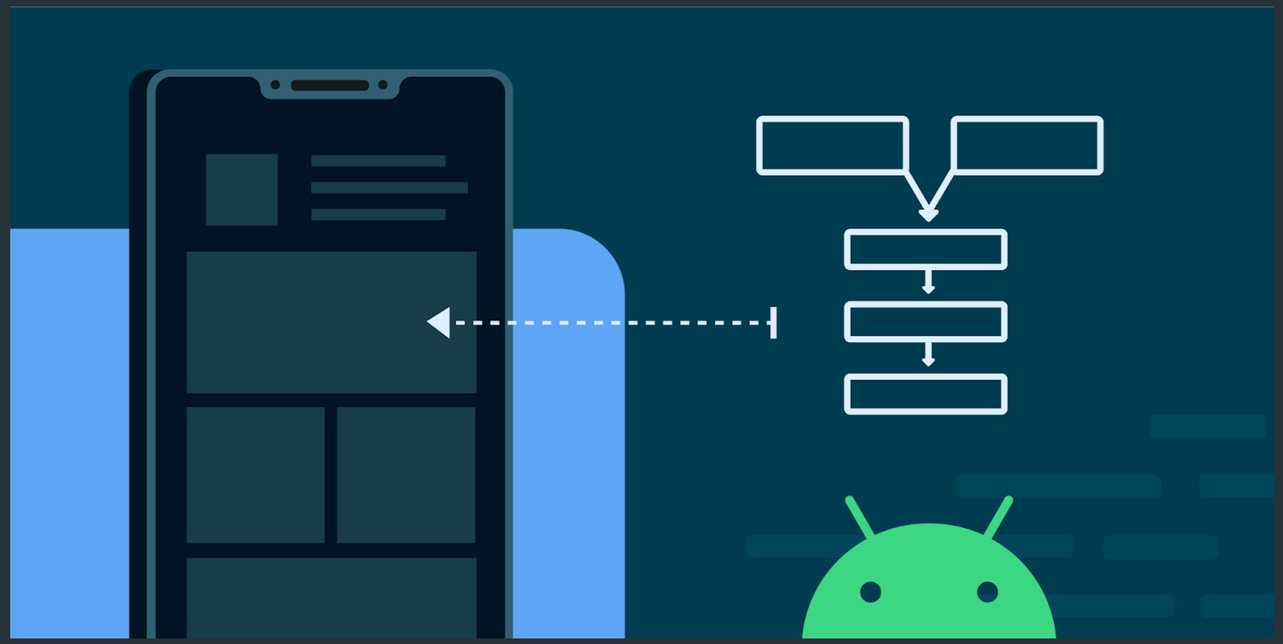
Lecture #13
Architecture Guide Update & Kotlin Multiplatform Mobile

Mobile Applications 2022-2023

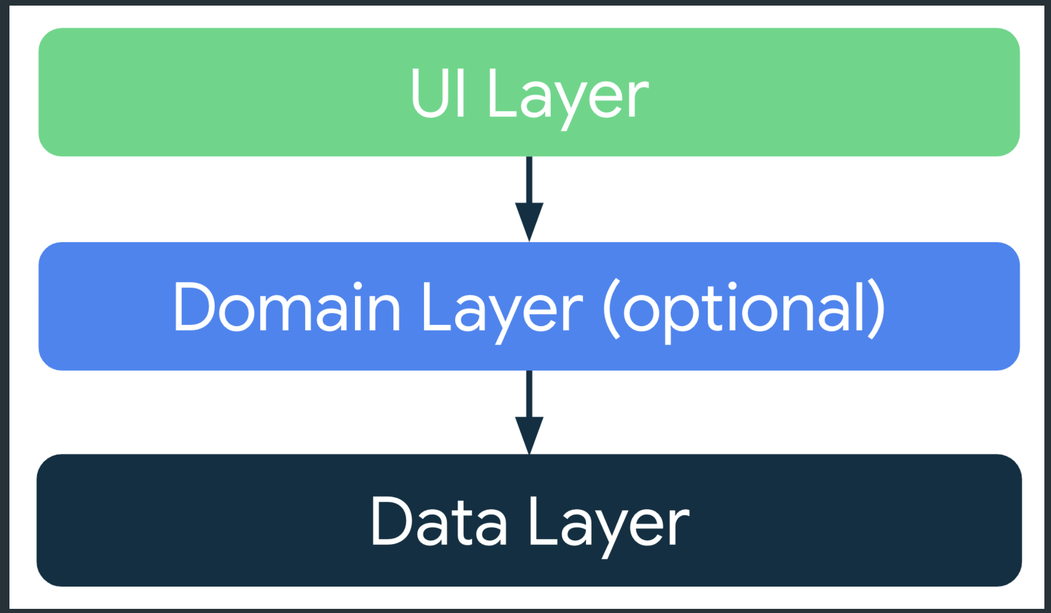
App Architecture

- Scale
- Quality
- Robustness
- Easier to test



Layers

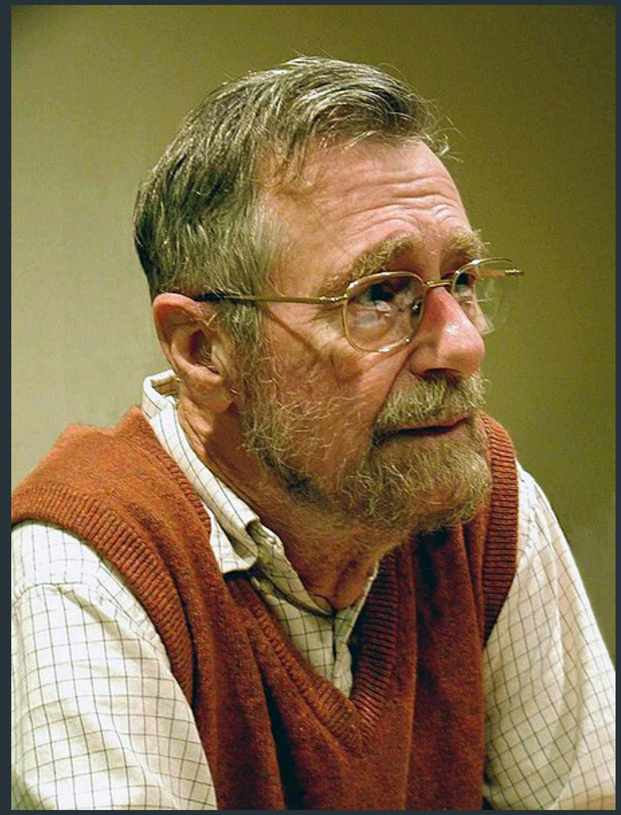
- UI - Display data on the screen.
- Data - Business logic.
- Domain - Reuse interactions.



https://developer.android.com/topic/architecture

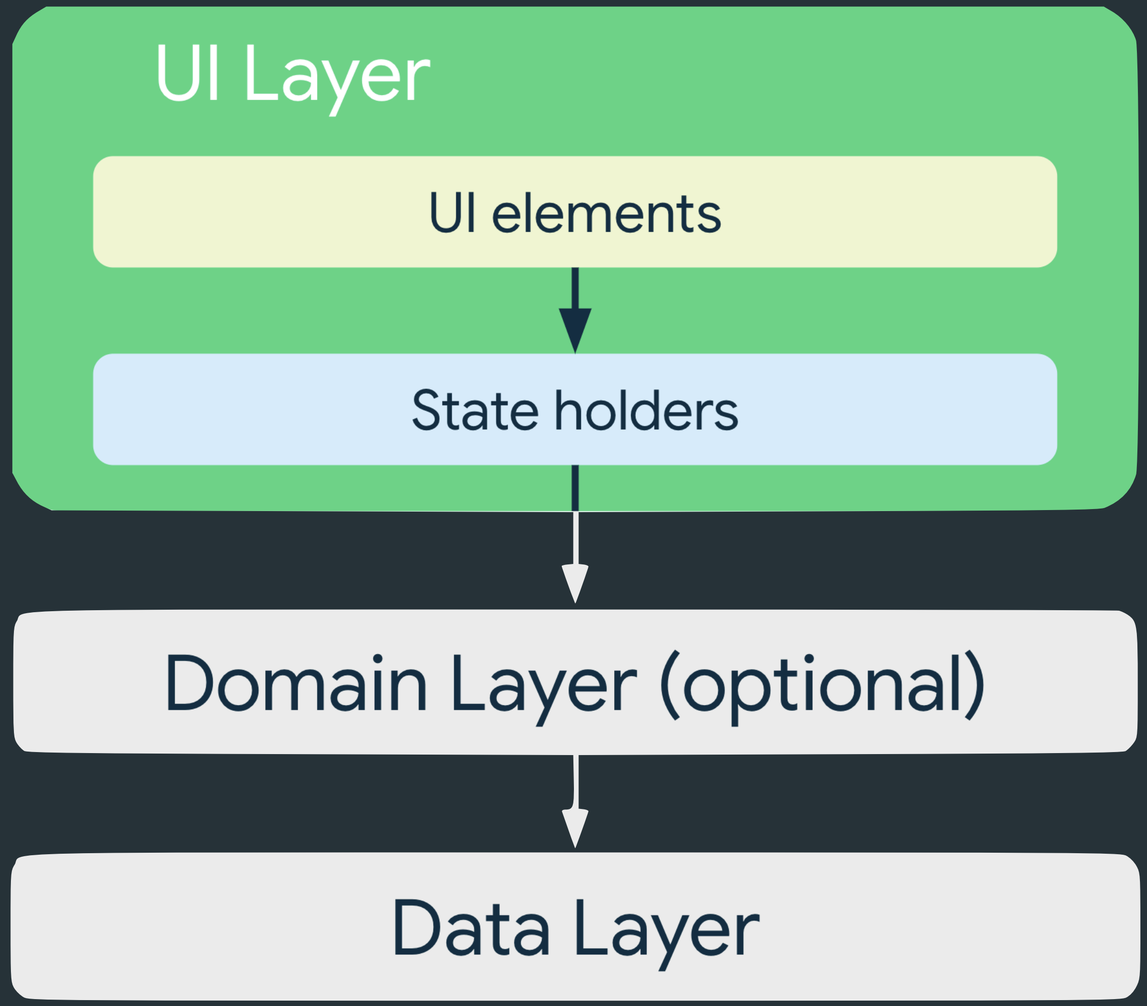
Overview

- Separation of concerns.
- Drive UI from data (persistent) models.
  - Users don’t lose data.
  - App will work even on bad connections or offline.

