

Module 5: Firebase & AI

Authentication, Cloud Storage & Gemini

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Agenda

1. **Module App**
2. **Firebase Auth & Firestore**
3. **Firebase Storage & App Check**
4. **Firebase AI Logic & Gemini**
5. **Deep Dive**
6. **Challenge Lab**

AI Chef App

An app that uses **AI to analyze ingredients** from photos and generate recipes.

Recipe List	Generator	Detail
		

What We're Building

Features:

1. **User Auth:** Email/password authentication
2. **Photo Analysis:** Gemini analyzes ingredient images
3. **Recipe Generation:** AI creates recipes from ingredients
4. **Image Generation:** AI creates photorealistic dish images
5. **Cloud Storage:** Cache generated images

The Challenge:

Coordinate Auth + Firestore + Storage + AI in a clean architecture.

2. Firebase Auth & Firestore

User Authentication & Real-time Database

Firestore Auth: Why?

The Problem (DIY Auth):

- Build password hashing, token management, session handling
- Implement email verification, password reset
- Handle security vulnerabilities
- Scale your auth server

The Solution (Firestore Auth):

- Pre-built, battle-tested authentication
- Multiple providers (Email, Google, Apple, etc.)
- Automatic token refresh
- Security rules integration

Auth Flow Visualization

Firestore Auth

[App]	[Firestore]	[Backend]
-- signIn(email,pw) --->		
	-- Verify ----->	
	<-- OK -----	
<-- ID Token -----		
(Token auto-refreshes every hour)		
-- Request + Token ---->		
	-- Validate ----->	
<-- Protected Data ----		

Live Code: AuthRepository Interface

```
//data/firebase/IAuthRepository.kt
interface IAuthRepository {
    val currentUserId: String?
    val isLoggedIn: Boolean

    fun observeAuthState(): Flow<AuthState>
    suspend fun signIn(email: String, password: String): Result<String>
    suspend fun signUp(email: String, password: String): Result<String>
    fun signOut()
}

sealed class AuthState {
    data object Loading : AuthState()
    data class Authenticated(val userId: String, val email: String?) : AuthState()
    data object Unauthenticated : AuthState()
}
```

Live Code: AuthRepository Implementation

```
//data/firebase/AuthRepository.kt
class AuthRepository @Inject constructor() : IAuthRepository {
    private val auth: FirebaseAuth = FirebaseAuth.getInstance()

    override val currentUserId: String?
        get() = auth.currentUser?.uid

    override val isLoggedIn: Boolean
        get() = auth.currentUser != null

    override suspend fun signIn(email: String, password: String): Result<String> {
        return try {
            val result = auth.signInWithEmailAndPassword(email, password).await()
            val userId = result.user?.uid
            ?: return Result.failure(Exception("User not found"))
            Result.success(userId)
        } catch (e: FirebaseAuthInvalidUserException) {
            Result.failure(Exception("User not found"))
        } catch (e: FirebaseAuthInvalidCredentialsException) {
            Result.failure(Exception("Incorrect password"))
        }
    }
}
```

Callback to Flow: AuthStateListener

```
override fun observeAuthState(): Flow<AuthState> = callbackFlow {  
    val authStateListener = FirebaseAuth.AuthStateListener { firebaseAuth ->  
        val user = firebaseAuth.currentUser  
        val state = if (user != null) {  
            AuthState.Authenticated(  
                userId = user.uid,  
                email = user.email  
            )  
        } else {  
            AuthState.Unauthenticated  
        }  
        trySend(state) // Emit to Flow  
    }  
  
    auth.addAuthStateListener(authStateListener)  
  
    // Cleanup when Flow is cancelled  
    awaitClose {  
        auth.removeAuthStateListener(authStateListener)  
    }  
}
```

Cloud Firestore: Why?

