Real-Time Chat Application using AWS AppSync & DynamoDB

Project Overview

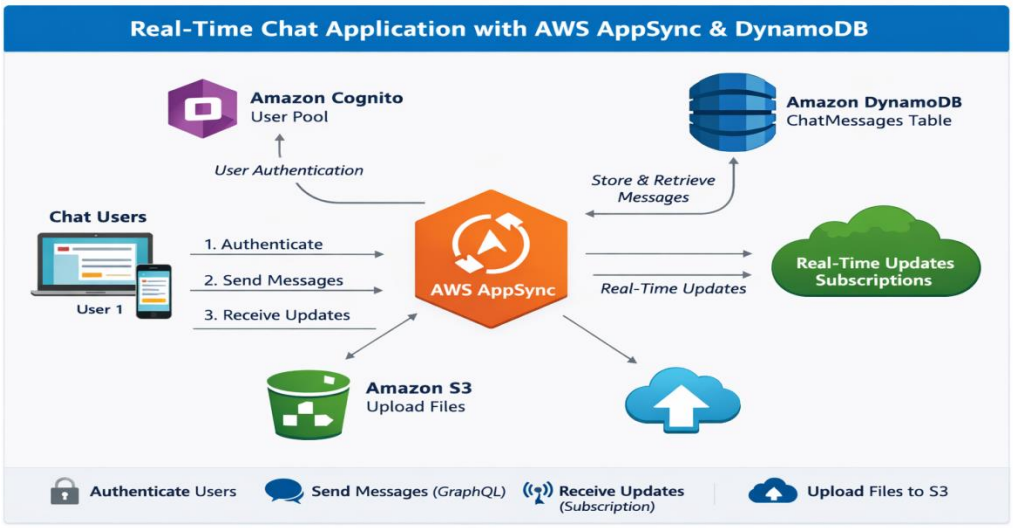
Services Used:

- **AWS AppSync** – Managed GraphQL service with real-time subscriptions
- **Amazon DynamoDB** – NoSQL database for chat messages
- **Amazon Cognito** – User authentication & authorization
- **Amazon S3** – File/image uploads in chat

Goal: Build a secure real-time chat backend using only the AWS Console.

Architecture (High Level)

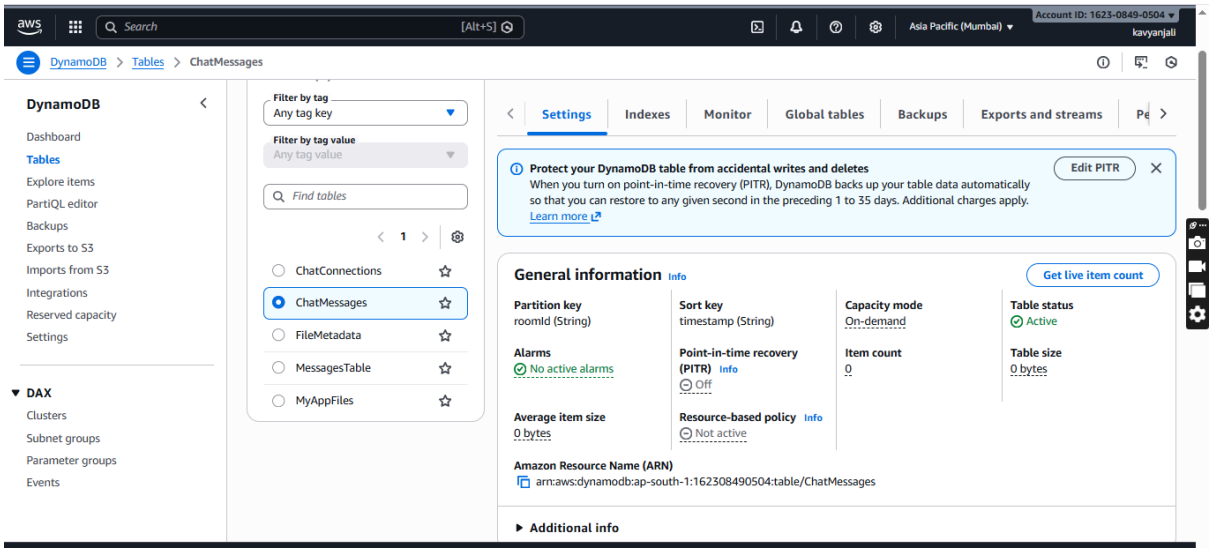
1. Users sign up / sign in using **Cognito User Pool**
2. Frontend connects to **AppSync GraphQL API**
3. Messages are stored in **DynamoDB**
4. Real-time updates via **GraphQL Subscriptions**
5. Files/images uploaded to **S3**



