GAME ARCHITECTURE MMO SHOOTER GAME

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Objective

Provision backend architecture for an MMO Shooter Game

Assumptions

- 40 million players at peak time
- Global provisioning
- 2 patch updates in a week
- Front end and game logic is handled by the client.
- No budget constraints

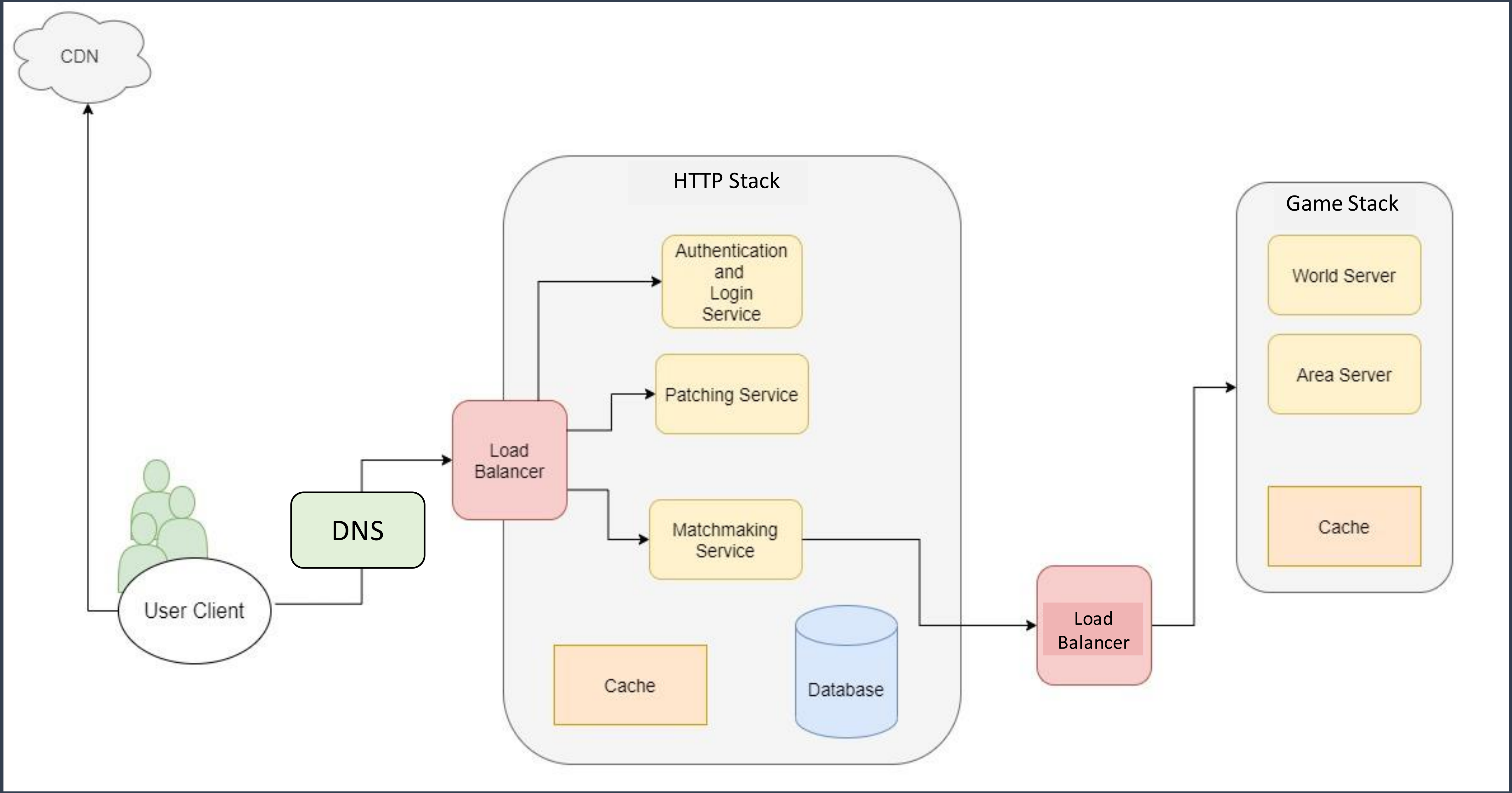
Scope

- Implementation of backend architecture ensuring low-latency game play.
- Cost estimation is out of scope
- Latency quantification is out of scope

Approach/methodology

- Game servers are located near players
- Everything else is handled by HTTP API
- Data replication is avoided, cache is used.
- No one really plays everywhere
- time critical (game play)and non-time critical (HTTP, pre-gameplay)
- Game is hosted on AWS

Bird's eye view : Block Diagram



Basic logic

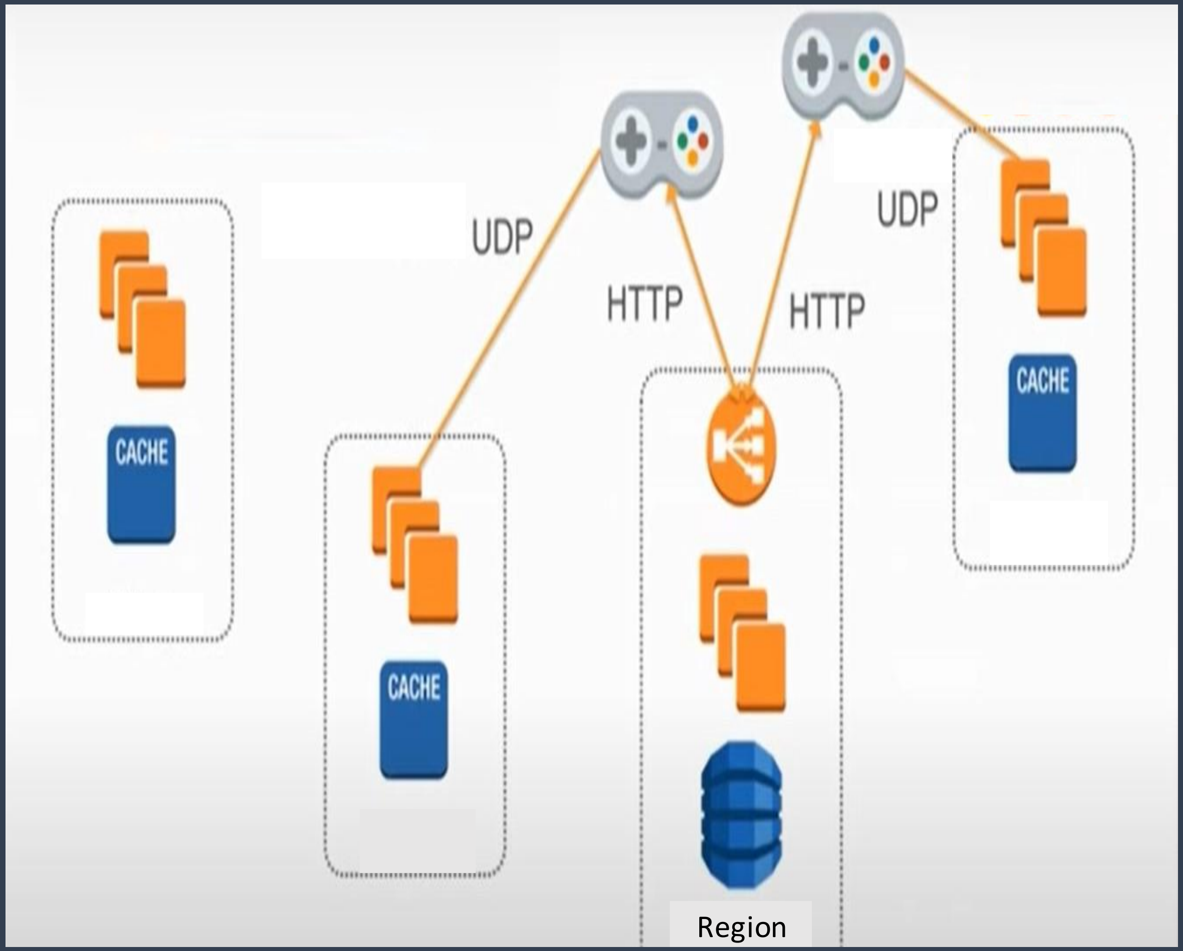
The loosely coupled stacks can communicate with each other, but are least dependent on each other.