The Problem (REST API):

- Polling for updates (inefficient)
- Manual caching logic
- Build your own query system
- No offline support

The Solution (Firestore):

- **Real-time listeners:** Data syncs instantly
- **Offline persistence:** Works without internet
- **Structured queries:** Filter, order, paginate
- **Security rules:** Server-side access control

Firestore Data Model

Firestore

recipes (Collection)

abc123 (Document)

— userId: "user_xyz"

— title: "Pasta Primavera"

— ingredients: ["pasta", "tomatoes", "basil"]

— steps: ["Boil water", "Add pasta", ...]

— imageUrl: "content://..."

— generatedImageUrl: "https://storage..."

— createdAt: 1703520000000

def456 (Document)

— ...

Live Code: Recipe Data Model

```
//domain/model/Recipe.kt
data class Recipe(
    val id: String = "",
    val userId: String = "",
    val title: String = "",
    val ingredients: List<String> = emptyList(),
    val steps: List<String> = emptyList(),
    val imageUrl: String = "",
    val generatedImageUrl: String = "",
    val createdAt: Long = System.currentTimeMillis()
) {
    fun toMap(): Map<String, Any> = mapOf(
        "userId" to userId,
        "title" to title,
        "ingredients" to ingredients,
        "steps" to steps,
        "imageUrl" to imageUrl,
        "generatedImageUrl" to generatedImageUrl,
        "createdAt" to createdAt
    )
}
```

Live Code: FirestoreRepository

```
//data/firebase/FirestoreRepository.kt
class FirestoreRepository @Inject constructor() : IFirestoreRepository {
    private val firestore = FirebaseFirestore.getInstance()
    private val recipesCollection = firestore.collection("recipes")

    override suspend fun saveRecipe(recipe: Recipe): Result<String> {
        return try {
            val documentRef = recipesCollection.add(recipe.toMap()).await()
            Result.success(documentRef.id)
        } catch (e: Exception) {
            Result.failure(Exception("Error saving: ${e.message}"))
        }
    }

    override suspend fun updateGeneratedImageUrl(
        recipeId: String,
        imageUrl: String
    ): Result<Unit> {
        return try {
            recipesCollection.document(recipeId)
                .update("generatedImageUrl", imageUrl)
                .await()
            Result.success(Unit)
        } catch (e: Exception) {
            Result.failure(e)
        }
    }
}
```

Real-time Sync with Snapshot Listeners

```
override fun observeUserRecipes(userId: String): Flow<List<Recipe>> = callbackFlow {  
    val query = recipesCollection  
        .whereEqualTo("userId", userId)  
        .orderBy("createdAt", Query.Direction.DESCENDING)  
  
    val listenerRegistration = query.addSnapshotListener { snapshot, error ->  
        if (error != null) {  
            trySend(emptyList())  
            return@addSnapshotListener  
        }  
  
        val recipes = snapshot?.documents?.mapNotNull { document ->  
            Recipe.fromFirestore(document.id, document.data ?: emptyMap())  
        } ?: emptyList()  
  
        trySend(recipes) // Emit updated list  
    }  
  
    awaitClose { listenerRegistration.remove() }  
}
```

Firestore Security Rules

```
rules_version = '2';
service cloud.firestore {
  match /databases/{database}/documents {
    match /recipes/{recipeId} {
      // Anyone logged in can read
      allow read: if request.auth != null;

      // Only owner can create (must set own userId)
      allow create: if request.auth != null
                    && request.auth.uid == request.resource.data.userId;

      // Only owner can update/delete
      allow update, delete: if request.auth != null
                            && request.auth.uid == resource.data.userId;
    }
  }
}
```

3. Firebase Storage & App Check

File Storage & Security

Firestore Storage: Why?