STEP 1: Create DynamoDB Table (Chat Messages)

1. Go to **AWS Console → DynamoDB**
2. Click **Create table**
3. Table details:
    - Table name: ChatMessages
    - Partition key: roomId (String)
    - Sort key: timestamp (String)
4. Table settings: Choose **Default settings**
5. Click **Create table**

This allows storing messages per chat room in time order



STEP 2: Create Cognito User Pool (Authentication)

1. Go to **AWS Console → Cognito**
2. Click **Create user pool**
3. Select **Cognito User Pool=** Real-Time Chat Application

Configure sign-in experience

- Authentication provider: **Cognito User Pool**
- Sign-in options: **Email**

Security requirements

- Password policy: Default
- MFA: Optional (Disable for demo)

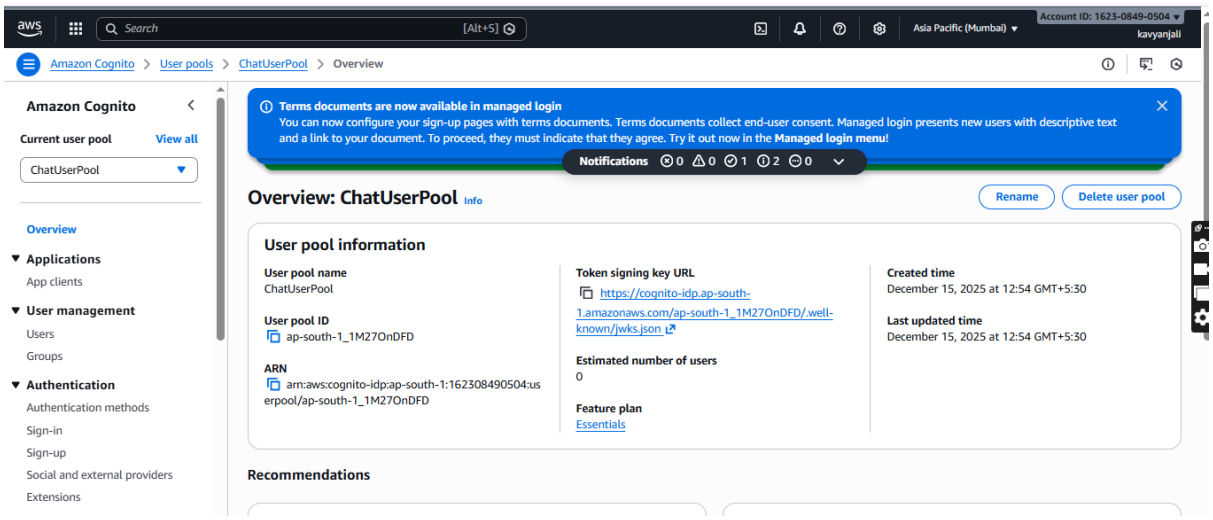
Sign-up experience

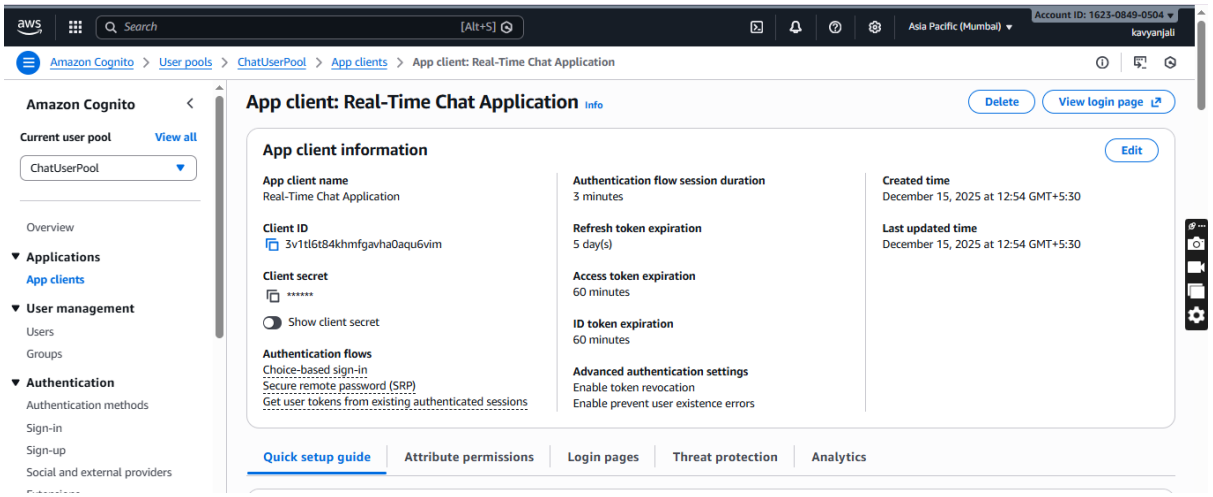
- Enable self sign-up: **Yes**
- Required attributes: Email