HTTP stack handles pre-gameplay -

- Authentication
- Patching and updates
- Matchmaking

Game stack handles game play and all games stacks are connected to the HTTP stack.

- The centralized HTTP stack has dedicated database with data of all game stacks.
- Pre-gameplay : HTTP API calls. Game Play : UDP & RUDP (faster than TCP)



Game Flow

Log in via HTTP API

Download game assets

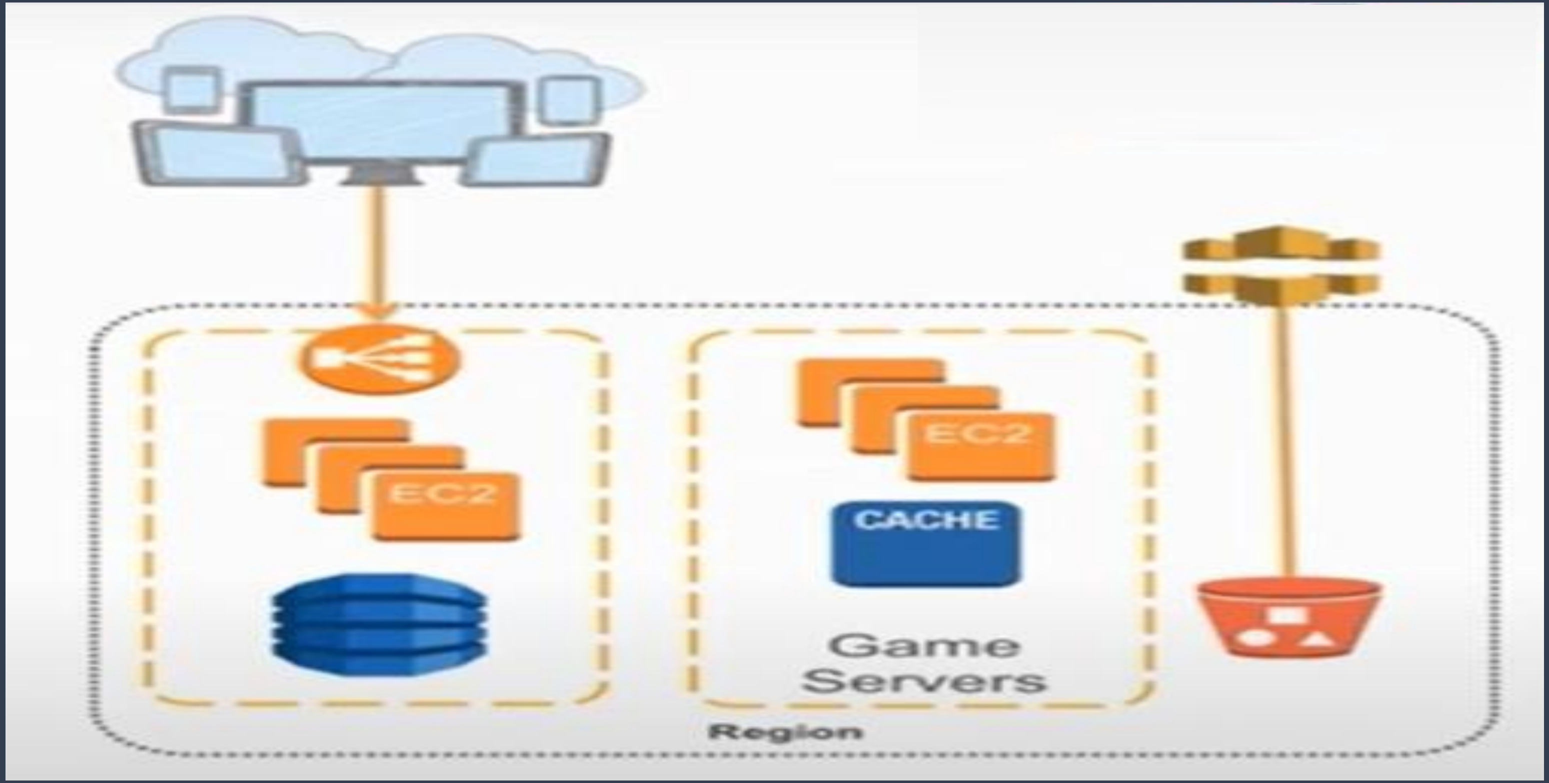
Matchmaking to server

Connect to server

Game begins

Game ends

Write via HTTP



HTTP Stack

Authentication and Authorization

1

- Handled using AWS Cognito(IAM service)
  - Authentication – Integrate with social media logins
  - Authorization –different levels(User, Group, Role, Policy)

Patching and Updating

2

- Handled by AWS S3(storage)+Cloudfront(CDN service)
- Update/Patch is pushed to S3 and distribution is handled by CloudFront(regional and EL Cache)

