d5fbf00
10.0.48.0/21
–
Web
subnet-0d793da5df7eee300
10.0.56.0/22
–
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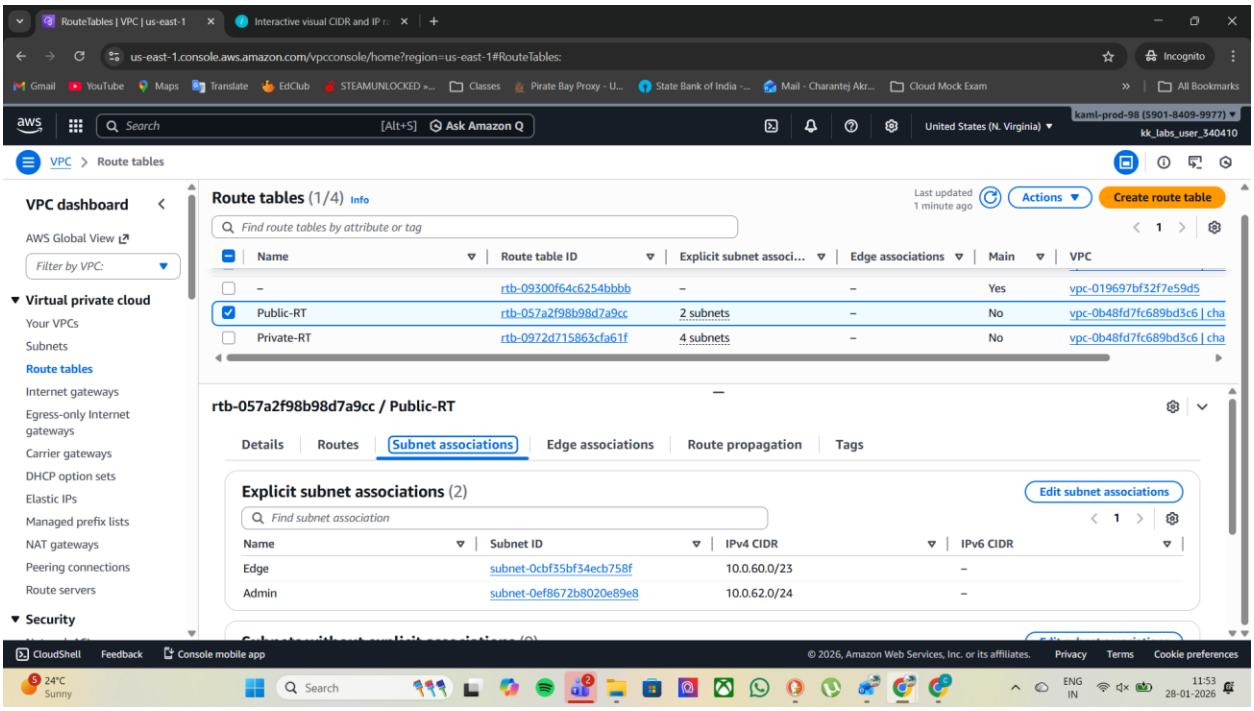
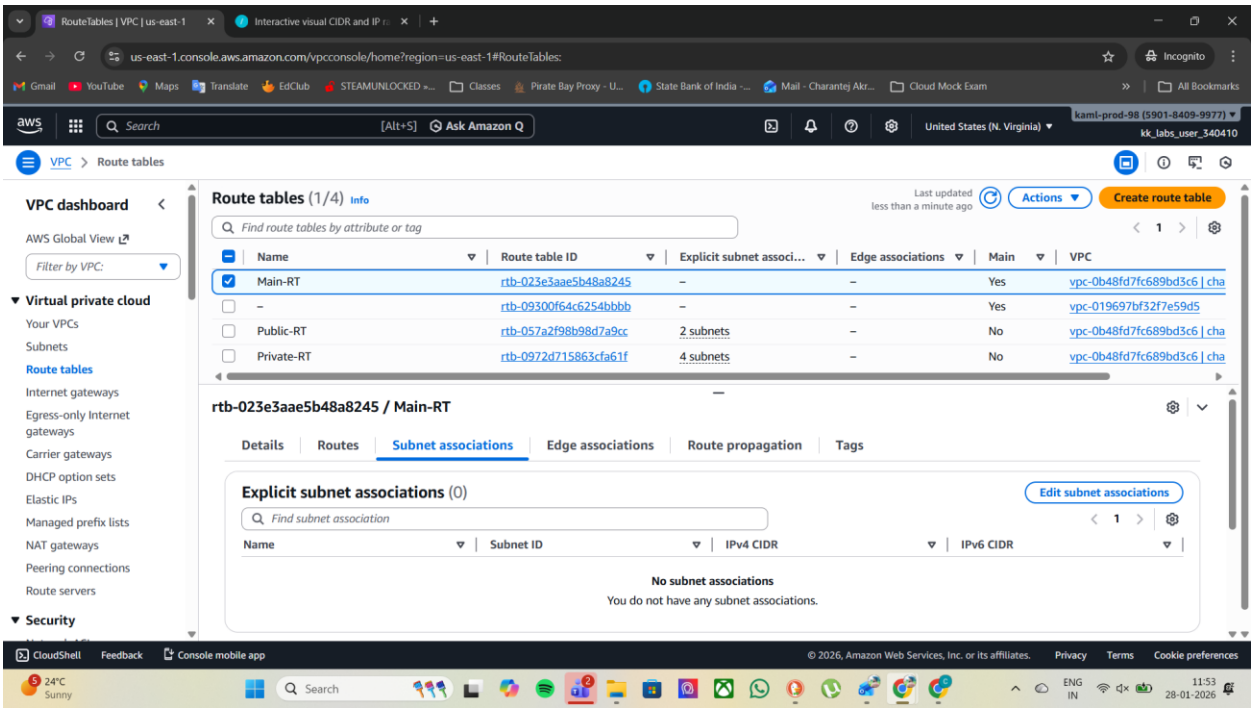