App integration

- User pool name: ChatUserPool
- App client name: ChatAppClient
- Client secret: ✕Do NOT generate

4. Click **Create user pool**





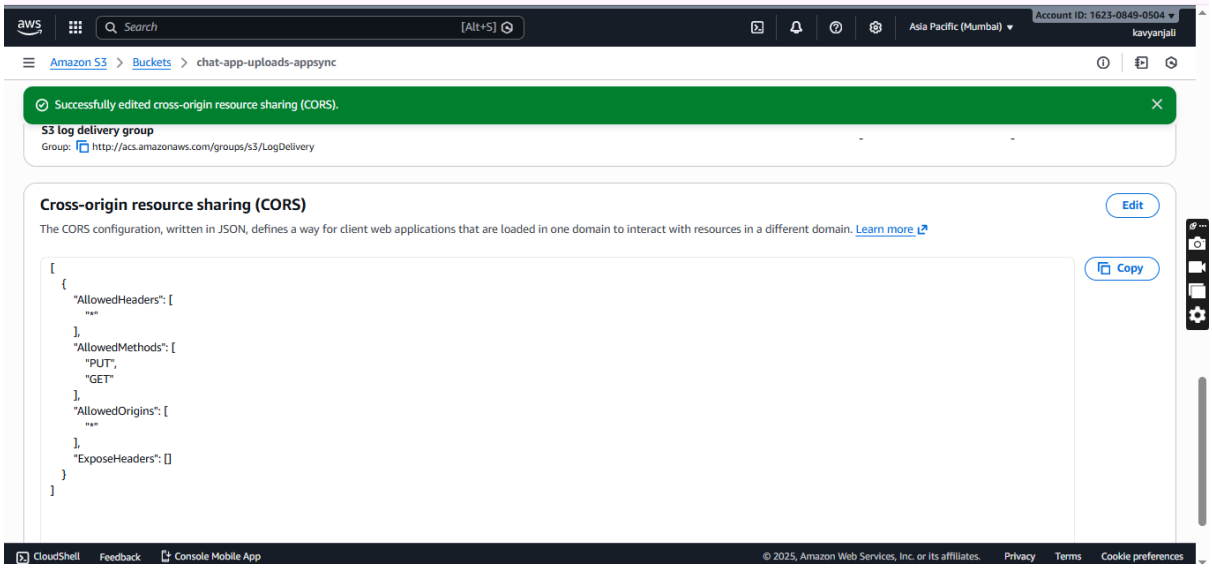
STEP 3: Create S3 Bucket (File Uploads)

1. Go to **AWS Console → S3**
2. Click **Create bucket**
3. Bucket name: chat-app-uploads-appasync
4. Region: Same as AppSync(Mumbai)
5. Block Public Access: ❌Uncheck all
6. Click **Create bucket**

Enable CORS

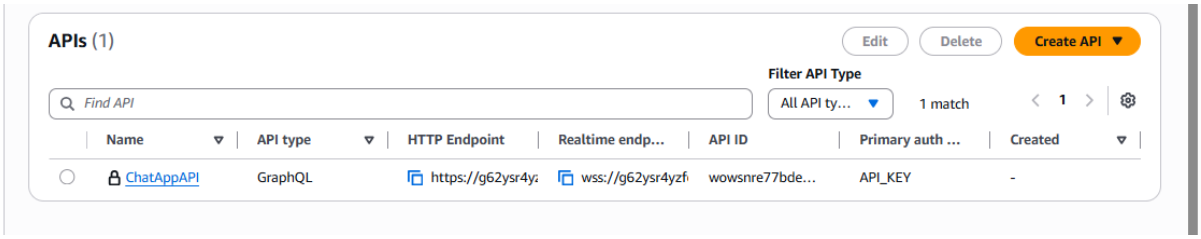
1. Open bucket → Permissions → CORS
2. Add:

```
[
  {
    "AllowedHeaders": ["*"],
    "AllowedMethods": ["PUT", "GET"],
    "AllowedOrigins": ["*"],
    "ExposeHeaders": []
  }
]
```