Matchmaking

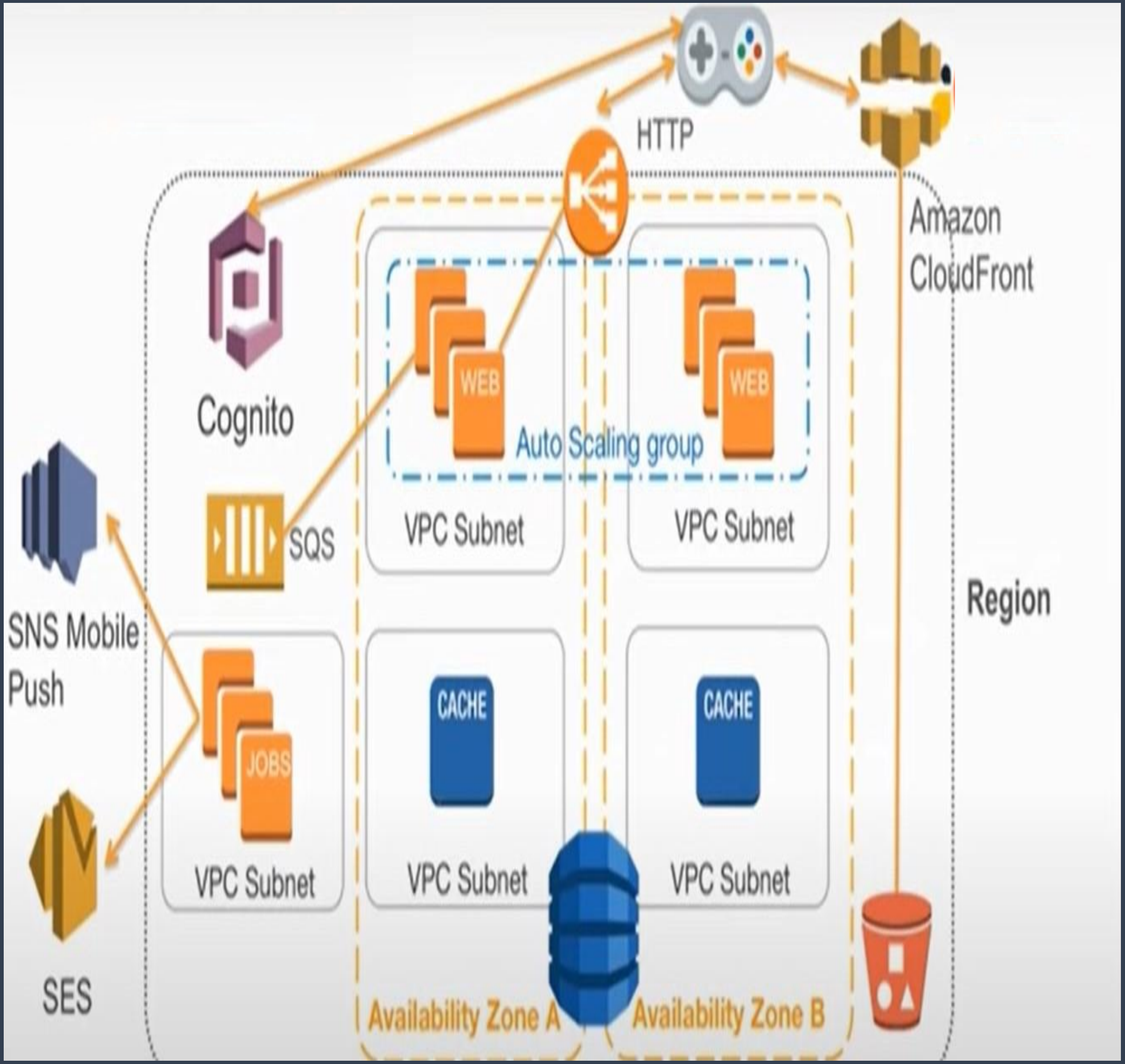
3

- Db has info about active game stacks in that regions
- ELB to decide which game stack is best for the player.

Notifications and Emails

4

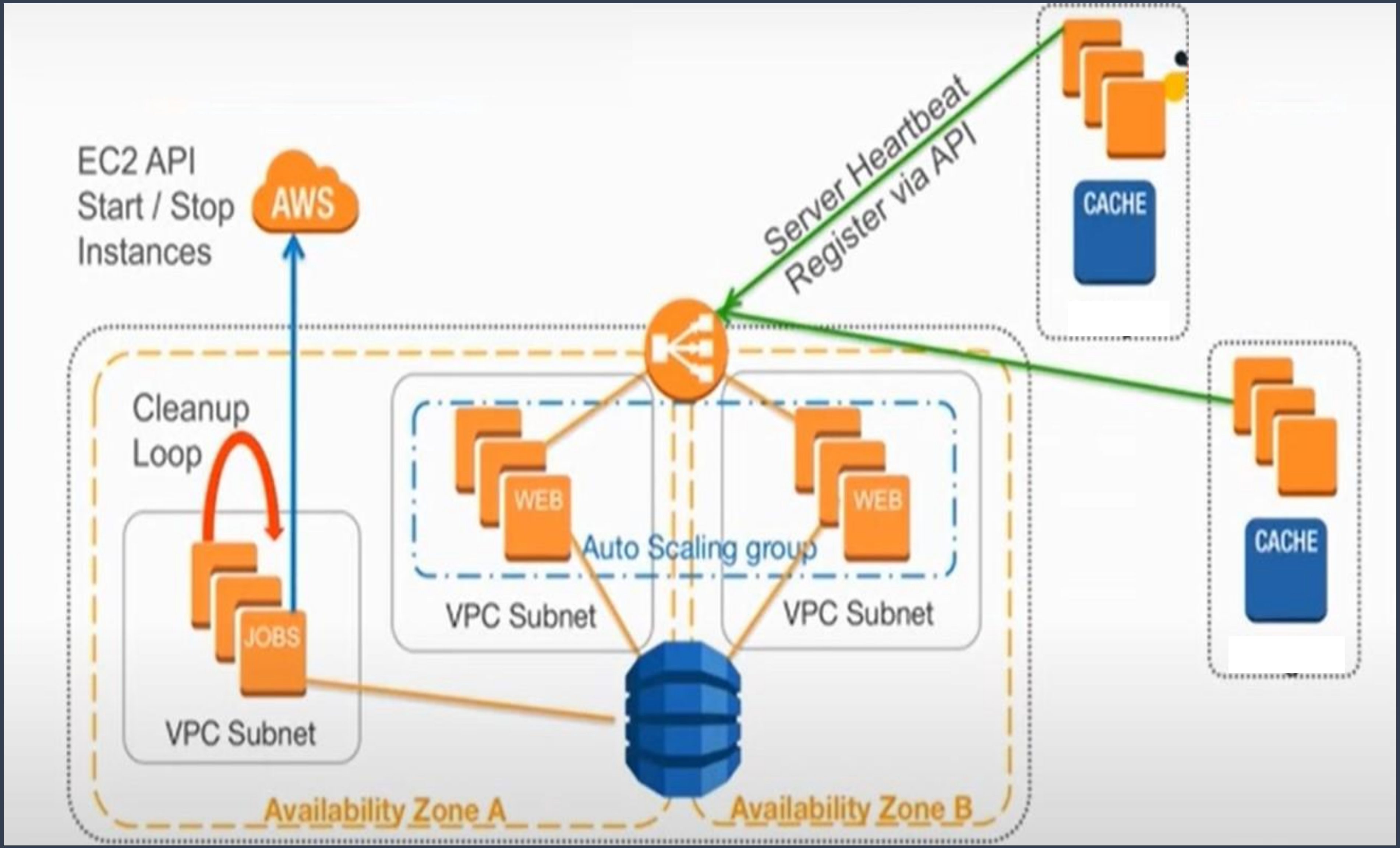
- Push notifications on the device
- For both end users and engineers(ASG, ELB Healthcheck etc)