The Problem:

- Store images on device → Lost on uninstall
- Store images in Firestore → Document size limit (1MB)
- Build your own file server → Cost, scaling, CDN

The Solution (Firestore Storage):

- Built on Google Cloud Storage
- Automatic CDN distribution
- Resumable uploads
- Security rules integration
- Up to 5GB per file

Storage Architecture

Firestore Storage

gs://your-bucket.appspot.com/

└─ recipe_images/

└─ abc123.jpg (Recipe ID as filename)

└─ def456.jpg

└─ ghi789.jpg

[App] -- upload(bitmap) --> [Storage] -- returns --> [URL]

Download URL: <https://firebasestorage.googleapis.com/...>

Live Code: StorageRepository

```
//data/firebase/StorageRepository.kt
class StorageRepository @Inject constructor() : IStorageRepository {
    private val storage = Firebase.storage
    private val recipeImagesRef = storage.reference.child("recipe_images")

    override suspend fun uploadRecipeImage(
        recipeId: String,
        bitmap: Bitmap
    ): Result<String> {
        return try {
            val imageRef = recipeImagesRef.child("$recipeId.jpg")

            // Compress Bitmap to JPEG
            val baos = ByteArrayOutputStream()
            bitmap.compress(Bitmap.CompressFormat.JPEG, 85, baos)
            val imageData = baos.toByteArray()

            // Upload bytes
            imageRef.putBytes(imageData).await()

            // Get download URL
            val downloadUrl = imageRef.downloadUrl.await().toString()
            Result.success(downloadUrl)
        } catch (e: Exception) {
            Result.failure(e)
        }
    }
}
```

Cache-First Strategy

```
override suspend fun imageExists(recipeId: String): Boolean {
    return try {
        val imageRef = recipeImagesRef.child("$recipeId.jpg")
        imageRef.metadata.await() // Throws if not exists
        true
    } catch (e: Exception) {
        false
    }
}

override suspend fun getImageUrl(recipeId: String): String? {
    return try {
        val imageRef = recipeImagesRef.child("$recipeId.jpg")
        imageRef.downloadUrl.await().toString()
    } catch (e: Exception) {
        null
    }
}
```

Why cache? AI image generation is expensive. Generate once, reuse forever.

Storage Security Rules

```
rules_version = '2';
service firebase.storage {
  match /b/{bucket}/o {
    match /recipe_images/{imageId} {
      // Anyone logged in can read
      allow read: if request.auth != null;

      // Write with restrictions
      allow write: if request.auth != null
        // Max 5MB
        && request.resource.size < 5 * 1024 * 1024
        // Only images
        && request.resource.contentType.matches('image/.*');
    }
  }
}
```

App Check: Why?

The Problem:

- Anyone can call your Firebase APIs with your API key
- API keys are visible in APK (easy to extract)
- Bots and scrapers abuse your backend
- You pay for fraudulent requests

The Solution (App Check):

- Verifies requests come from YOUR app
- Uses device attestation (Play Integrity, DeviceCheck)
- Blocks requests from modified apps, emulators, scripts
- **Required for Firebase AI Logic**

App Check Flow

App Check Flow

[Your App]	[Play Integrity]	[Firebase]
-- Get attestation --->		
<----- Device token --		
-- Exchange token ----->		
<----- App Check token -----		
-- API Request + App Check token ----->		
(Firebase validates token before processing)		
<----- Response -----		

App Check Setup

```
//AiChefApplication.kt
@HiltAndroidApp
class AiChefApplication : Application() {

    override fun onCreate() {
        super.onCreate()

        // Initialize Firebase
        Firebase.initialize(this)

        // ===== CRITICAL FOR FIREBASE AI LOGIC =====
        // Firebase AI Logic REQUIRES App Check enabled
        Firebase.appCheck.installAppCheckProviderFactory(
            // DEBUG: Use debug provider (generates debug token)
            DebugAppCheckProviderFactory.getInstance()

            // PRODUCTION: Use Play Integrity
            // PlayIntegrityAppCheckProviderFactory.getInstance()
        )
    }
}
```

Debug Token Registration

Step 1: Run app in debug mode

Step 2: Find token in Logcat

```
D/DebugAppCheckProvider: Enter this debug token in Firebase Console:  
XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX
```

Step 3: Register in Firebase Console

```
Firebase Console → Build → App Check → Apps →  
Your App → Manage debug tokens → Add debug token
```

Step 4: Wait ~5 minutes for propagation

4. Firebase AI Logic & Gemini

Multimodal AI in Your App

Firestore AI Logic: What Is It?