8. Security-Driven Network Behavior

Internet Access Rules

- Only **Admin & Edge** subnets have a default route to IGW

- Private subnets have **no path to the internet**

Internal Communication

- All subnets communicate via **implicit local VPC routing**
- No additional routes required

This design enforces **network-level security by default**.

9. Validation & Testing

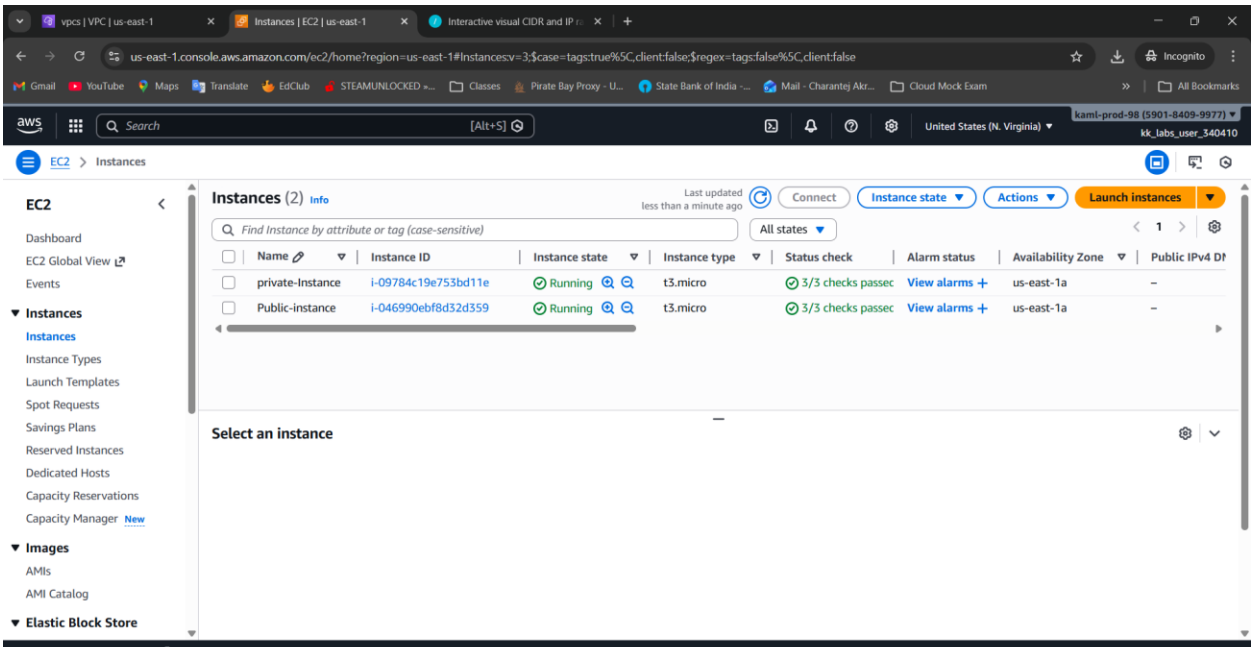
9.1 Public Subnet Test

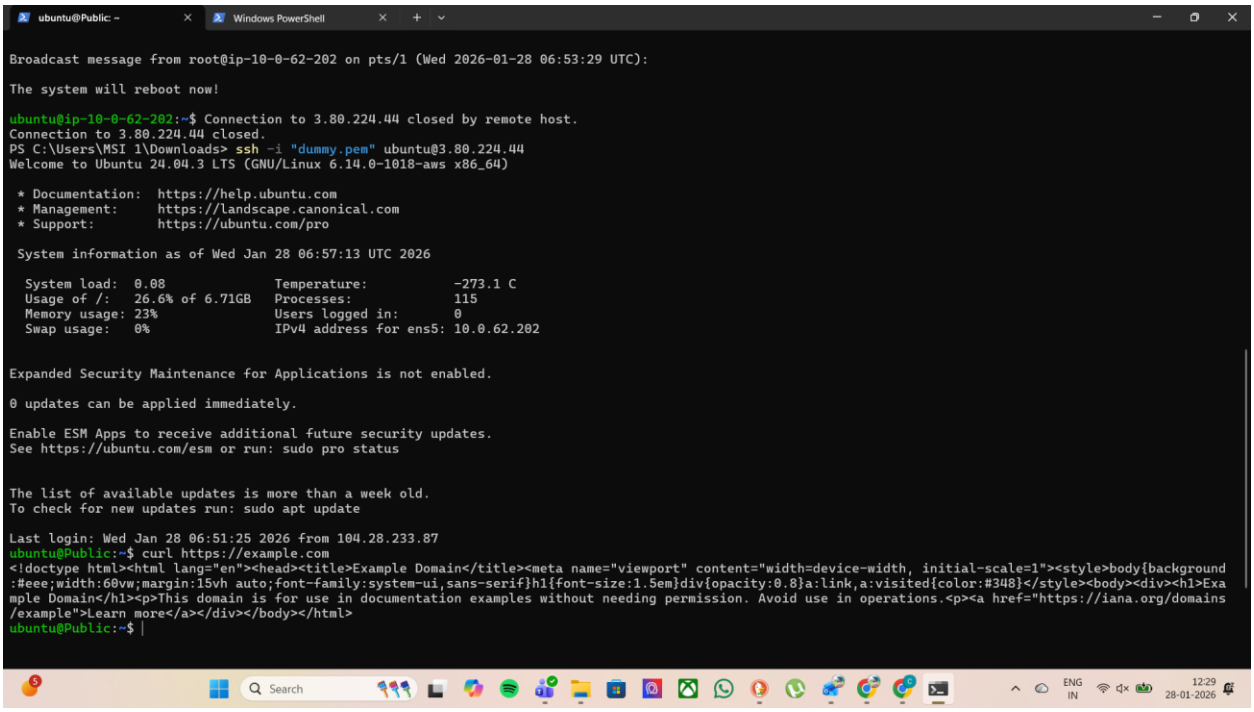
Expected Behavior:

- EC2 instance in Admin or Edge subnet
- Can reach the internet (ping, curl, yum update)

Reason:

- Route to IGW exists
- Public IP assigned





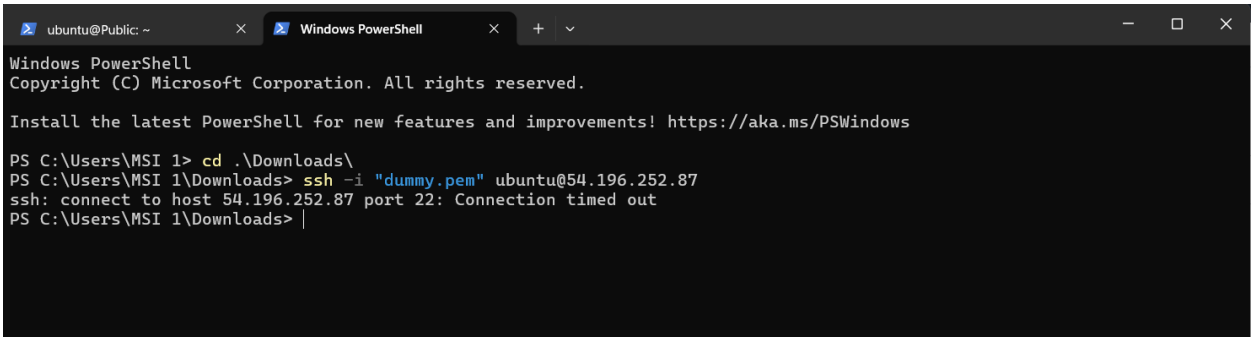
9.2 Private Subnet Test

Expected Behavior:

- EC2 instance in Web/App/Platform/Shared
- Cannot access the internet

Reason:

- No 0.0.0.0/0 route
- IGW not reachable



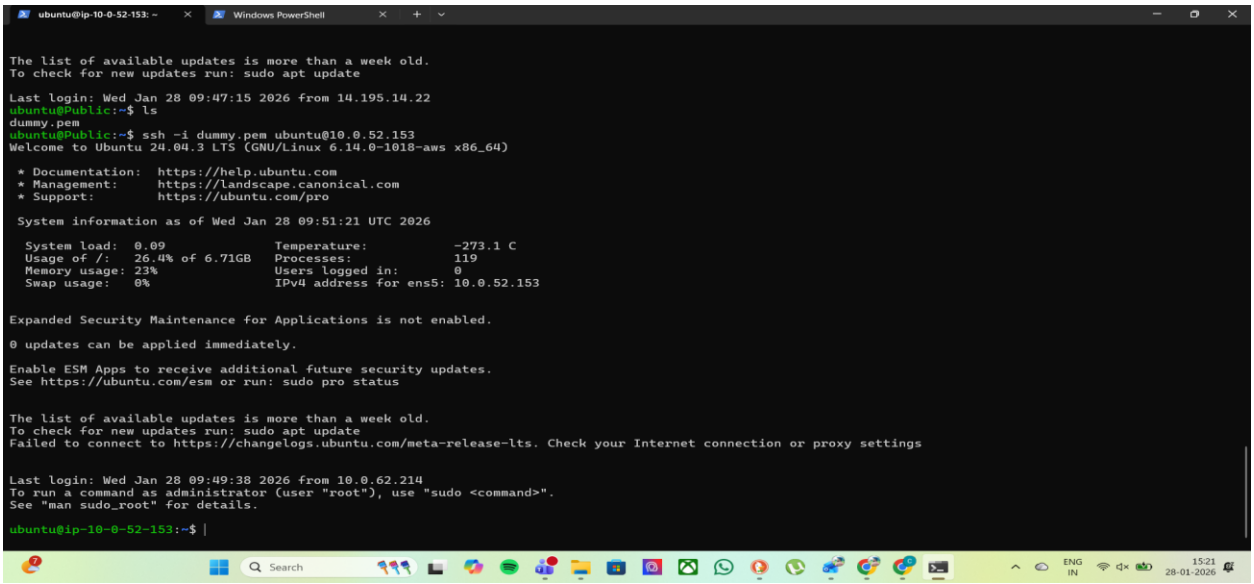
9.3 Internal Communication Test

Expected Behavior:

- Instances across subnets can communicate internally

Reason:

- Local VPC route automatically present



```
ubuntu@ip-10-0-52-153:~$ ls
ubuntu@ip-10-0-52-153:~$ sudo hostnamectl set-hostname Private
ubuntu@ip-10-0-52-153:~$ sudo init 6

Broadcast message from root@ip-10-0-52-153 on pts/1 (Wed 2026-01-28 09:51:54 UTC):

The system will reboot now!

ubuntu@ip-10-0-52-153:~$ Connection to 10.0.52.153 closed by remote host.
Connection to 10.0.52.153 closed.
```