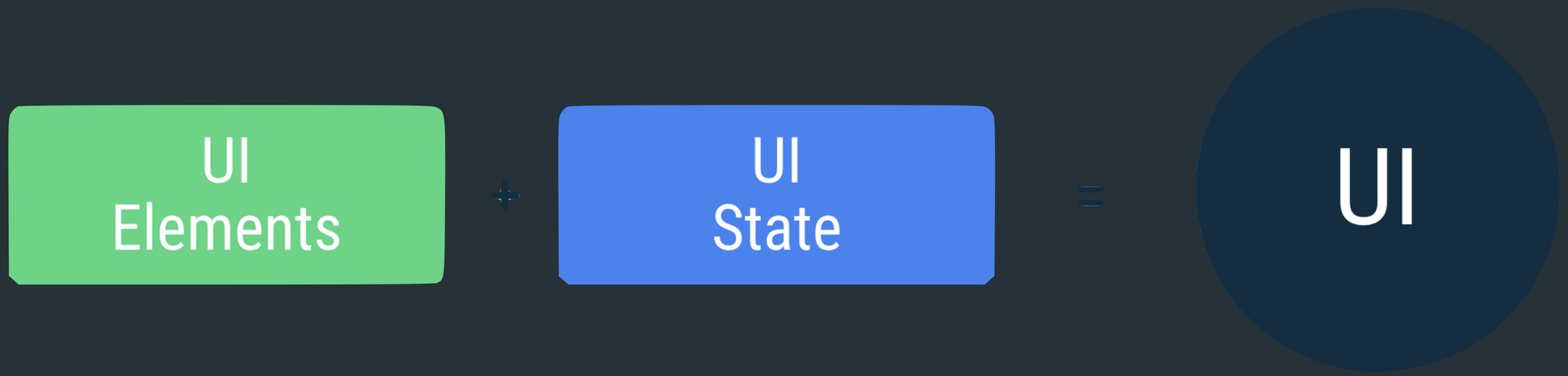


UI Layer

- Ui elements that render the data - Views or Compose functions.
- State holders
  - Hold data.
  - Expose to the UI
  - Handle logic.

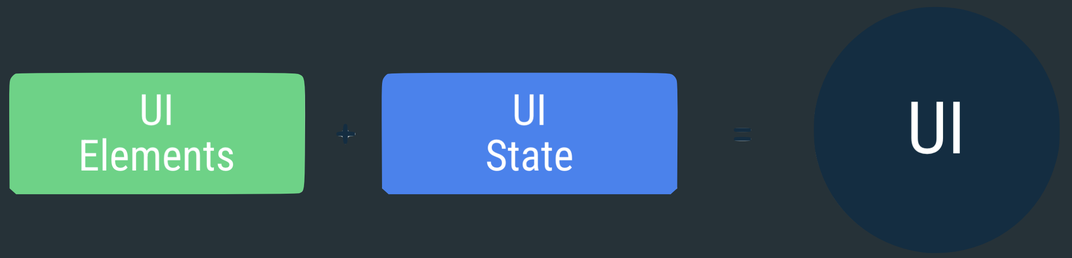


UI Layer

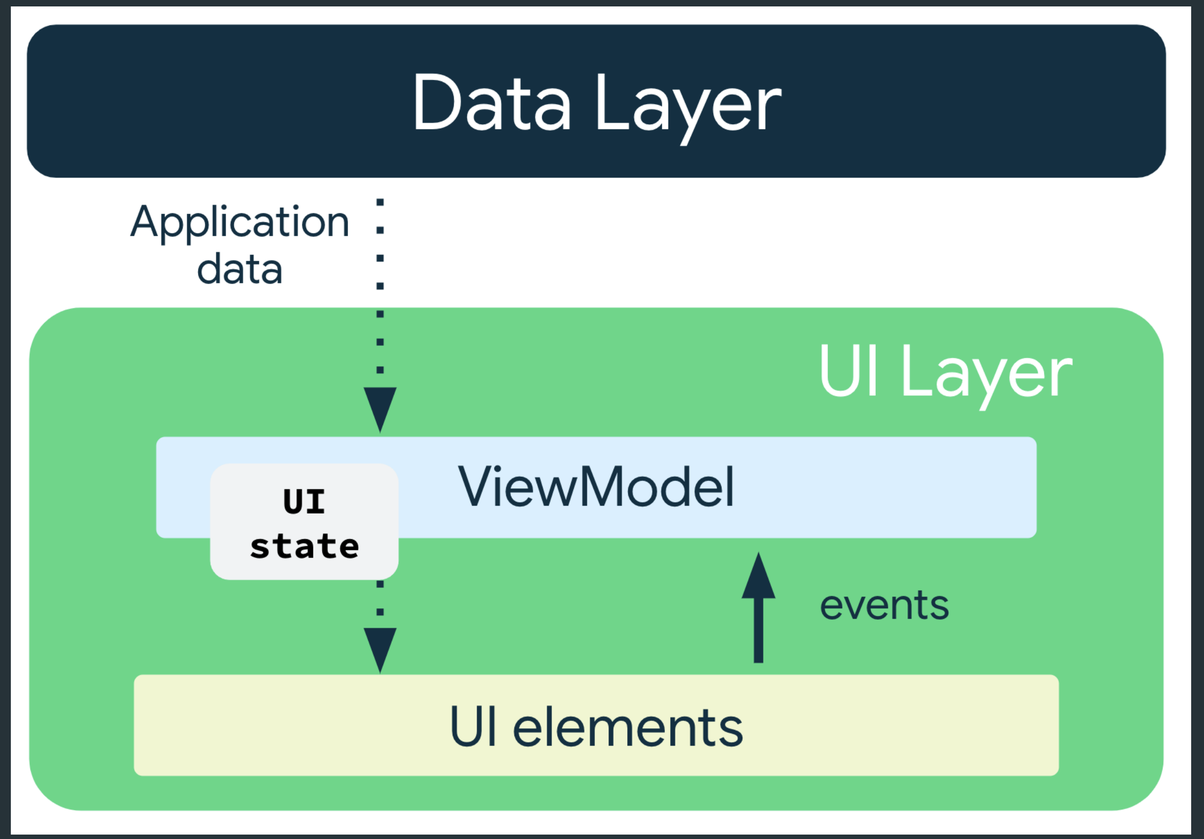


Define UI state

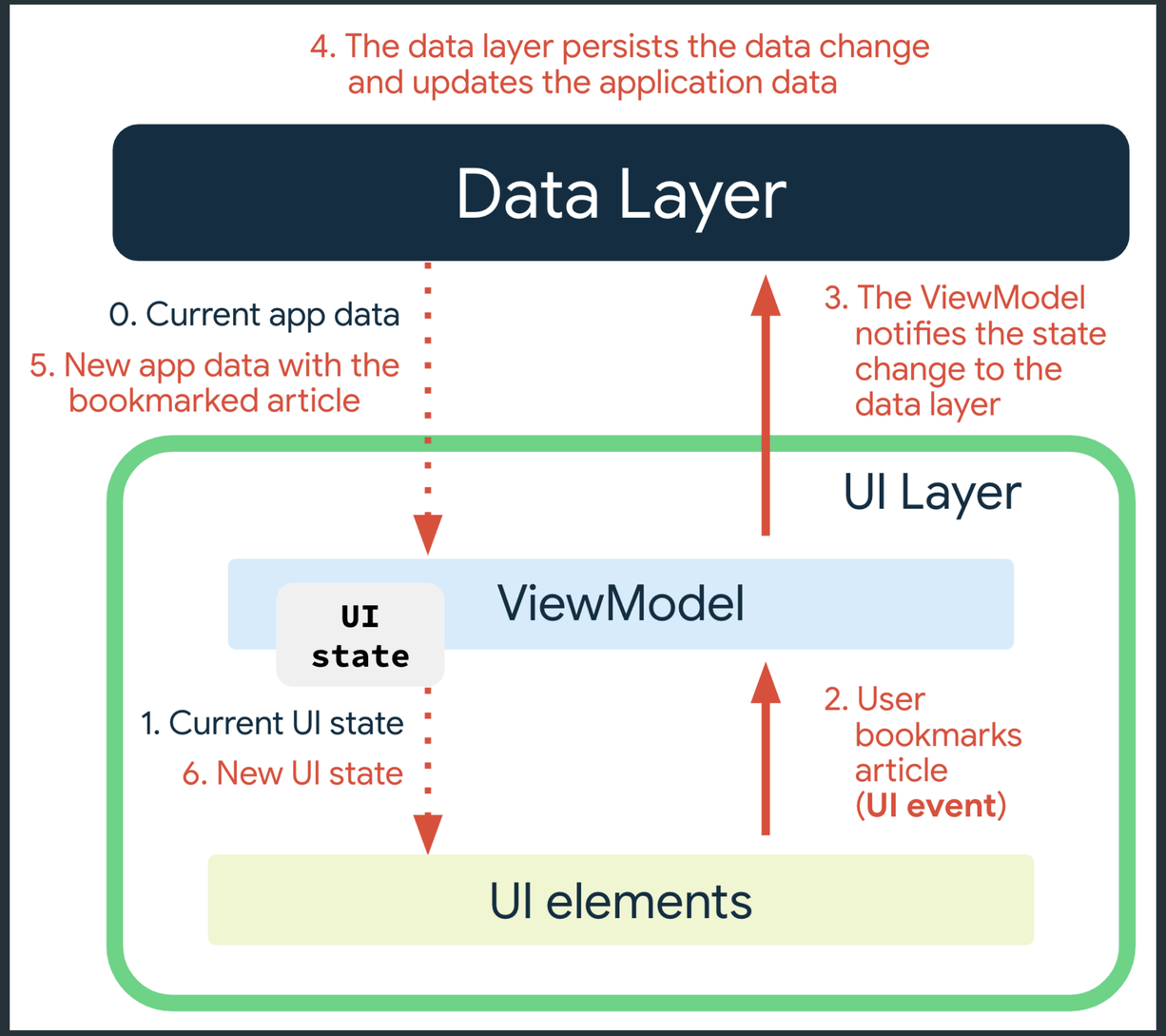
```
data class NewsUiState(
    val isSignedIn: Boolean = false,
    val isPremium: Boolean = false,
    val newsItems: List<NewsItemUiState> = listOf(),
    val userMessages: List<Message> = listOf()
)

data class NewsItemUiState(
    val title: String,
    val body: String,
    val bookmarked: Boolean = false,
    ...
)
```



Define UI state

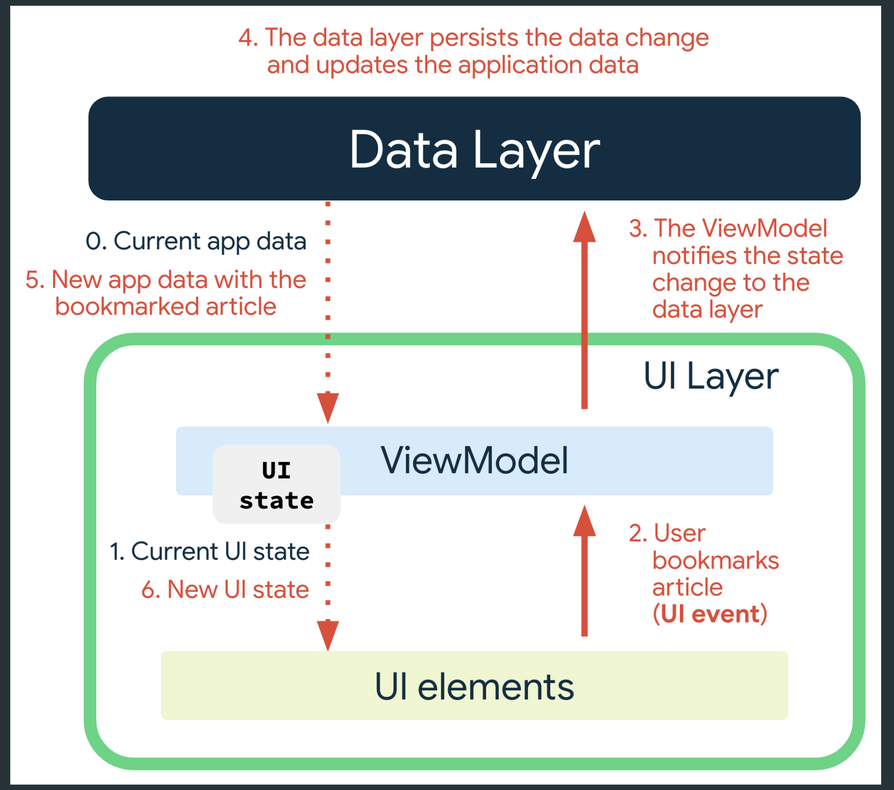


Unidirectional Data Flow



Why use UDF?