The Evolution:

1. `com.google.ai.client.generativeai` → Direct Gemini API (deprecated)
2. `firebase-vertexai` → Vertex AI backend (deprecated)
3. `firebase-ai` → Firestore AI Logic (current, 2025+)

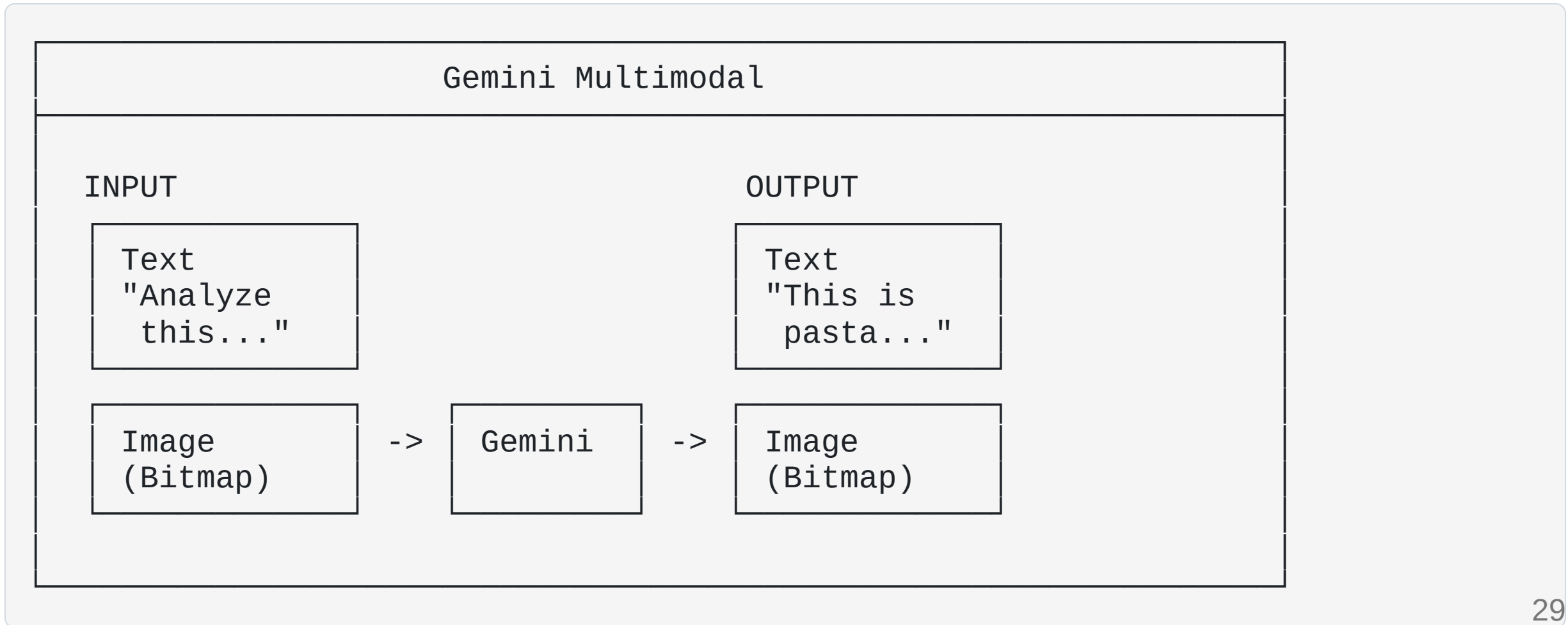
Why Firestore AI Logic?