10. Failure & Audit Scenarios

10.1 IGW Detached

- All internet access stops immediately
- No impact on internal communication

10.2 Private Subnet Associated with Public-RT

- Subnet becomes internet-reachable
- Violates security model
- Major audit finding

10.3 Incorrect /19 Starting Address

- CIDR misalignment
- Overlapping subnets
- AWS rejects configuration or routing breaks

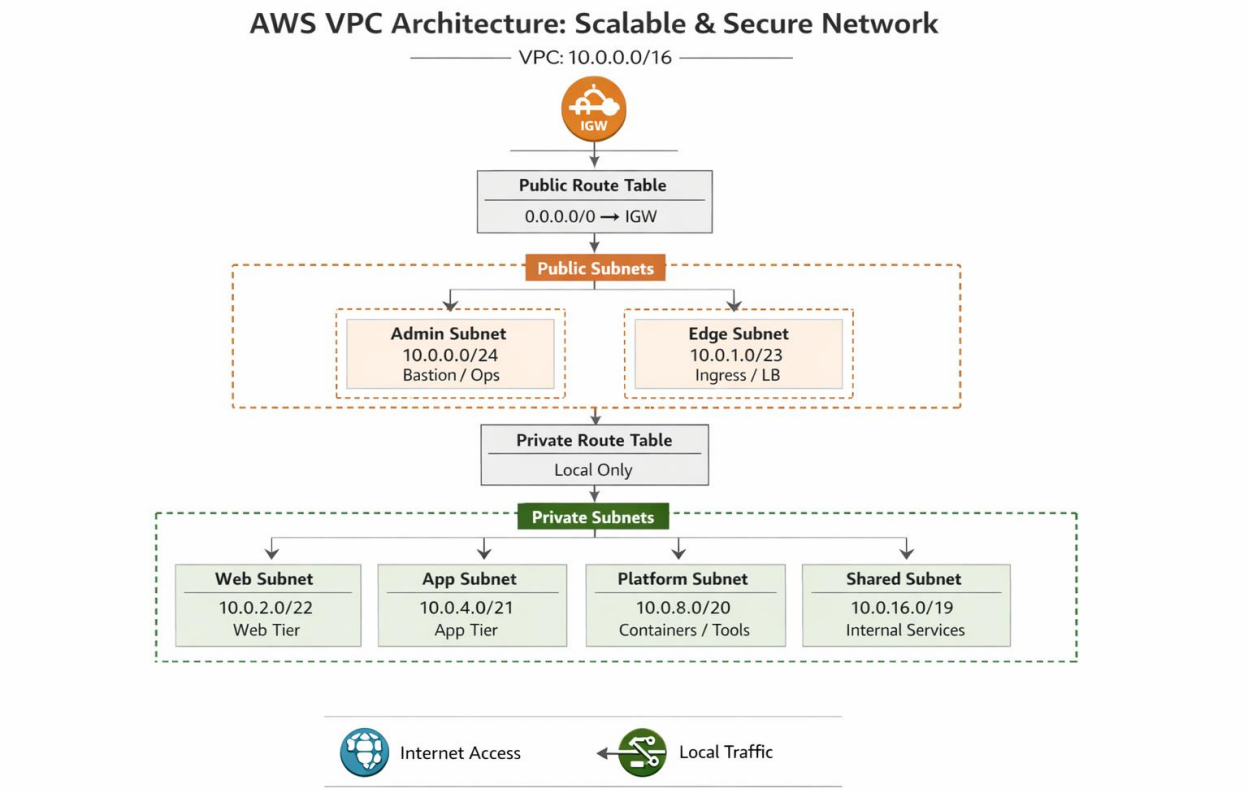
10.4 Future Growth Support

- Large unused CIDR space available
- New tiers can be added safely
- No subnet resizing required

11. Architecture Diagram

📐 Logical Network Diagram

- VPC boundary
- All 6 subnets
- Public vs Private route tables
- Internet Gateway



12. Conclusion

This VPC design:

- Meets enterprise scalability requirements
- Enforces security through routing
- Is simple to audit and reason about
- Supports long-term growth without redesign

✅ Production-ready ✅ Audit-friendly ✅ Scalable by design