- Data consistency - Single source of truth.
- Testability - Isolated state, testable independent of the UI.
- Maintainability - Mutations follow a well-defined pattern.



Expose UI state

```
class NewsViewModel(...) : ViewModel() {

    private val _uiState = MutableStateFlow(NewsUiState())
    val uiState: StateFlow<NewsUiState> = _uiState.asStateFlow()

    ...

}
```

```
class NewsViewModel(...) : ViewModel() {

    var uiState by mutableStateOf(NewsUiState())
        private set

    ...
}
```

Consume UI state

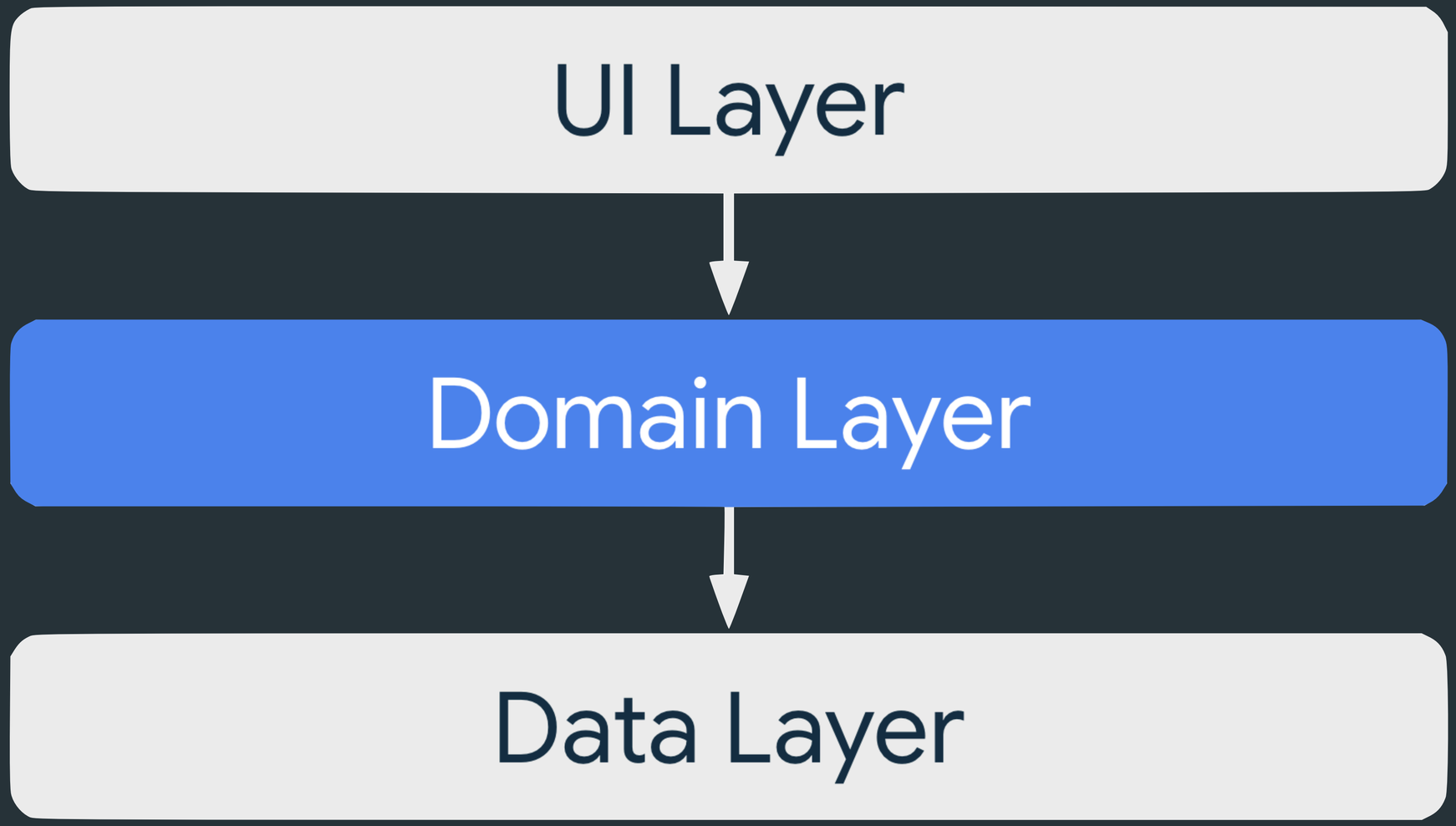
```
class NewsActivity : AppCompatActivity() {

    private val viewModel: NewsViewModel by viewModels()

    override fun onCreate(savedInstanceState: Bundle?) {
        ...

        lifecycleScope.launch {
            repeatOnLifecycle(Lifecycle.State.STARTED) {
                viewModel.uiState.collect {
                    // Update UI elements
                }
            }
        }
    }
}
```

```
@Composable
fun LatestNewsScreen(
    viewModel: NewsViewModel = viewModel()
) {
    // Show UI elements based on the viewModel.uiState
}
```

Show in-progress operations

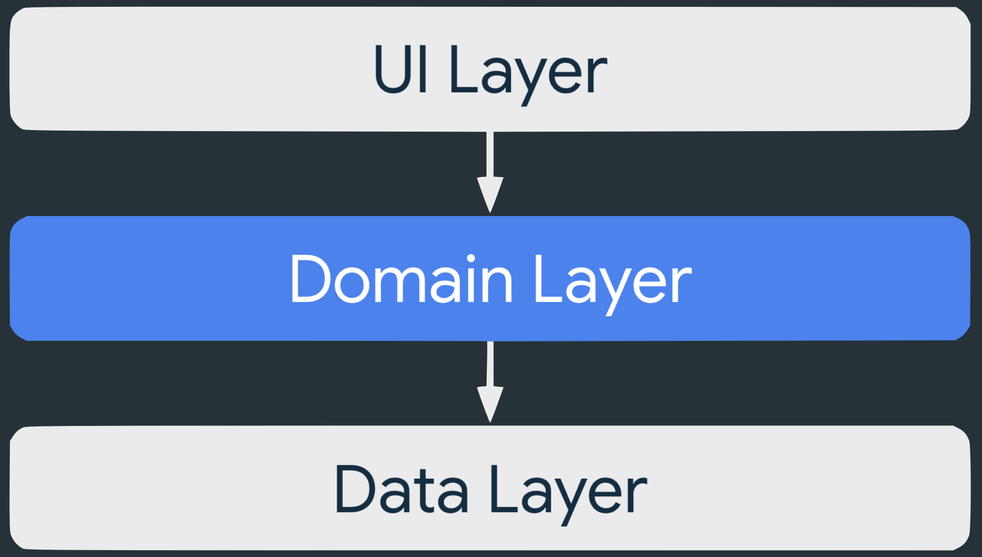
```
data class NewsUiState(
    val isFetchingArticles: Boolean = false,
    ...
)
```

Domain Layer

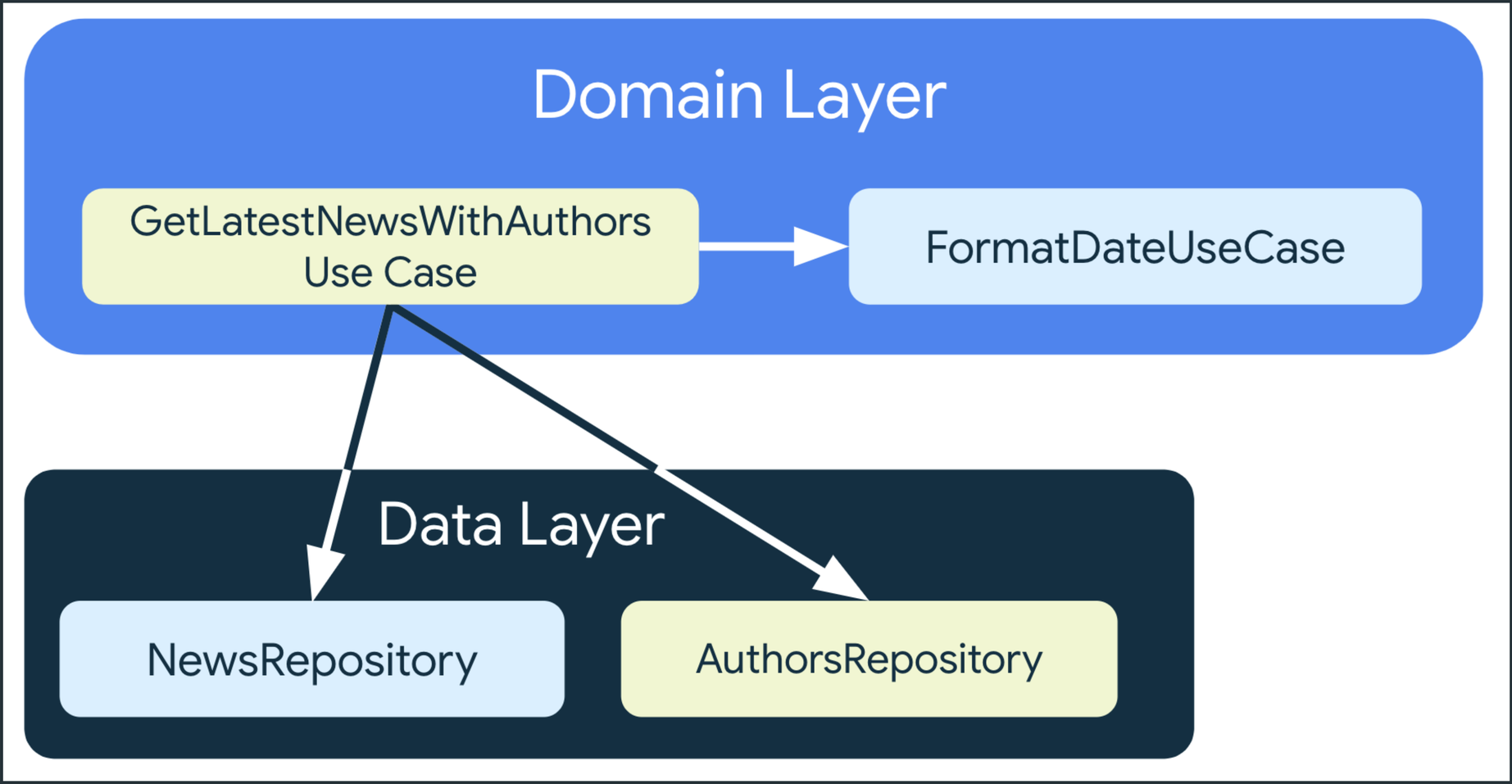


Domain Layer

- Avoids code duplication.
- Improves readability.
- Improves testability.
- Split responsibilities.