- Unified with Firestore ecosystem
- App Check integration (prevents abuse)
- Automatic token management
- Access to latest Gemini models

Multimodal AI Explained

Traditional AI: Text in → Text out

Multimodal AI: Text + Images + Audio → Text + Images



Two Models, Two Purposes

```
//data/remote/AiLogicDataSource.kt

// MODEL 1: Recipe Analysis (Text output from Image input)
private val generativeModel = Firebase.ai(
    backend = GenerativeBackend.googleAI()
).generativeModel("gemini-3-flash-preview")

// MODEL 2: Image Generation (Image output from Text input)
private val imageModel = Firebase.ai(
    backend = GenerativeBackend.googleAI()
).generativeModel(
    modelName = "gemini-3-pro-image-preview",
    generationConfig = generationConfig {
        // Tell Gemini we want images back
        responseModalities = listOf(
            ResponseModality.TEXT,
            ResponseModality.IMAGE
        )
    }
)
```

Live Code: Recipe from Image

```
override suspend fun generateRecipeFromImage(imageBitmap: Bitmap): GeneratedRecipe {
    val prompt = content {
        image(imageBitmap) // Multimodal: Add image
        text("""
            Analyze this image of ingredients and generate a recipe.

            Respond EXACTLY in this format:

            TÍTULO: [creative recipe name]

            INGREDIENTES:
            - [ingredient 1 with quantity]
            - [ingredient 2 with quantity]

            PASOS:
            1. [first step]
            2. [second step]
            """).trimIndent()
    }

    val response = generativeModel.generateContent(prompt)
    val responseText = response.text ?: throw Exception("Empty response")

    return parseRecipeResponse(responseText)
}
```

Parsing AI Response

```
private fun parseRecipeResponse(response: String): GeneratedRecipe {  
    // Extract title  
    val titleRegex = Regex("""TÍTULO:\s*(.+)"", RegexOptions.IGNORE_CASE)  
    val title = titleRegex.find(response)?.groupValues?.get(1)?.trim()  
        ?: "Mystery Recipe"  
  
    // Extract ingredients section  
    val ingredientsSection = response  
        .substringAfter("INGREDIENTES:", "")  
        .substringBefore("PASOS:", "")  
  
    val ingredients = ingredientsSection  
        .lines()  
        .filter { it.trim().startsWith("-") }  
        .map { it.removePrefix("-").trim() }  
        .filter { it.isNotBlank() }  
  
    // Extract steps section  
    val stepsSection = response.substringAfter("PASOS:", "")  
  
    val steps = stepsSection  
        .lines()  
        .filter { it.trim().firstOrNull()?.isDigit() == true }  
        .map { it.replace(Regex("""^\d+\.\s*"""), "").trim() }  
  
    return GeneratedRecipe(title, ingredients, steps)  
}
```

Live Code: Image Generation

```
override suspend fun generateRecipeImage(
    recipeTitle: String,
    ingredients: List<String>
): Bitmap {
    val ingredientsList = ingredients.take(5).joinToString(", ")

    val prompt = content {
        text("""
            Generate a professional food photography image:

            Dish: $recipeTitle
            Ingredients: $ingredientsList

            Requirements:
            - Photorealistic, appetizing
            - Beautiful plating
            - Warm lighting
            - Restaurant-quality presentation
            """).trimIndent()
    }

    val response = imageModel.generateContent(prompt)

    // Extract Bitmap from response
    return response.candidates
        .firstOrNull()?.content?.parts
        ?.filterIsInstance<ImagePart>()
        ?.firstOrNull()?.image
        ?: throw Exception("No image generated")
}
```