STEP 4: Create AppSync GraphQL API

1. Go to **AWS Console → AppSync**
2. Click **Create API**
3. Choose **Build from scratch**
4. API name: ChatAppAPI
5. Authorization type: **Amazon Cognito User Pool**
6. Select User Pool: ChatUserPool
7. Click **Create API**



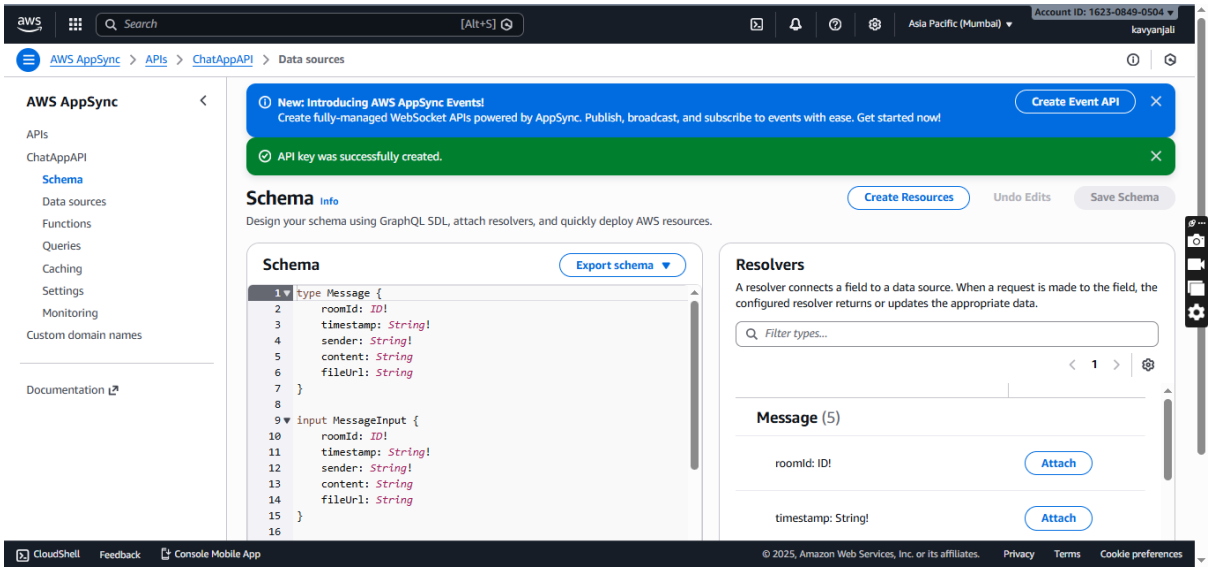
STEP 5: Define GraphQL Schema

In AppSync → Schema → Edit schema

```
type Message {
  roomId: ID!
  timestamp: String!
  sender: String!
  content: String
  fileUrl: String
}

input MessageInput {
  roomId: ID!
  timestamp: String!
  sender: String!
  content: String
  fileUrl: String
```

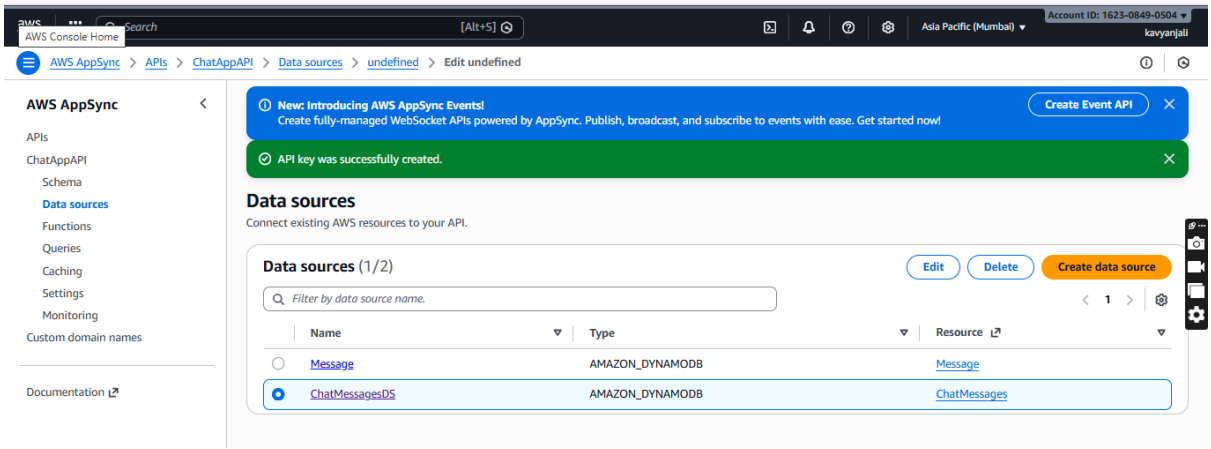
```
}

type Query {
  getMessages(roomId: ID!): [Message]
}

type Mutation {
  sendMessage(input: MessageInput!): Message
}

type Subscription {
  onNewMessage(roomId: ID!): Message
    @aws_subscribe(mutations: ["sendMessage"])
}

schema {
  query: Query
  mutation: Mutation
  subscription: Subscription
}
```