Domain Layer



Usage

```
class FormatDateUseCase(userRepository: UserRepository) {

    private val formatter = SimpleDateFormat(
        userRepository.getPreferredDateFormat(),
        userRepository.getPreferredLocale()
    )

    operator fun invoke(date: Date): String {
        return formatter.format(date)
    }
}
```

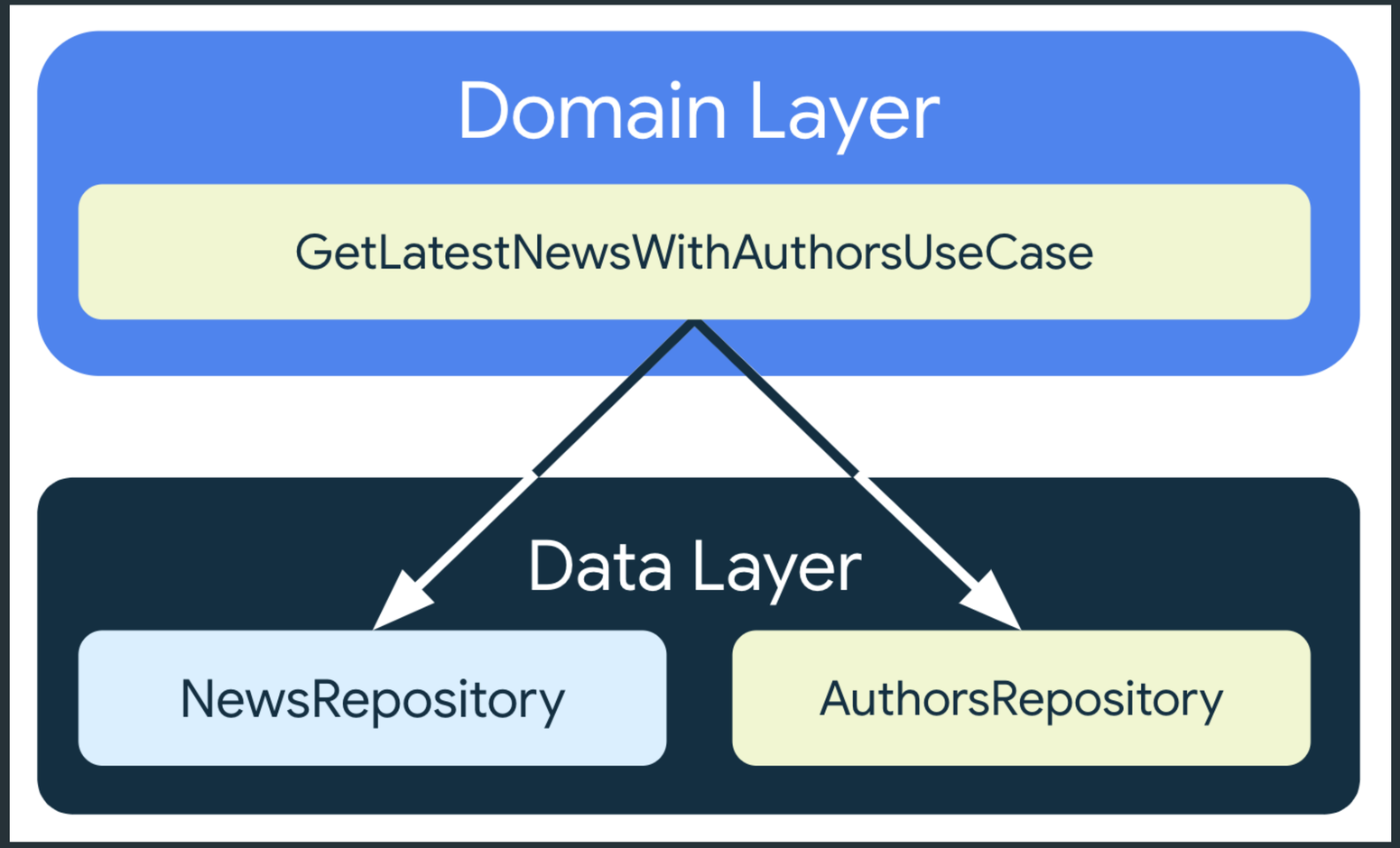
Usage

```
class MyViewModel(formatDateUseCase: FormatDateUseCase) : ViewModel() {
    init {
        val today = Calendar.getInstance()
        val todaysDate = formatDateUseCase(today)
        /* ... */
    }
}
```

Threading

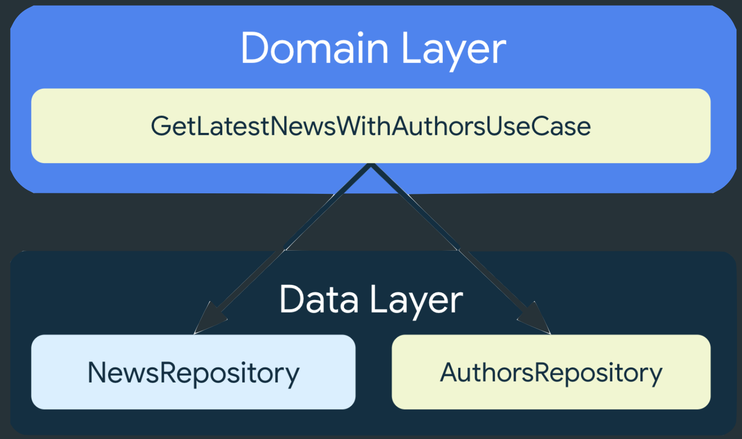
```
class MyUseCase(
    private val defaultDispatcher: CoroutineDispatcher = Dispatchers.Default
) {

    suspend operator fun invoke(...) = withContext(defaultDispatcher) {
        // Long-running blocking operations happen on a background thread.
    }
}
```

Combine repositories

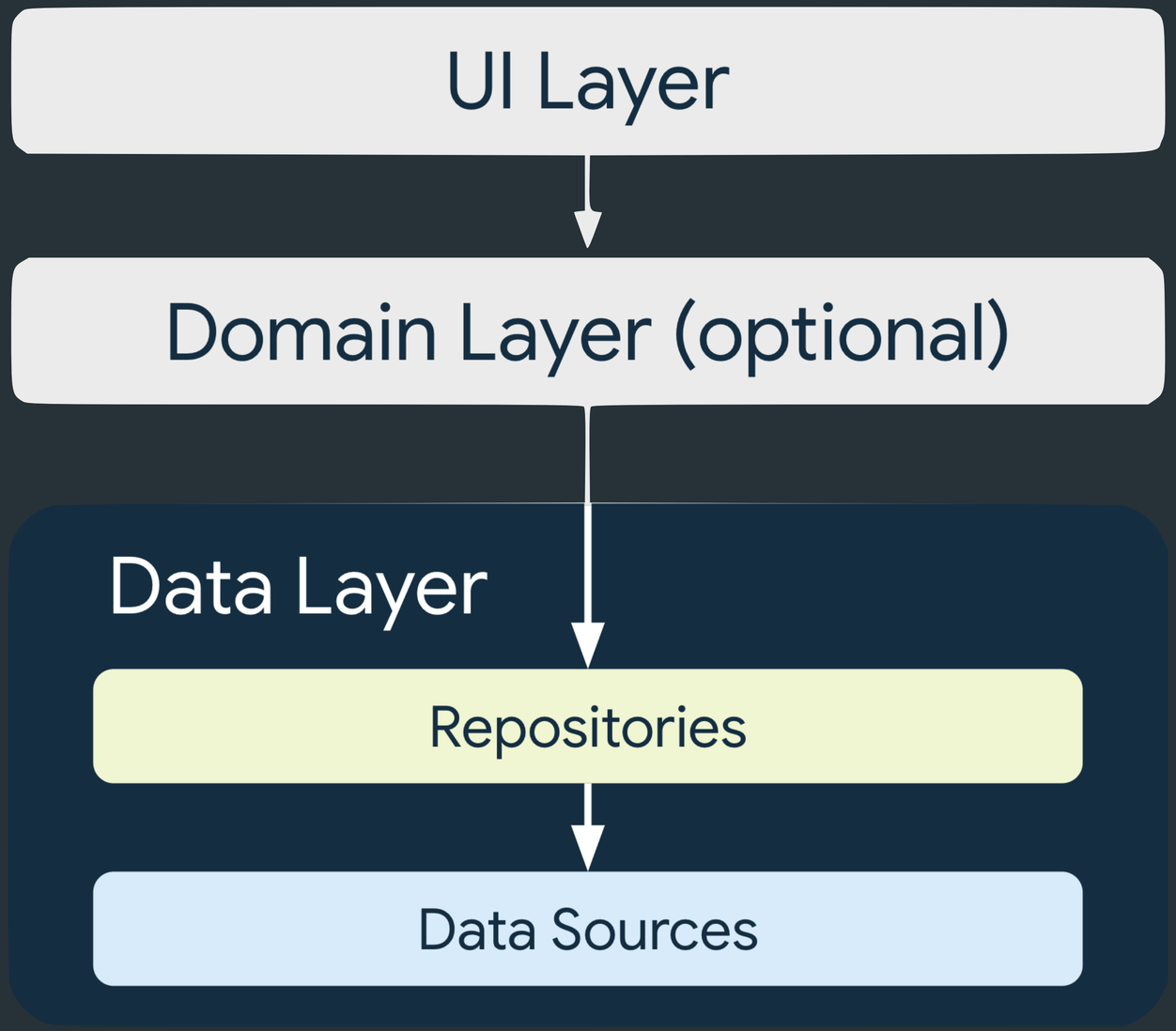


Combine repositories

```
class GetLatestNewsWithAuthorsUseCase(
  private val newsRepository: NewsRepository,
  private val authorsRepository: AuthorsRepository,
  private val defaultDispatcher: CoroutineDispatcher = Dispatchers.Default
) {
    suspend operator fun invoke(): List<ArticleWithAuthor> =
        withContext(defaultDispatcher) {
            val news = newsRepository.fetchLatestNews()
            val result: MutableList<ArticleWithAuthor> = mutableListOf()
            // This is not parallelized, the use case is linearly slow.
            for (article in news) {
                // The repository exposes suspend functions
                val author = authorsRepository.getAuthor(article.authorId)
                result.add(ArticleWithAuthor(article, author))
            }
            result
        }
}
```