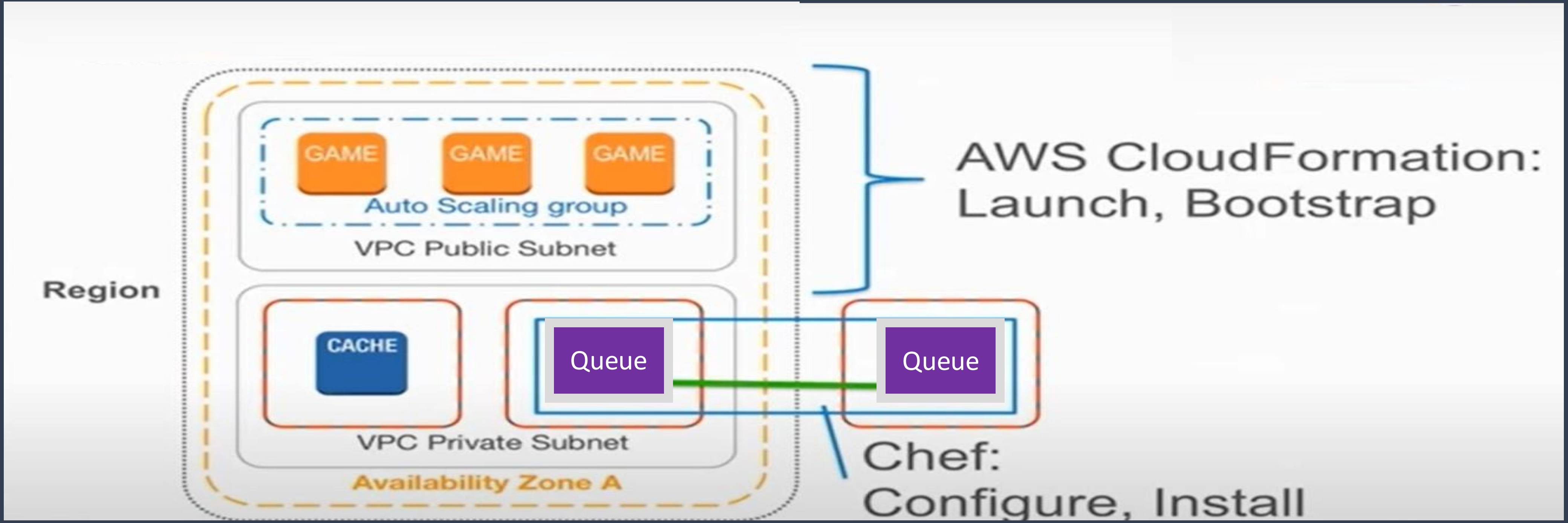
Game Stack Registration

Cleanup loop checks DB at intervals and removes data related to game stacks whose last update is outdated.

Availability handled using heartbeat between Game Stack and HTTP Server



Cloud Formation and Chef



Set of **Infrastructure as Code(IAC)** and automation tool used to configure the entire system of servers

Cloud Formation : describes EC2 instances and the AWS resources and creates a **JSON template** out of them

These templates can then be used to **replicate the resources** in other regions or even same region

Chef runs a bunch of scripts having instructions of software and its configuration/installation specification