Response Structure

GenerateContentResponse

```
candidates: List<Candidate>
├── [0]: Candidate
│   ├── content: Content
│   │   ├── parts: List<Part>
│   │   │   ├── [0]: TextPart("Here's your dish...")
│   │   │   └── [1]: ImagePart(bitmap: Bitmap)
│   └── ...
└── ...

// Extract image:
response.candidates[0].content.parts
    .filterIsInstance<ImagePart>()
    .first().image // Bitmap
```

ViewModel: Putting It Together

```
//ui/viewmodel/ChefViewModel.kt
fun generateRecipe(imageBitmap: Bitmap) {
    viewModelScope.launch {
        try {
            _generationState.value = UiState.Loading("Analyzing...")

            // 1. AI analyzes image
            val recipe = aiLogicDataSource.generateRecipeFromImage(imageBitmap)

            // 2. Save to Firestore
            val result = firestoreRepository.saveRecipe(
                Recipe(
                    userId = authRepository.currentUserId!!,
                    title = recipe.title,
                    ingredients = recipe.ingredients,
                    steps = recipe.steps
                )
            )

            result.fold(
                onSuccess = { id -> _generationState.value = UiState.Success(id) },
                onFailure = { e -> _generationState.value = UiState.Error(e.message) }
            )
        } catch (e: Exception) {
            _generationState.value = UiState.Error(e.message)
        }
    }
}
```

Image Caching Flow

```
fun generateRecipeImage(
    recipeId: String,
    existingImageUrl: String, // From Firestore
    recipeTitle: String,
    ingredients: List<String>
) {
    viewModelScope.launch {
        // 1. Check cache first
        if (existingImageUrl.isNotBlank()) {
            _imageState.value = UiState.Success(existingImageUrl)
            return@launch
        }

        // 2. Generate with AI
        _imageState.value = UiState.Loading("Generating image...")
        val bitmap = aiLogicDataSource.generateRecipeImage(recipeTitle, ingredients)

        // 3. Upload to Storage
        val url = storageRepository.uploadRecipeImage(recipeId, bitmap)

        // 4. Save URL to Firestore (cache)
        firestoreRepository.updateGeneratedImageUrl(recipeId, url)

        _imageState.value = UiState.Success(url)
    }
}
```

5. Deep Dive

Under the Hood

1. callbackFlow: Bridging Callbacks to Coroutines

```
fun observeAuthState(): Flow<AuthState> = callbackFlow {  
    // 1. Create callback  
    val listener = FirebaseAuth.AuthStateListener { auth ->  
        trySend(mapToState(auth.currentUser)) // Emit to Flow  
    }  
  
    // 2. Register callback  
    auth.addAuthStateListener(listener)  
  
    // 3. CRITICAL: Cleanup when Flow is cancelled  
    awaitClose {  
        auth.removeAuthStateListener(listener)  
    }  
}
```

Key Rules:

- Use `trySend()` (non-blocking) not `send()` (suspending)
- Always call `awaitClose {}` to prevent memory leaks

2. flatMapLatest: Switching Flows

```
val recipes: StateFlow<List<Recipe>> = authState
    .flatMapLatest { state ->
        when (state) {
            is AuthState.Authenticated ->
                firestoreRepository.observeUserRecipes(state.userId)
            else -> flowOf(emptyList())
        }
    }
    .stateIn(viewModelScope, ...)
```

What happens:

1. User logs in → `authState` emits `Authenticated`
2. `flatMapLatest` cancels previous Flow (if any)
3. Starts new Flow for user's recipes
4. User logs out → cancels recipes Flow, emits empty list

3. Firestore Composite Index

Error you might see:

```
FAILED_PRECONDITION: The query requires an index.  
You can create it here: https://console.firebase.google.com/...
```

Why?

Firestore can only use ONE index per query. Queries with multiple fields need a **composite index**.

```
// This query needs: userId (ASC) + createdAt (DESC)  
recipesCollection  
  .whereEqualTo("userId", userId)  
  .orderBy("createdAt", Query.Direction.DESCENDING)
```

Solution: Click the link in the error to auto-create the index.