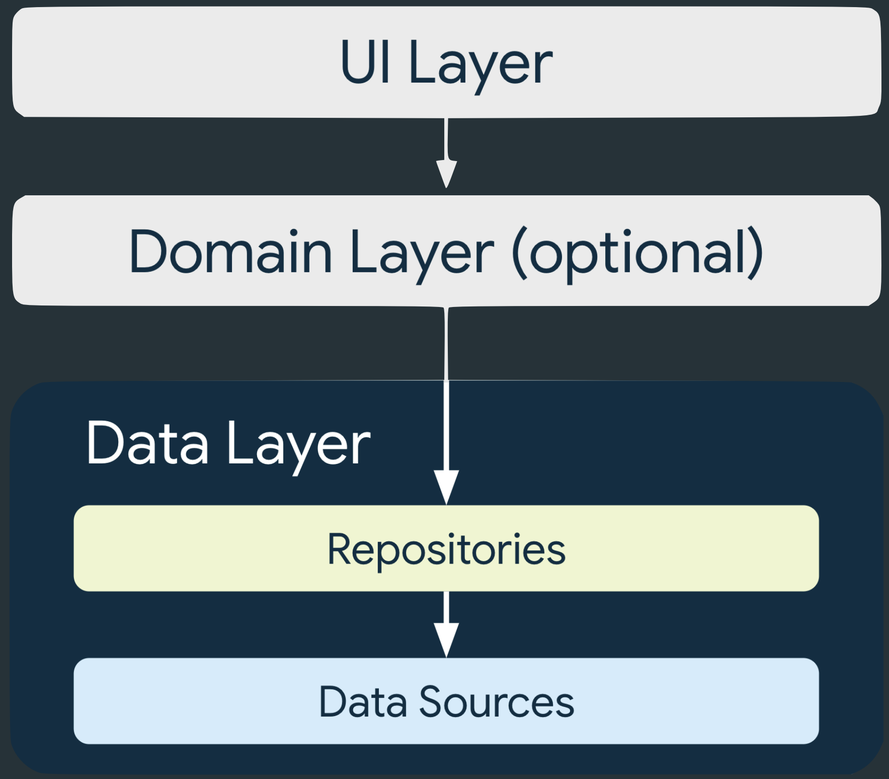


Data Layer


UI Layer
Domain Layer (optional)
Data Layer
Repositories
Data Sources

Data Layer

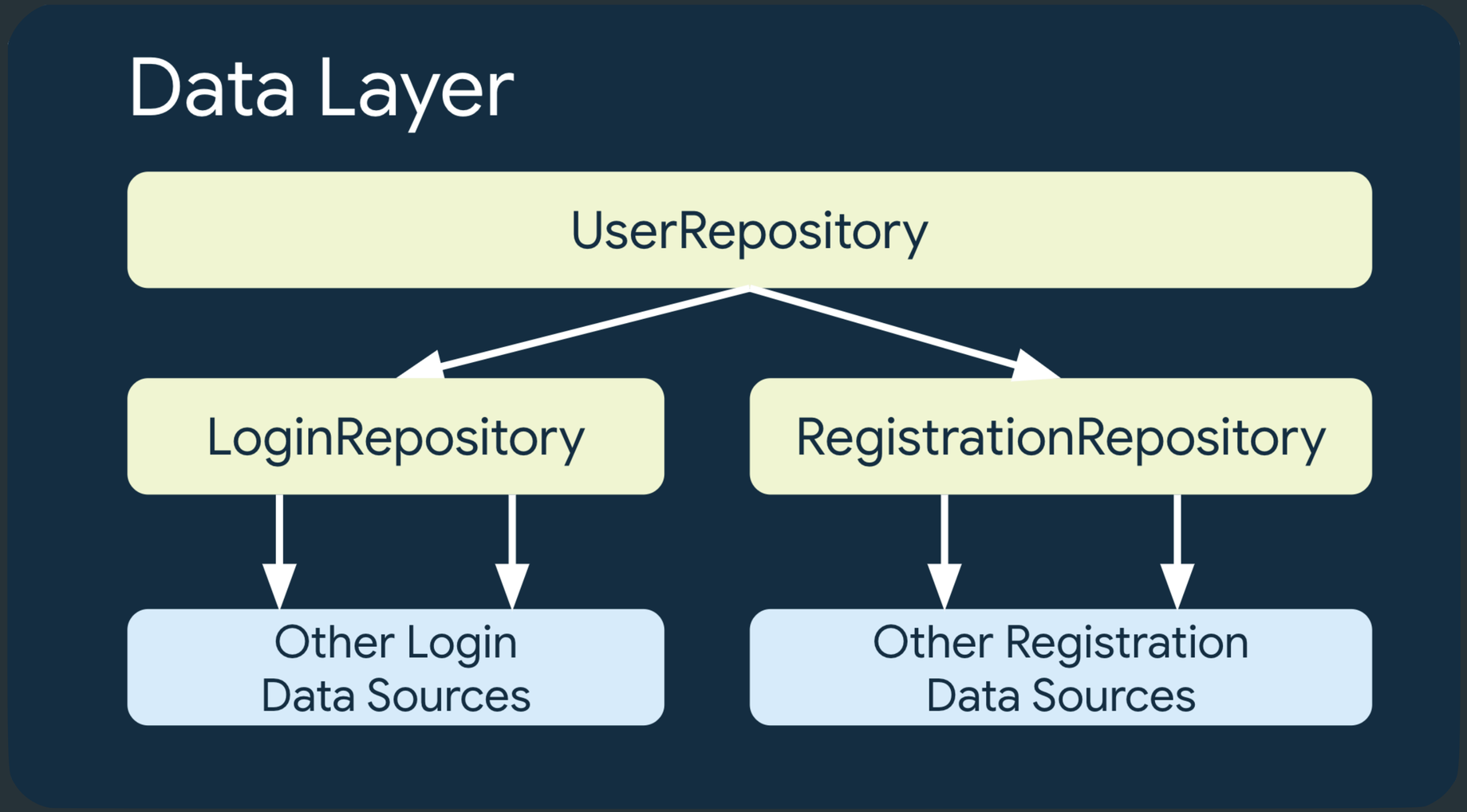
- Exposing data.
- Centralizing data changes.
- Resolving conflicts.
- Abstracting sources of data.
- Combining business logic.



Expose APIs

```
class ExampleRepository(
    private val exampleRemoteDataSource: ExampleRemoteDataSource, // network
    private val exampleLocalDataSource: ExampleLocalDataSource // database
) {

    val data: Flow<Example> = ...

    suspend fun modifyData(example: Example) { ... }
}
```

Multiple levels of repositories



Represent Business Models

```
data class ArticleApiModel(
    val id: Long,
    val title: String,
    val content: String,
    val publicationDate: Date,
    val modifications: Array<ArticleApiModel>,
    val comments: Array<CommentApiModel>,
    val lastModificationDate: Date,
    val authorId: Long,
    val authorName: String,
    val authorDateOfBirth: Date,
    val readTimeMin: Int
)
```

Represent Business Models

- Saves app memory usage.
- Adapts external data types to used data types.
- Provides better separation of concerns.

Create the Repository

```
// NewsRepository is consumed from other layers of the hierarchy.
class NewsRepository(
    private val newsRemoteDataSource: NewsRemoteDataSource
) {
    suspend fun fetchLatestNews(): List<ArticleHeadline> =
        newsRemoteDataSource.fetchLatestNews()
}
```

Cache the Result

```
class NewsRepository(
  private val newsRemoteDataSource: NewsRemoteDataSource
) {
    // Mutex to make writes to cached values thread-safe.
    private val latestNewsMutex = Mutex()
    // Cache of the latest news got from the network.
    private var latestNews: List<ArticleHeadline> = emptyList()
    suspend fun getLatestNews(refresh: Boolean = false): List<ArticleHeadline> {
        if (refresh || latestNews.isEmpty()) {
            val networkResult = newsRemoteDataSource.fetchLatestNews()
            // Thread-safe write to latestNews
            latestNewsMutex.withLock {
                this.latestNews = networkResult
            }
        }
        return latestNewsMutex.withLock { this.latestNews }
    }
}
```

```
class NewsRepository(
    private val newsRemoteDataSource: NewsRemoteDataSource,
    private val externalScope: CoroutineScope
) {
    /* ... */

    suspend fun getLatestNews(refresh: Boolean = false): List<ArticleHeadline> {
        return if (refresh) {
            externalScope.async {
                newsRemoteDataSource.fetchLatestNews().also { networkResult ->
                    // Thread-safe write to latestNews.
                    latestNewsMutex.withLock {
                        latestNews = networkResult
                    }
                }
            }.await()
        } else {
            return latestNewsMutex.withLock { this.latestNews }
        }
    }
}
```

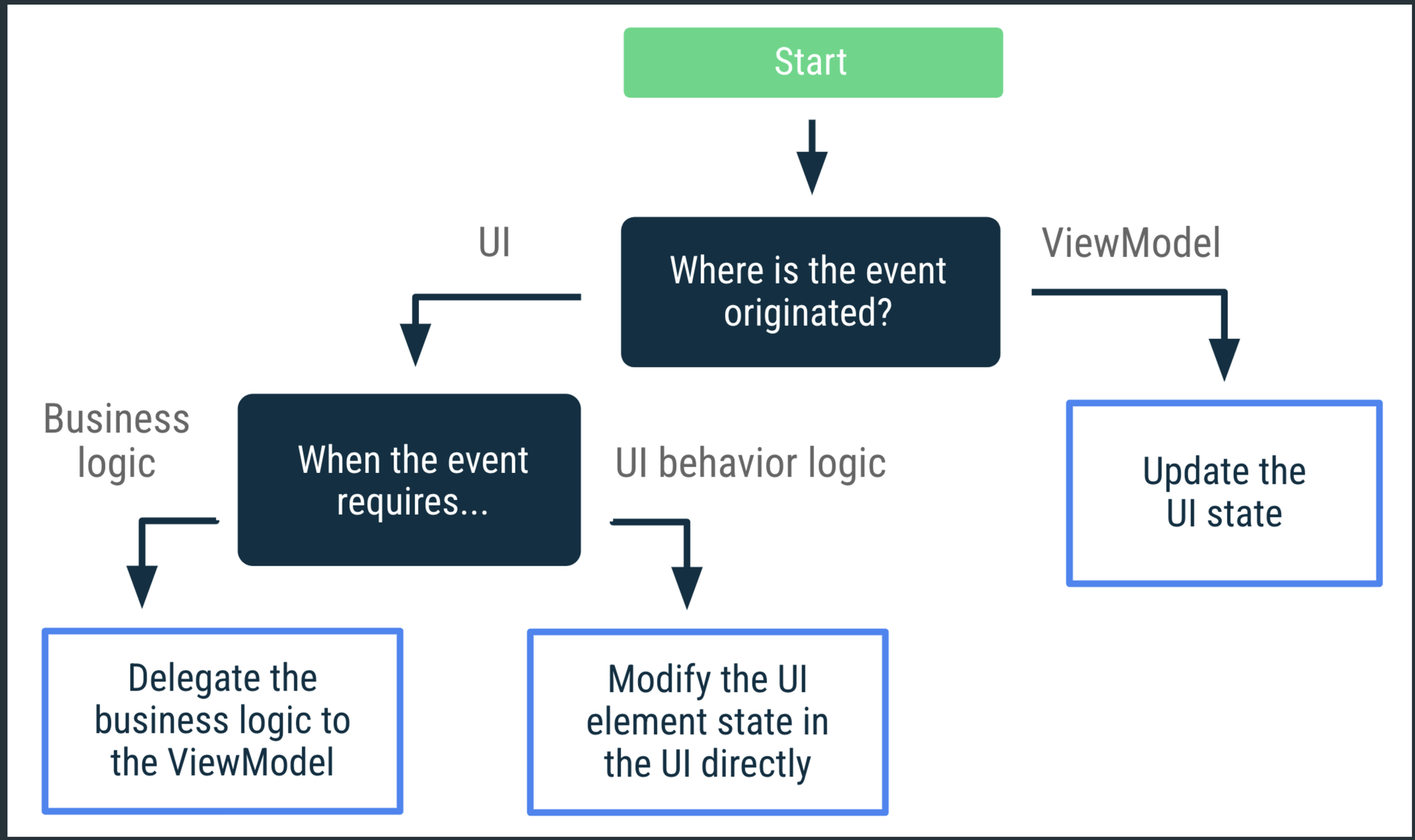
Schedule Tasks

```
class RefreshLatestNewsWorker(
    private val newsRepository: NewsRepository,
    context: Context,
    params: WorkerParameters
) : CoroutineWorker(context, params) {

    override suspend fun doWork(): Result = try {
        newsRepository.refreshLatestNews()
        Result.success()
    } catch (error: Throwable) {
        Result.failure()
    }
}
```