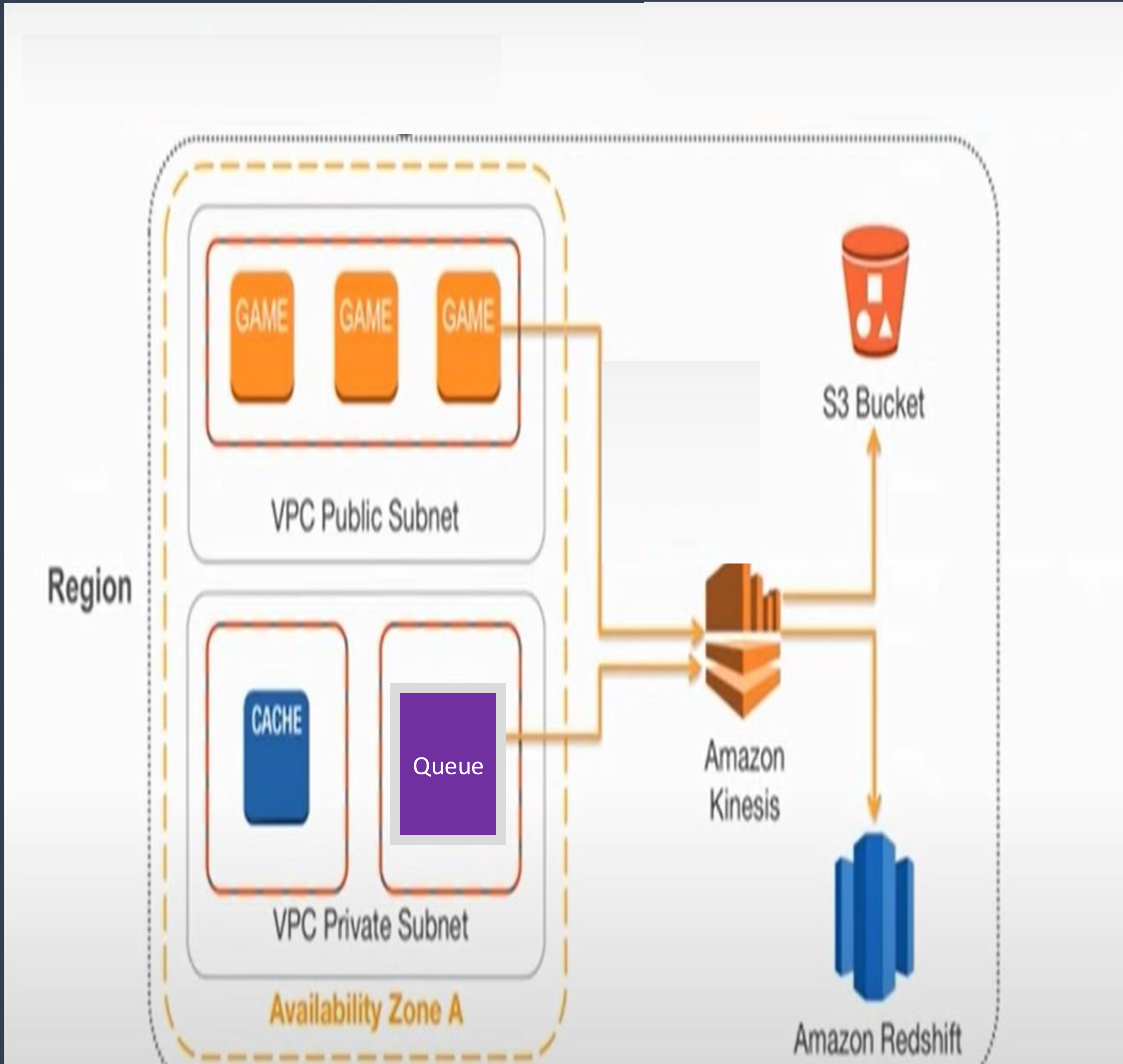
Logs and Analytics

Kinesis Data Firehose sends data to S3 , Amazon Redshift, and enables real-time data analysis on the streaming data.

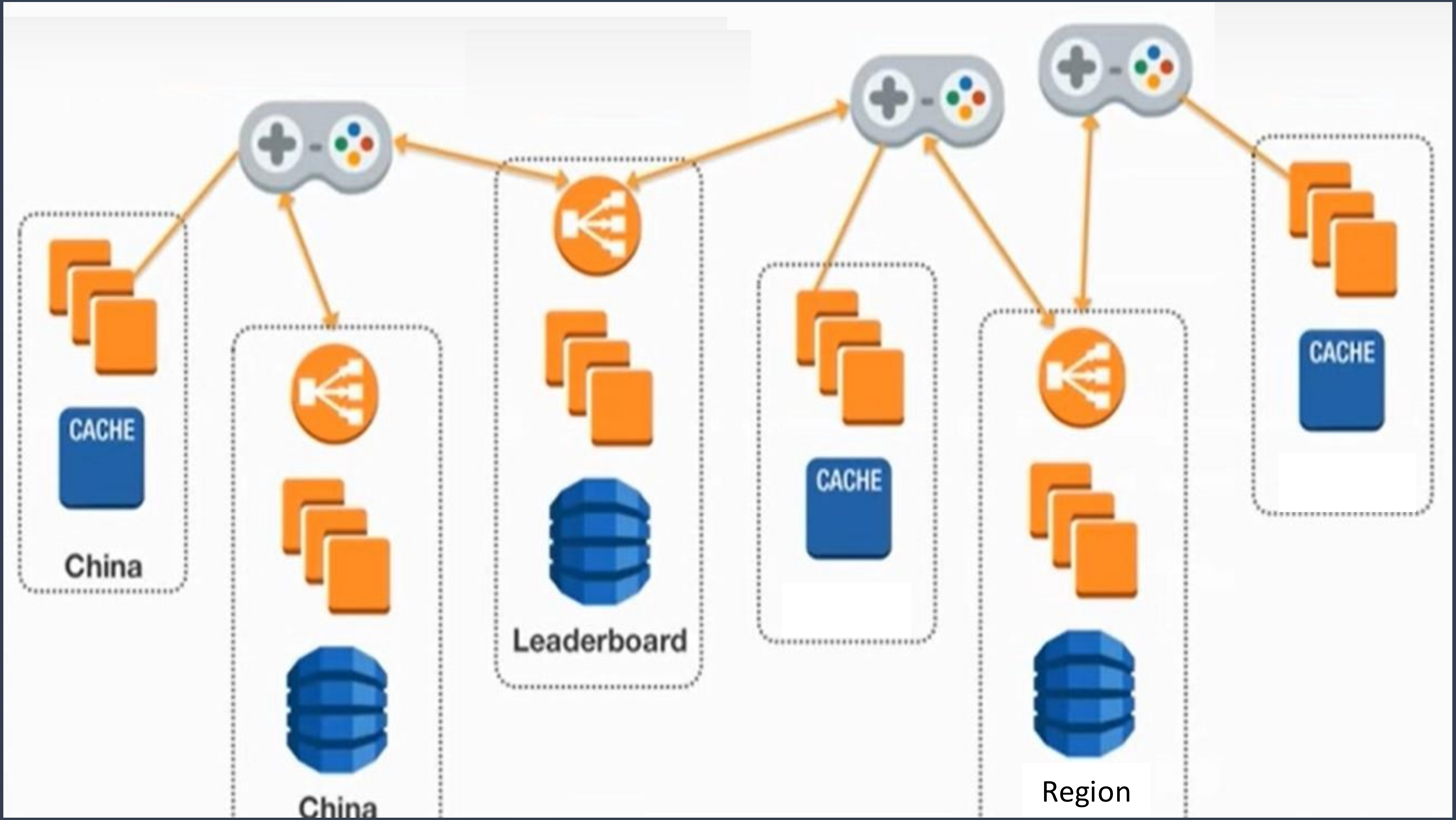
APIs can be used to auto-scale the capacity. Data can also be transferred from DynamoDB for analysis.