4. App Check Token Flow



Production:

Replace `DebugAppCheckProviderFactory` with `PlayIntegrityAppCheckProviderFactory`.
This uses hardware attestation (SafetyNet successor).

5. Hilt Dependency Graph

Hilt Dependency Graph

`@HiltAndroidApp`
`AiChefApplication`



`@Module @InstallIn(SingletonComponent)`
`AppModule`



`@Binds IAuthRepository ← AuthRepository`
`@Binds IFirebaseRepository ← FirebaseRepository`
`@Binds IStorageRepository ← StorageRepository`
`@Binds IAILogicDataSource ← AILogicDataSource`



`@HiltViewModel`
`ChefViewModel @Inject constructor(...)`

6. Challenge Lab

Practice & Application

Part 1: Recipe Favorites

Context:

Users can save recipes but have no way to mark their favorites. We need a favorites system with filtering capability.

Your Task:

Implement a favorites feature that:

- Adds a heart icon to each recipe card
- Toggles favorite status on tap (updates Firestore)
- Provides a filtered view showing only favorites
- Persists across sessions (stored in Firestore)

Files to Modify:

- `domain/model/Recipe.kt`
- `data/firebase/FirestoreRepository.kt`
- `ui/viewmodel/ChefViewModel.kt`
- `ui/screens/RecipeListScreen.kt` (or equivalent)

Part 1: Definition of Done

Criteria	Description
Model updated	<code>Recipe</code> has <code>isFavorite: Boolean</code> field
Firestore sync	<code>toggleFavorite()</code> updates document in Firestore
Heart icon visible	Each recipe card shows filled/outlined heart
Toggle works	Tapping heart updates state and syncs to cloud
Filter exists	User can switch to "Favorites only" view
Real-time updates	Changes reflect immediately (Firestore listener)
Optimistic UI	Heart toggles instantly, reverts on error

Part 2: Recipe Sharing

Context:

Users want to share their AI-generated recipes with friends via social media or messaging apps.

Your Task:

Implement recipe sharing that:

- Captures the recipe detail view as an image
- Includes the AI-generated dish photo and recipe info
- Uses Android's native share sheet
- Works with any app that accepts images

Files to Modify:

- `ui/screens/RecipeDetailScreen.kt`
- Create `util/ShareUtils.kt`
- `AndroidManifest.xml` (FileProvider if needed)

Part 2: Definition of Done

Criteria	Description
Share button exists	FAB or menu item triggers sharing
Composable captured	Recipe card rendered as Bitmap
Image includes content	Generated image + title + ingredients visible
Share sheet opens	Android's native app chooser appears
Multiple apps work	Can share to WhatsApp, Telegram, Email, etc.
File cleanup	Temporary files deleted after sharing
Loading state	Shows progress while preparing share image

Resources & Wrap-up

Resources

Firebase Auth	Cloud Firestore
Firebase Auth Documentation	Firestore Documentation
Auth with Email/Password	Security Rules
Auth State Listener	Realtime Listeners
Custom Auth Claims	Offline Persistence
Codelab: Firebase Auth	Composite Indexes

Resources

Firestore Storage & App Check	Firestore AI Logic (Gemini)
Storage Documentation	Firestore AI Logic Overview
Storage Security Rules	Gemini API Quickstart
App Check Overview	Multimodal Prompting
Debug Provider Setup	Image Generation with Gemini
Play Integrity Integration	Prompt Engineering Guide

Recommended Articles

Firestore Auth & Firestore

- [Firestore Auth Best Practices](#) - Firestore Developers
- [Firestore Data Modeling](#) - Firestore Developers
- [Offline-First with Firestore](#) - ProAndroidDev

Generative AI in Android

- [Integrating Gemini in Android Apps](#) - Android Developers
- [Multimodal AI: Vision + Text](#) - ProAndroidDev
- [Prompt Engineering for Developers](#) - DeepLearning.AI (Free Course)