Schedule Tasks

```
private const val REFRESH_RATE_HOURS = 4L
private const val FETCH_LATEST_NEWS_TASK = "FetchLatestNewsTask"
private const val TAG_FETCH_LATEST_NEWS = "FetchLatestNewsTaskTag"

class NewsTasksDataSource(
    private val workManager: WorkManager
) {
    fun fetchNewsPeriodically() {
        val fetchNewsRequest = PeriodicWorkRequestBuilder<RefreshLatestNewsWorker>(
            REFRESH_RATE_HOURS, TimeUnit.HOURS
        ).setConstraints(
            Constraints.Builder()
                .setRequiredNetworkType(NetworkType.TEMPORARILY_UNMETERED)
                .setRequiresCharging(true)
                .build()
        )
            .addTag(TAG_FETCH_LATEST_NEWS)

        workManager.enqueueUniquePeriodicWork(
            FETCH_LATEST_NEWS_TASK,
            ExistingPeriodicWorkPolicy.KEEP,
            fetchNewsRequest.build()
        )
    }

    fun cancelFetchingNewsPeriodically() {
        workManager.cancelAllWorkByTag(TAG_FETCH_LATEST_NEWS)
    }
}
```

Handling UI Events



Handling UI Events

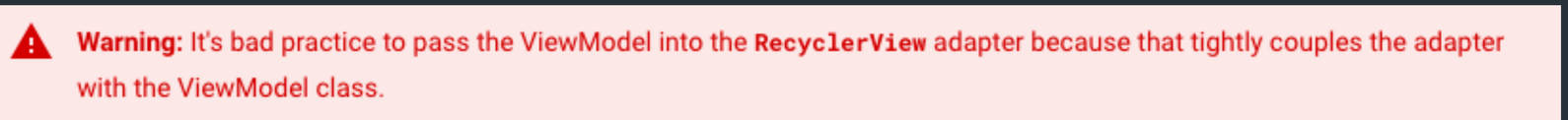
```
class LatestNewsActivity : AppCompatActivity() {

    private lateinit var binding: ActivityLatestNewsBinding
    private val viewModel: LatestNewsViewModel by viewModels()

    override fun onCreate(savedInstanceState: Bundle?) {
        /* ... */

        // The expand details event is processed by the UI that
        // modifies a View's internal state.
        binding.expandButton.setOnClickListener {
            binding.expandedSection.visibility = View.VISIBLE
        }

        // The refresh event is processed by the ViewModel that is in charge
        // of the business logic.
        binding.refreshButton.setOnClickListener {
            viewModel.refreshNews()
        }
    }
}
```

```
@Composable
fun LatestNewsScreen(viewModel: LatestNewsViewModel = viewModel()) {

    // State of whether more details should be shown
    var expanded by remember { mutableStateOf(false) }

    Column {
        Text("Some text")
        if (expanded) {
            Text("More details")
        }

        Button(
          // The expand details event is processed by the UI that
          // modifies this composable's internal state.
          onClick = { expanded = !expanded }
        ) {
          val expandText = if (expanded) "Collapse" else "Expand"
          Text("$expandText details")
        }

        // The refresh event is processed by the ViewModel that is in charge
        // of the UI's business logic.
        Button(onClick = { viewModel.refreshNews() }) {
            Text("Refresh data")
        }
    }
}
```

User events in RecyclerViews

```
data class NewsItemUiState(
    val title: String,
    val body: String,
    val bookmarked: Boolean = false,
    val publicationDate: String,
    val onBookmark: () -> Unit
)
```

```
class LatestNewsViewModel(
    private val formatDateUseCase: FormatDateUseCase,
    private val repository: NewsRepository
)
    val newsListUiItems = repository.latestNews.map { news ->
        NewsItemUiState(
            title = news.title,
            body = news.body,
            bookmarked = news.bookmarked,
            publicationDate = formatDateUseCase(news.publicationDate),
            // Business logic is passed as a lambda function that the
            // UI calls on click events.
            onBookmark = {
                repository.addBookmark(news.id)
            }
        )
    }
}
```



Consuming events and trigger state updates

```
// Models the UI state for the Latest news screen.
data class LatestNewsUiState(
    val news: List<News> = emptyList(),
    val isLoading: Boolean = false,
    val userMessage: String? = null
)
```

Consuming events and trigger state updates

```
// Models the UI state for the Latest news screen.
data class LatestNewsUiState(
    val news: List<News> = emptyList(),
    val isLoading: Boolean = false,
    val userMessage: String? = null
)
```

```
class LatestNewsViewModel(/* ... */) : ViewModel() {

    var uiState by mutableStateOf(LatestNewsUiState())
        private set

    fun refreshNews() {
        viewModelScope.launch {
            // If there isn't internet connection, show a new message on the screen.
            if (!internetConnection()) {
                uiState = uiState.copy(userMessage = "No Internet connection")
                return@launch
            }

            // Do something else.
        }
    }

    fun userMessageShown() {
        uiState = uiState.copy(userMessage = null)
    }
}
```

Consuming events and trigger state updates

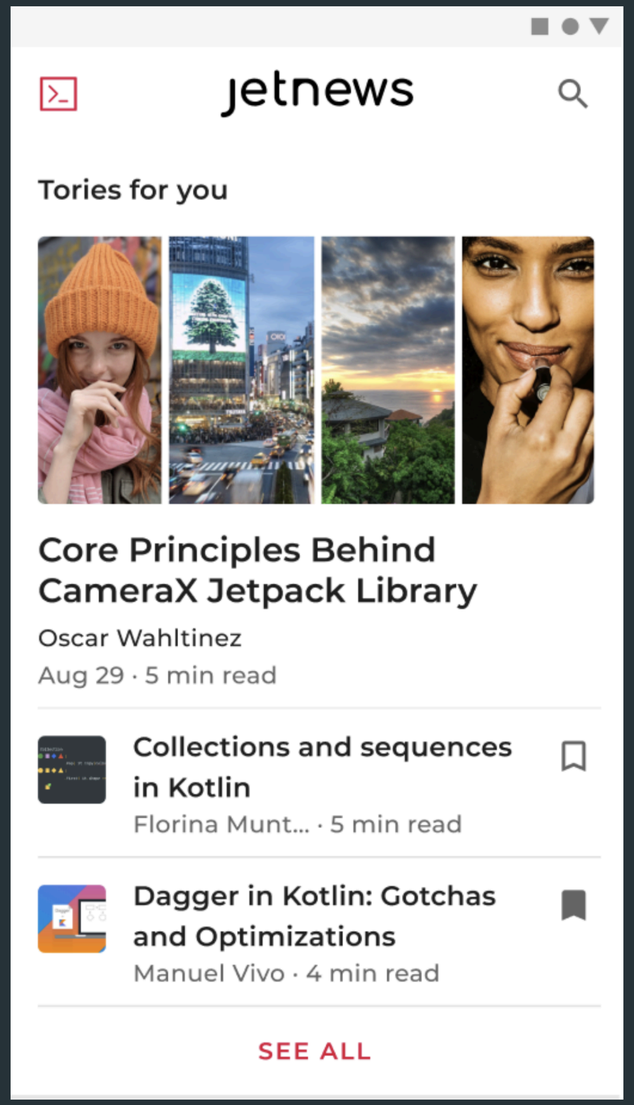
```
@Composable
fun LatestNewsScreen(
    snackbarHostState: SnackbarHostState,
    viewModel: LatestNewsViewModel = viewModel(),
) {
    // Rest of the UI content.

    // If there are user messages to show on the screen,
    // show it and notify the ViewModel.
    viewModel.uiState.userMessage?.let { userMessage ->
        LaunchedEffect(userMessage) {
            snackbarHostState.showSnackbar(userMessage)
            // Once the message is displayed and dismissed, notify the ViewModel.
            viewModel.userMessageShown()
        }
    }
}
```

Navigation Events

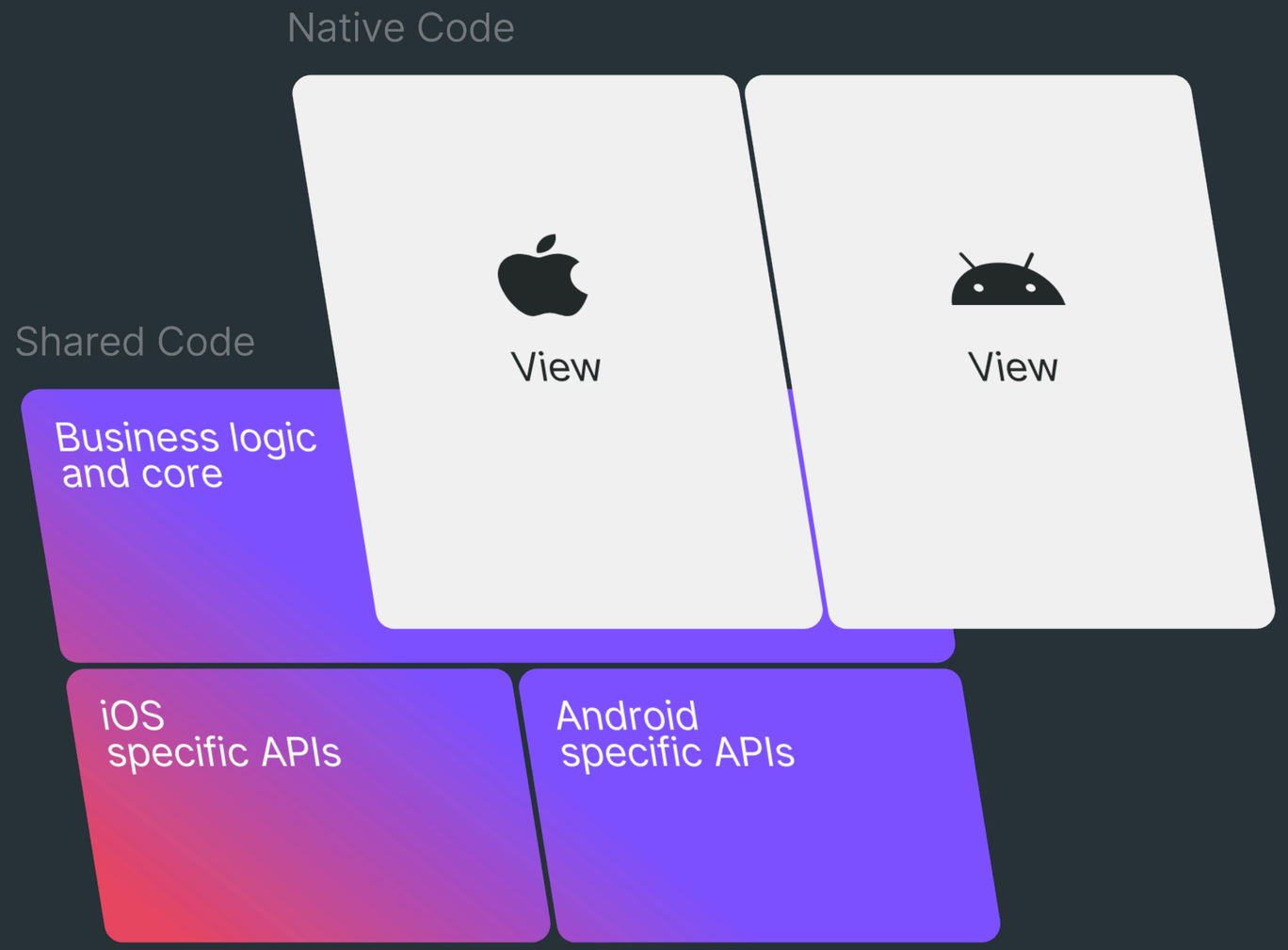
```
@Composable
fun NewsApp() {
    val navController = rememberNavController()
    NavHost(navController = navController, startDestination = "latestNews") {
        composable("latestNews") {
            MyScreen(
                // The navigation event is processed by calling the NavController
                // navigate function that mutates its internal state.
                onProfileClick = { navController.navigate("profile") }
            )
        }
        /* ... */
    }
}

@Composable
fun LatestNewsScreen(
    viewModel: LatestNewsViewModel = viewModel(),
    onProfileClick: () -> Unit
) {
    Column {
```