Amazon redshift is optimized for data sets ranging from a few hundred gigabytes to a petabyte

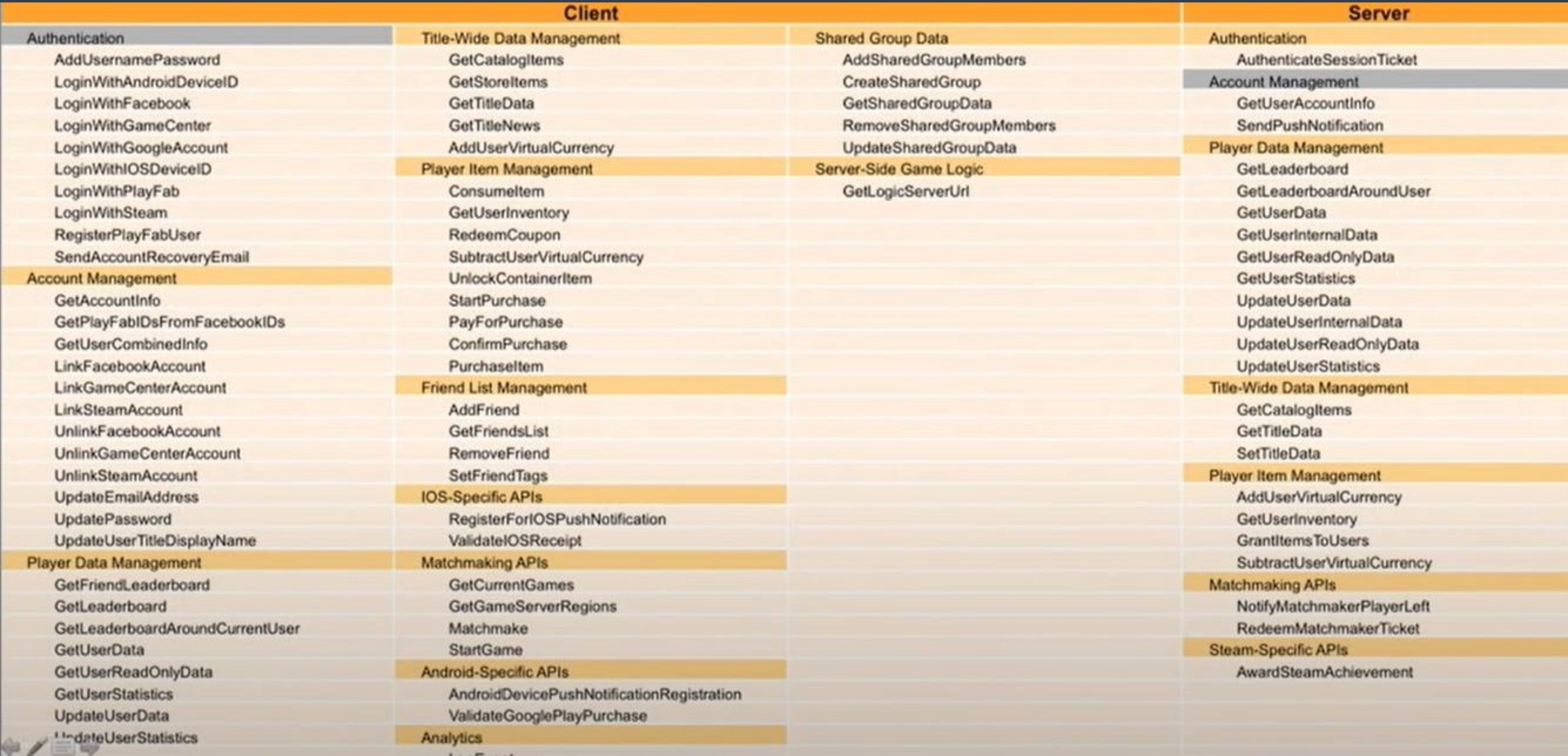
Amazon Redshift delivers fast query and I/O performance for virtually any size dataset by using columnar storage technology while parallelizing and distributing queries across multiple nodes



Special Cases



Possible HTTP Requests



Client

- Authentication
  - AddUsernamePassword
  - LoginWithAndroidDeviceID
  - LoginWithFacebook
  - LoginWithGameCenter
  - LoginWithGoogleAccount
  - LoginWithIOSDeviceID
  - LoginWithPlayFab
  - LoginWithSteam
  - RegisterPlayFabUser
  - SendAccountRecoveryEmail
- Account Management
  - GetAccountInfo
  - GetPlayFabIDsFromFacebookIDs
  - GetUserCombinedInfo
  - LinkFacebookAccount
  - LinkGameCenterAccount
  - LinkSteamAccount
  - UnlinkFacebookAccount
  - UnlinkGameCenterAccount
  - UnlinkSteamAccount
  - UpdateEmailAddress
  - UpdatePassword
  - UpdateUserTitleDisplayName
- Player Data Management
  - GetFriendLeaderboard
  - GetLeaderboard
  - GetLeaderboardAroundCurrentUser
  - GetUserData
  - GetUserReadOnlyData
  - GetUserStatistics
  - UpdateUserData
  - UpdateUserStatistics
- Title-Wide Data Management
  - GetCatalogItems
  - GetStoreItems
  - GetTitleData
  - GetTitleNews
  - AddUserVirtualCurrency
- Player Item Management
  - ConsumeItem
  - GetUserInventory
  - RedeemCoupon
  - SubtractUserVirtualCurrency
  - UnlockContainerItem
  - StartPurchase
  - PayForPurchase
  - ConfirmPurchase
  - PurchaseItem
- Friend List Management
  - AddFriend
  - GetFriendsList
  - RemoveFriend
  - SetFriendTags
- IOS-Specific APIs
  - RegisterForIOSPushNotification
  - ValidateIOSReceipt
- Matchmaking APIs
  - GetCurrentGames
  - GetGameServerRegions
  - Matchmake
  - StartGame
- Android-Specific APIs
  - AndroidDevicePushNotificationRegistration
  - ValidateGooglePlayPurchase
- Analytics
- Shared Group Data
  - AddSharedGroupMembers
  - CreateSharedGroup
  - GetSharedGroupData
  - RemoveSharedGroupMembers
  - UpdateSharedGroupData
- Server-Side Game Logic
  - GetLogicServerUrl

Server

- Authentication
  - AuthenticateSessionTicket
- Account Management
  - GetUserAccountInfo
  - SendPushNotification
- Player Data Management
  - GetLeaderboard
  - GetLeaderboardAroundUser
  - GetUserData
  - GetUserInternalData
  - GetUserReadOnlyData
  - GetUserStatistics
  - UpdateUserData
  - UpdateUserInternalData
  - UpdateUserReadOnlyData
  - UpdateUserStatistics
- Title-Wide Data Management
  - GetCatalogItems
  - GetTitleData
  - SetTitleData
- Player Item Management
  - AddUserVirtualCurrency
  - GetUserInventory
  - GrantItemsToUsers
  - SubtractUserVirtualCurrency
- Matchmaking APIs
  - NotifyMatchmakerPlayerLeft
  - RedeemMatchmakerTicket
- Steam-Specific APIs
  - AwardSteamAchievement