Click **Save schema**



STEP 6: Create DynamoDB Data Source

1. AppSync → Data Sources
2. Click **Create data source**
3. Type: **Amazon DynamoDB**
4. Name: ChatMessagesDS
5. Table: ChatMessages
6. IAM Role: Create new role
7. Click **Create**



STEP 7: Attach Resolvers

Mutation Resolver (sendMessage)

1. Schema → Mutation → sendMessage
2. Attach resolver → DynamoDB
3. Use **Unit Resolver**

Request Mapping Template:

```
{
  "version": "2018-05-29",
  "operation": "PutItem",
  "key": {
    "roomId": {"S": "$ctx.args.input.roomId"},
    "timestamp": {"S": "$ctx.args.input.timestamp"}
  },
  "attributeValues": {
    "sender": {"S": "$ctx.args.input.sender"},
    "content": {"S": "$ctx.args.input.content"},
    "fileUrl": {"S": "$ctx.args.input.fileUrl"}
  }
}
```

Response Mapping Template:

```
$util.toJson($ctx.args.input)
```

Query Resolver (getMessages)

1. Query → getMessages
2. Attach resolver → DynamoDB

Request Template:

```
{
  "version": "2018-05-29",
  "operation": "Query",
  "query": {
```

```
    "expression": "roomId = :roomId",
    "expressionValues": {
      ":roomId": {"S": "$ctx.args.roomId"}
    }
  }
}
```

Response Template:

```
$util.toJson($ctx.result.items)
```

STEP 8: Test GraphQL API

1. AppSync → Queries
2. Login using Cognito user

Test Mutation

```
mutation {
  sendMessage(input: {
    roomId: "room1",
    timestamp: "2025-01-01T10:00:00",
    sender: "user1",
    content: "Hello!"
  }) {
    roomId
    content
  }
}
```

Test Subscription

```
subscription {
  onNewMessage(roomId: "room1") {
    content
    sender
  }
}
```

STEP 9: File Upload Flow (S3)

1. User uploads file to S3 (via frontend)
2. S3 returns file URL
3. URL stored in DynamoDB using sendMessage

STEP 10: Security & IAM Notes

- Cognito secures AppSync access
- AppSync IAM role allows DynamoDB read/write
- S3 access controlled via bucket policy or pre-signed URLs

Summary

In this project, a **Real-Time Chat Application** is designed and implemented using **AWS managed services**, focusing on scalability, security, and real-time communication.

The application uses **AWS AppSync** as the core service to provide a **GraphQL API** that handles all client communication. AppSync enables **queries** for fetching chat messages, **mutations** for sending messages, and **subscriptions** for real-time message delivery without polling.

Amazon Cognito manages user authentication and authorization. Users sign up and sign in using a Cognito User Pool, and only authenticated users are allowed to access the AppSync API. This ensures secure communication between clients and backend services.

Amazon DynamoDB is used as the backend database to store chat messages. Messages are stored using a partition key (roomId) and sort key (timestamp), which allows efficient querying of messages per chat room in chronological order. DynamoDB's serverless and highly scalable nature makes it suitable for real-time chat workloads.

Amazon S3 is used for file and media uploads such as images or documents shared in chat messages. Uploaded file URLs are stored along with chat messages in DynamoDB, enabling users to access shared files securely.

The entire system is implemented using **AWS Console only**, without the need for server management or infrastructure provisioning, making it a fully serverless architecture.

Conclusion

This Real-Time Chat Application demonstrates how modern cloud-native applications can be built using **serverless AWS services**. By combining AppSync, DynamoDB, Cognito, and S3, the application achieves:

- **Real-time communication** using GraphQL subscriptions
- **Secure user authentication** using Amazon Cognito
- **Highly scalable data storage** using DynamoDB
- **Efficient file handling** using Amazon S3
- **Low operational overhead** with a fully managed, serverless architecture

The project effectively showcases key cloud computing concepts such as **API-driven design, real-time data streaming, authentication, NoSQL database modeling, and managed cloud services**.