Jetnews

DEMO



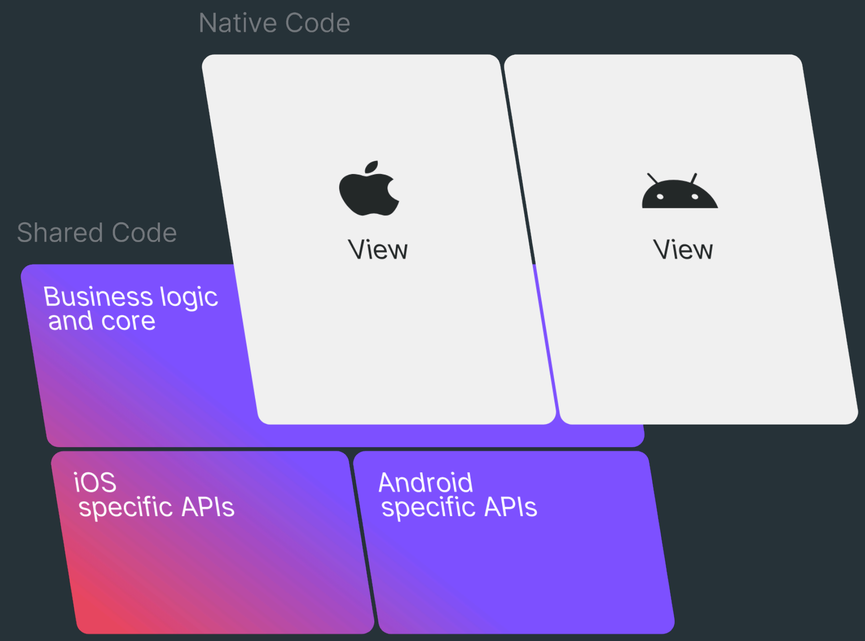
KMM



https://kotlinlang.org/docs/kmm-overview.html

Supported platforms

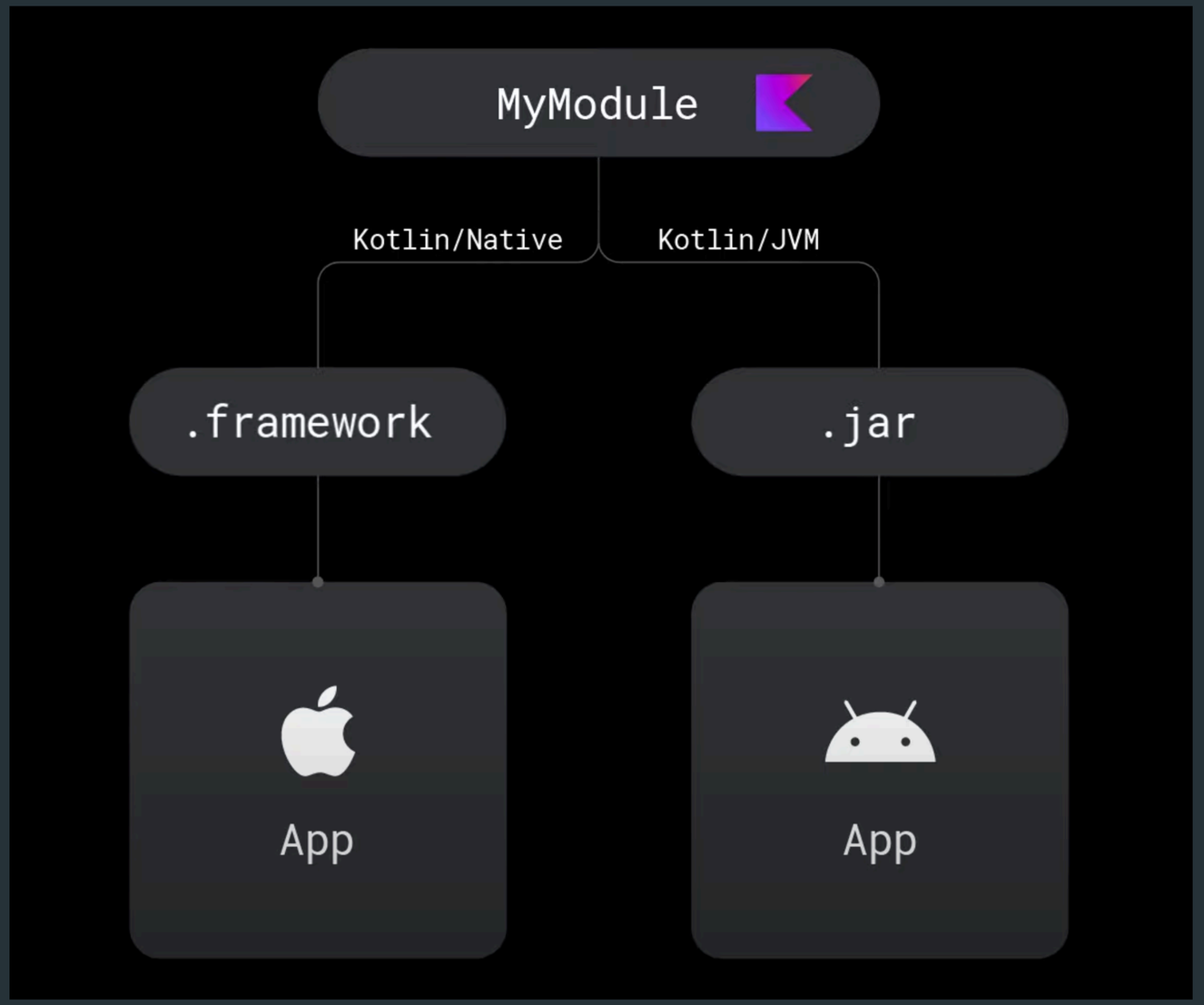
- Android applications and libraries.
- Android Native Development Kit (NDK).
- Apple iOS on ARM64 (>= iPhone 5s).
- Apple watchOs on ARM64 (>= Series 4).



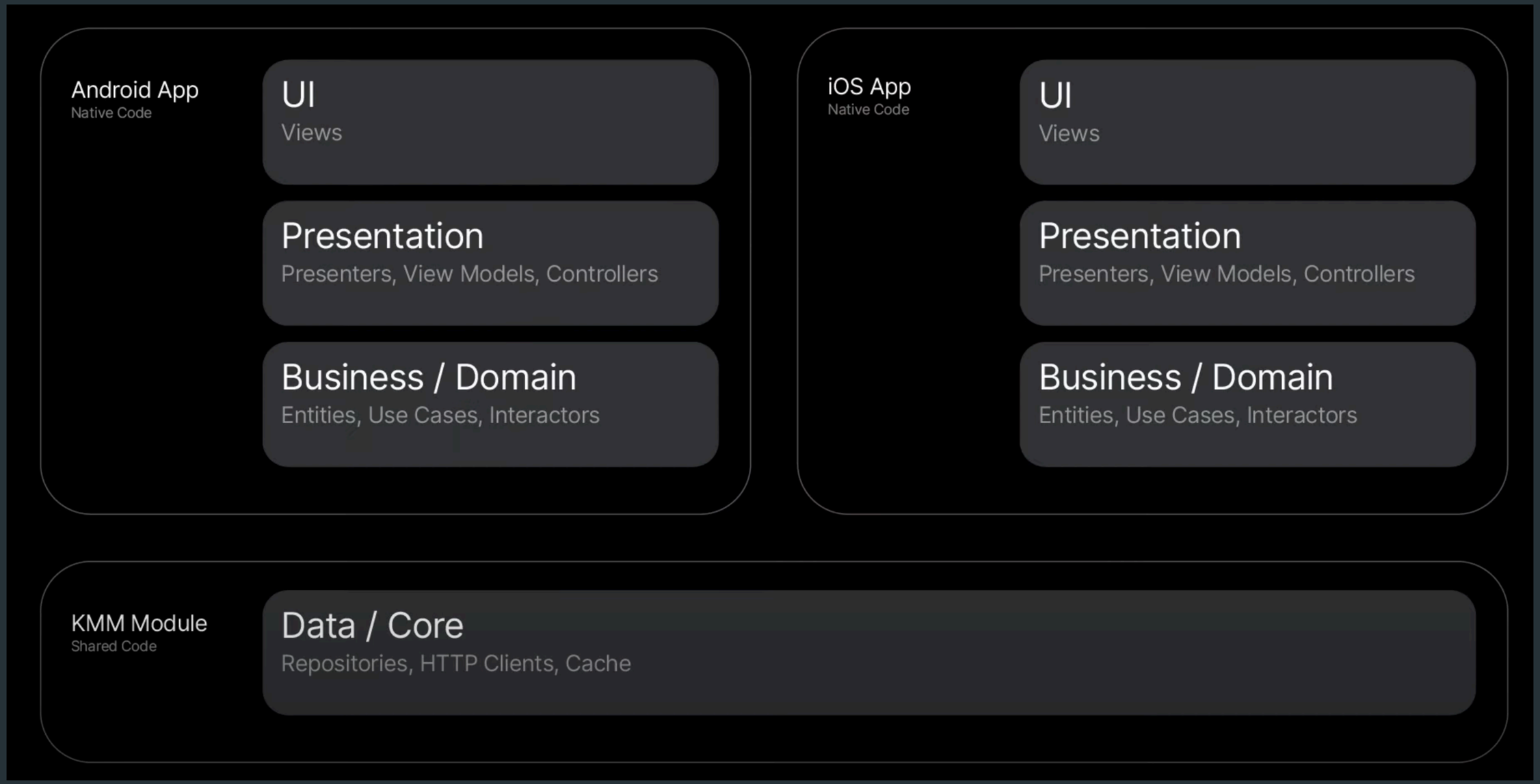
KMP - Supported platforms

Target platform	Target preset
Kotlin/JVM	`jvm`
Kotlin/JS	`js`
Android applications and libraries	`android`
Android NDK	`androidNativeArm32`, `androidNativeArm64`, `androidNativeX86`, `androidNativeX64`
iOS	`iosArm32`, `iosArm64`, `iosX64`, `iosSimulatorArm64`
watchOS	`watchosArm32`, `watchosArm64`, `watchosX86`, `watchosX64`, `watchosSimulatorArm64`
tvOS	`tvosArm64`, `tvosX64`, `tvosSimulatorArm64`
macOS	`macosX64`, `macosArm64`
Linux	`linuxArm64`, `linuxArm32Hfp`, `linuxMips32`, `linuxMipsel32`, `linuxX64`
Windows	`mingwX64`, `mingwX86`
WebAssembly	`wasm32`