Example of Web API Call

API Request:

```
POST https://3.playfabapi.com/Client/Matchmake
Content-Type: application/json;
X-Authentication: 7BC920BC255F7E60-0-0-5F4
{
  "BuildVersion": "5.01",
  "Region": "USCentral",  "GameMode": "0",
  "LobbyId": "Lobby 32",
  "EnableQueue": false
}
```

Response from Web Services:

```
HTTP/1.1 200 OK
Content-Type: application/json; charset=utf-8
{
  "LobbyID": "Lobby 32",
  "ServerHostname": "192.168.0.1",
  "ServerPort": 7777,
  "Ticket": "e98yf289f248902f4904f0924f9pj",
  "Status": "Waiting",
  "Queue": [
    "User1",
    "User2"
  ]
}
```

Additional Important Points

Choice of Instances

- HTTP Web Servers -- Storage optimized
    - **I3 and I3en** -- They are optimized to deliver tens of thousands of low-latency, random I/O operations per second (IOPS) to applications.
    - Default vCPUs – 2 to 96 RAM – 16 to 768 GB
- Game Servers -- **C5 EC2 instance**
    - Compute bound high performance processor
    - Latest and highly Cost optimized as compared to precursors(C4/C3)
    - Powered by AWS Nitro Systems(hypervisor that provides high bandwidth; great throughput and low latency)
    - vCPU : 2 to 72 RAM 4 to 192 GB Network B/W : upto 25Gbps
    - uses Elastic Network Adapter(ENA) for enhanced networking

Auto Scaling Policy

- Target Tracking Scaling Policy – clearly define the target metric(say CPU utilization) and ASG scales to always stay near it.
- The developers set the maximum, minimum and desired capacity of ASG
- Scale-out and scale-in policies are always decided together and not in isolation
- It is a dynamic policy and can even update maximum and minimum ASG capacities to meet the target
- Best among other options – simple scaling policy, step-up policy, predictive scaling(rarely used)

Health Checks

- EC2 instance 2/2 status check report (status must be “running”)
- ELB’s instance health check report (status must be “in service”)
- Elastic IP is released when an ASG terminates an unhealthy EC2 instance

Note that the health must exclude the warm-up and cool-down period of instances(specified by us)

Scenarios

Player wants to connect to a match

Player wants to play from a different region than he played from last time

What happens when a match instance or a map instance goes down during gameplay?

How are across-the-map shots handled?

Player wants to connect to a match

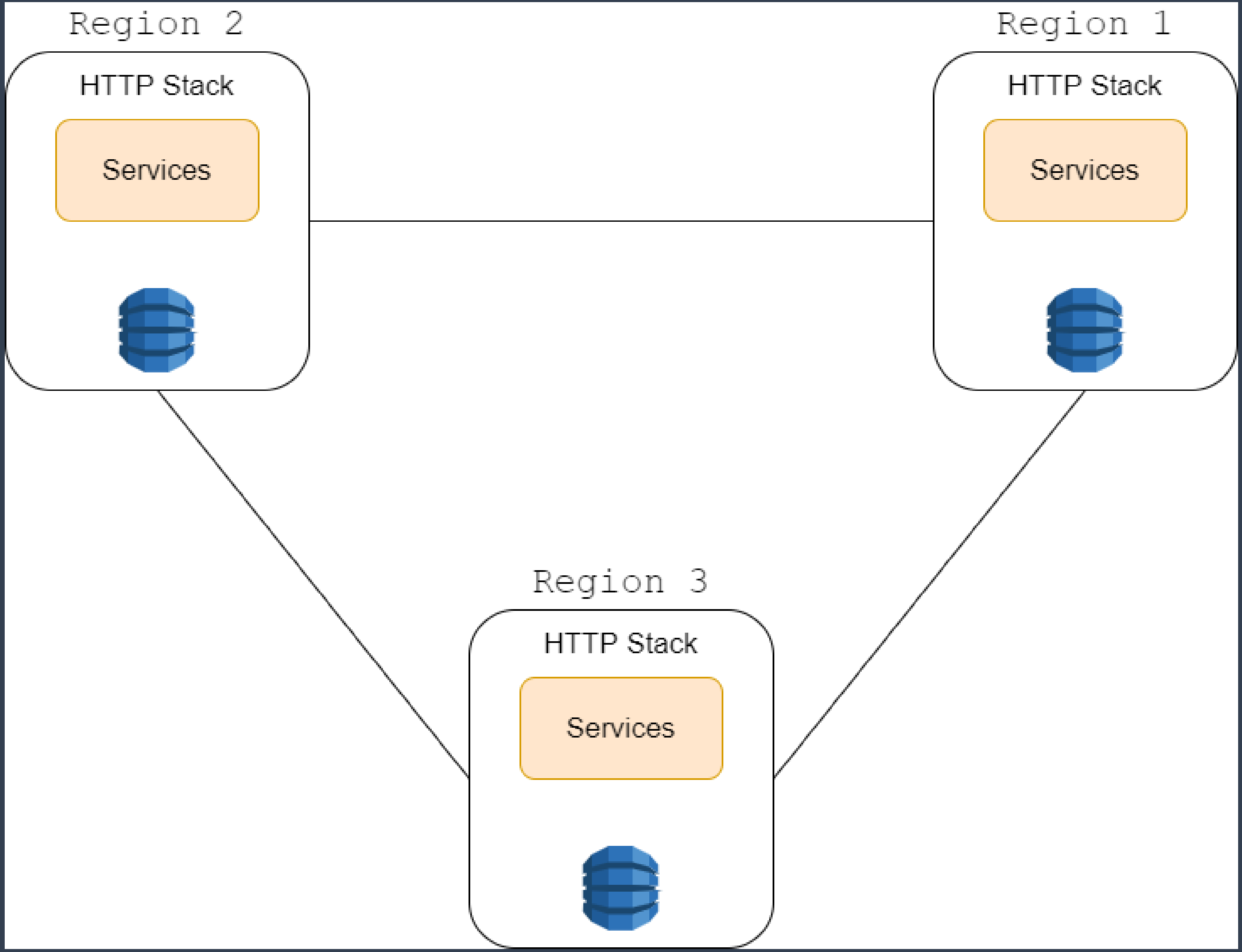
01 Player contacts the matchmaking service and a flag against the player is set stating that the player is ready for matchmaking

02 A matchmake request is sent through the load balancer to an appropriate game stack(nearest server is preferred)

03 The appropriate game stack checks the availability of a match or creates a new match and sends a response with the players match code.