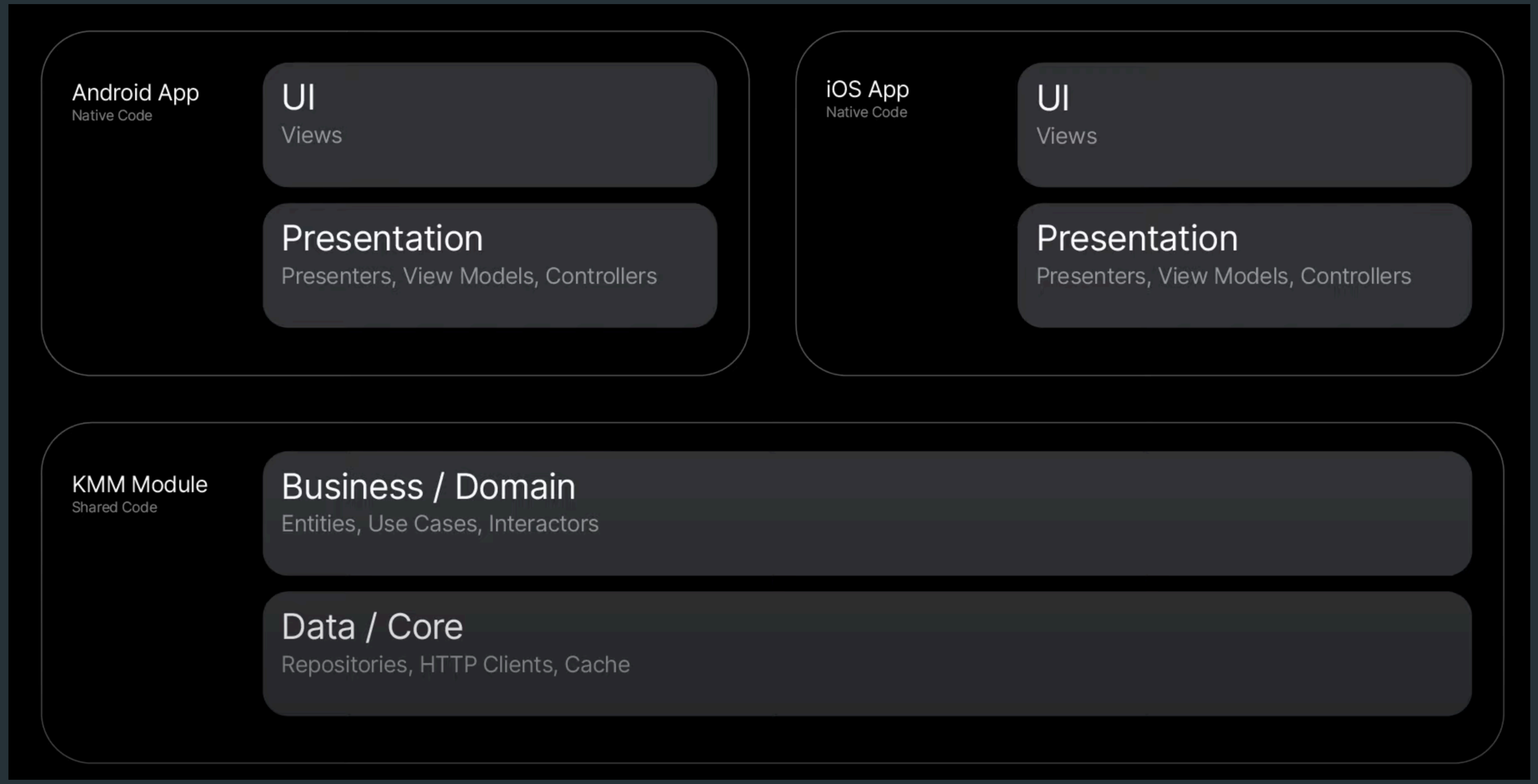
Compilation



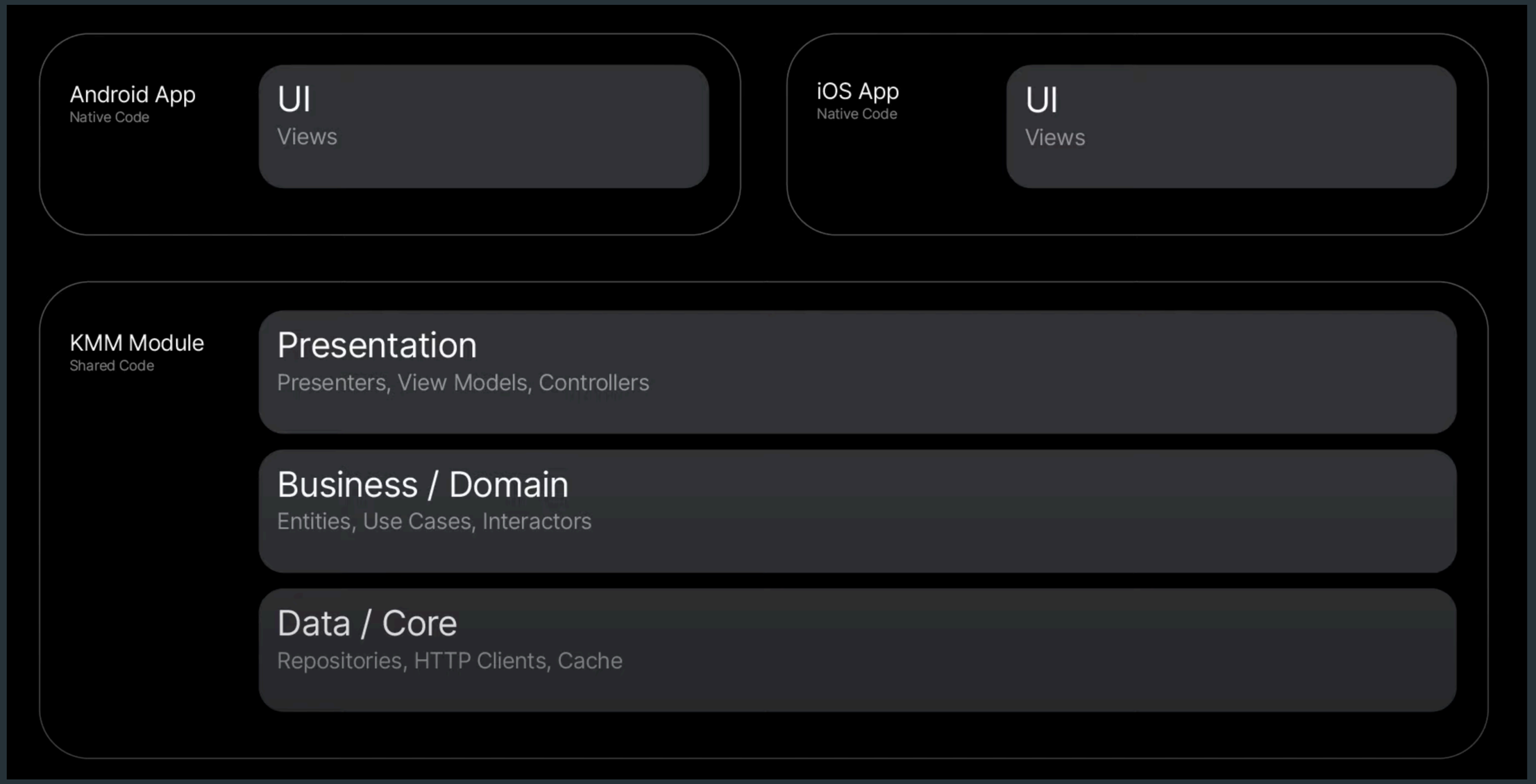
Architecture



Architecture

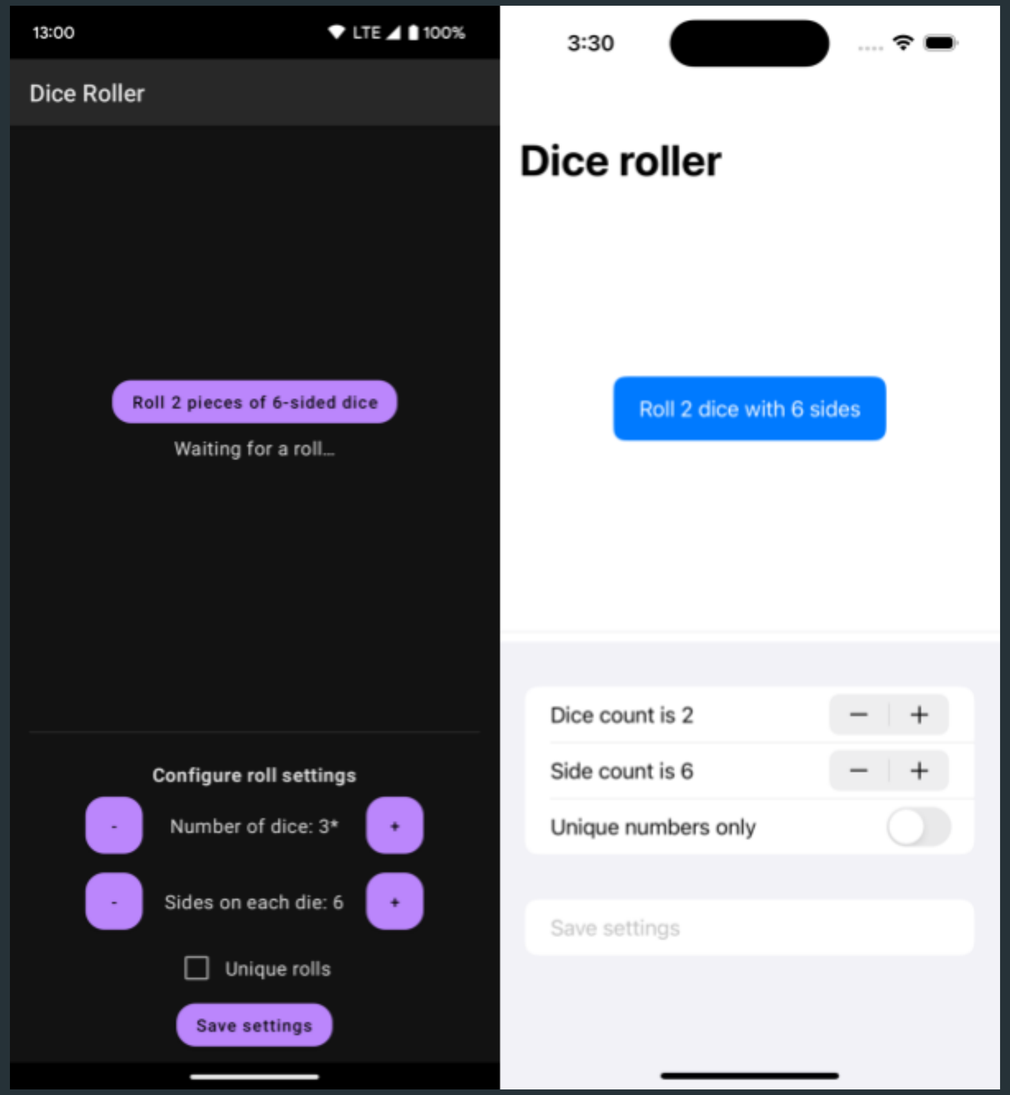


Architecture



DiceRoller

DEMO



Lecture outcomes

- Learn about App Architecture.
- How to handle events.
- KMM/KMP.