04 The player connects to the match using the code send to him.

Player wants to play from a different region than he played from last time



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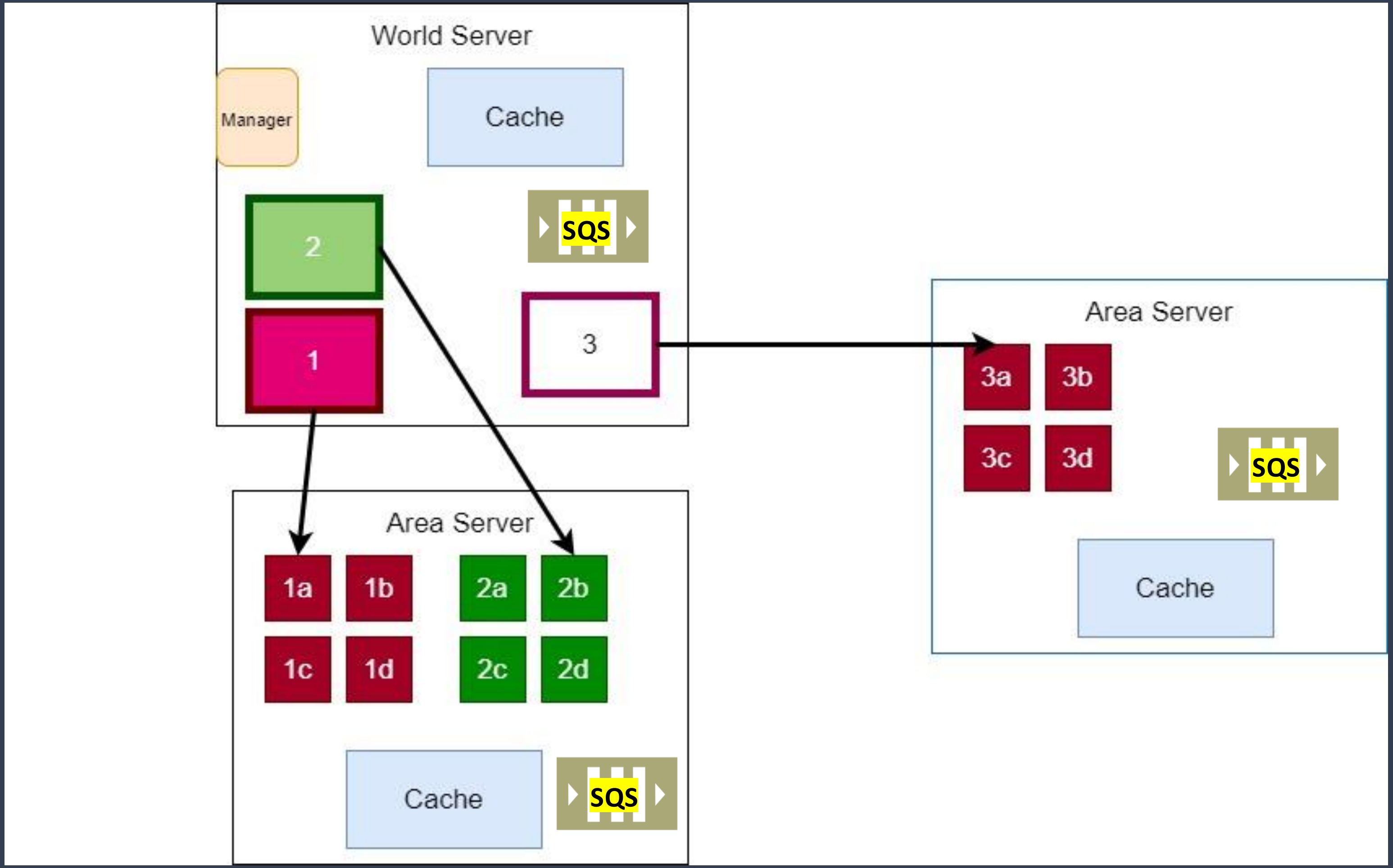
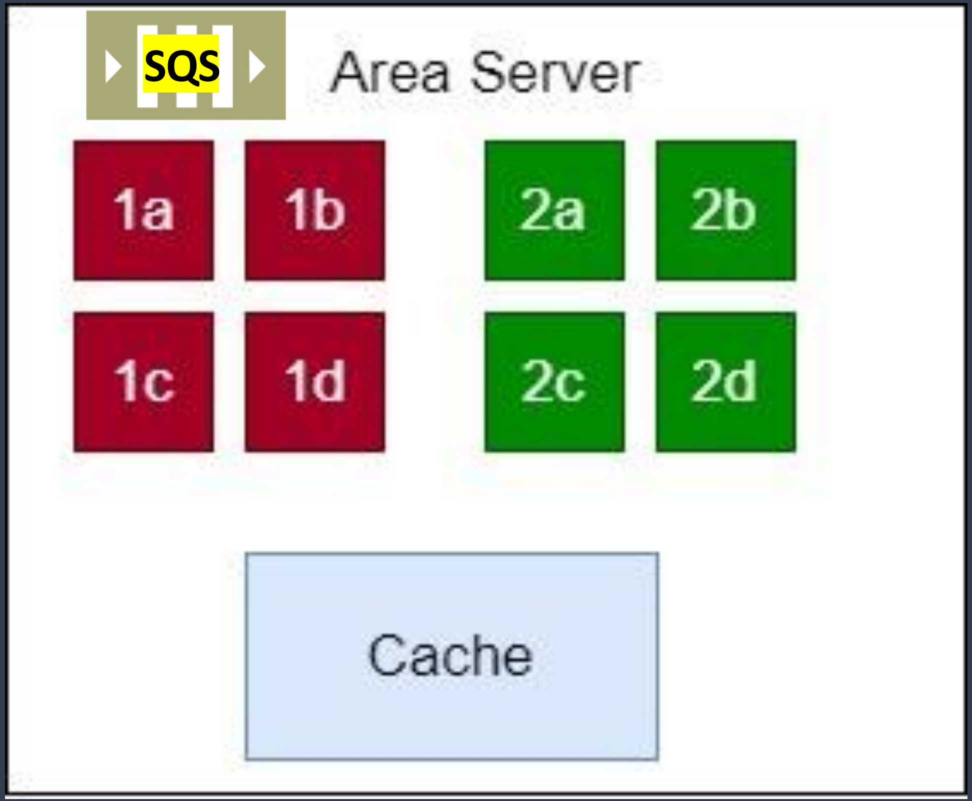


How are across-the-map shots handled?



THANK YOU