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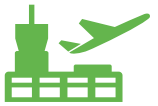
Architecting .NET Applications

- By Aniket Inge

Introduction / Course Agenda



Principles of architecture

Goals of architecture (*-ities)

Central theme of application architectures

Architecture types

Future

Q & A

About Me

Aniket Inge

Associate Technical Architect

Payments & Loyalty Solutions Group

Architecting applications in .NET, Java and JavaScript

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Principles of architecture

Principles of architecture

- **Single Responsibility Principle (SRP)**

  Every component/module in the architecture of the system must exist for single reason only & should be as loosely coupled as possible with other components/modules of the system

- **Separation of Concerns (SOC)**

  It is a pattern of separating application into distinct sections such that, each section addresses a separate concern.

- **Open Close Principle (OCP)**

  The system should be “Open” for extension, but “Closed” for modification

- **Law of Demeter (LoD)**

  The components of the system should only have limited knowledge of other components & must talk only to it’s immediate “friends” using loosely coupled interfaces

- **Don’t Repeat Yourself (DRY)**

  No two components in the system should have similar responsibilities/reason for existence

- **You Ain’t Gonna Need It (YAGNI)**

  Don’t add redundant components in the system. Avoid BDUF (Big Design Upfront)

- **Keep it Simple, Stupid (KISS)**

  The system as a whole should be easy to comprehend, reason about and as simple as possible

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Goals of architecture (*-ities)

Goals of architecture

- Substitutability
- Scalability
- Evolvability
- Testability
- Availability
- Reliability
- Security
- Independent Deploy-ability (Upgradability)
- Performance
- Auditability

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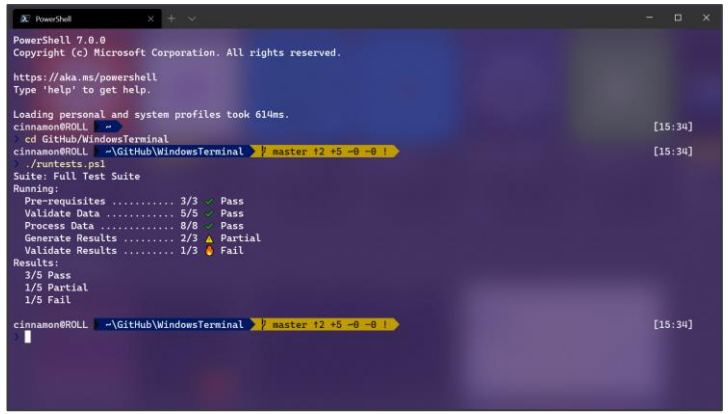
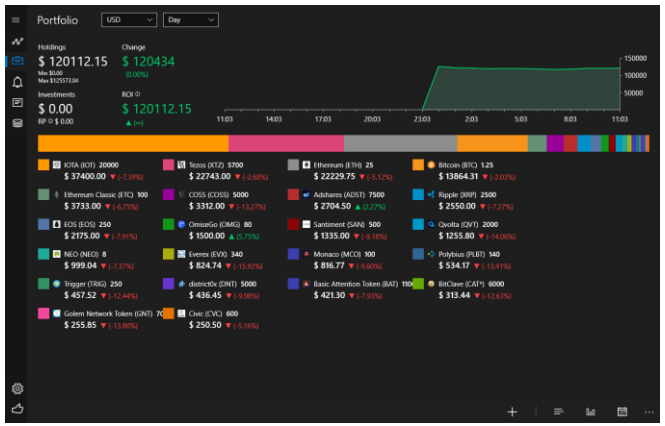
Central theme of application architecture

Central theme / Application Types

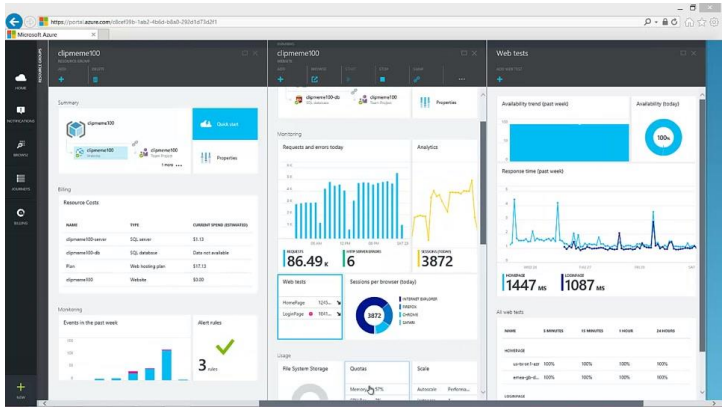
Terminal Applications



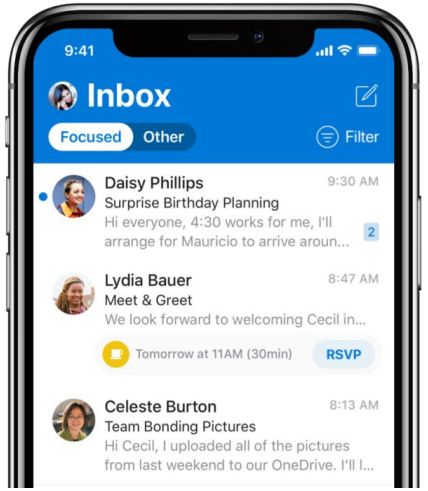
Desktop Applications



Web Applications

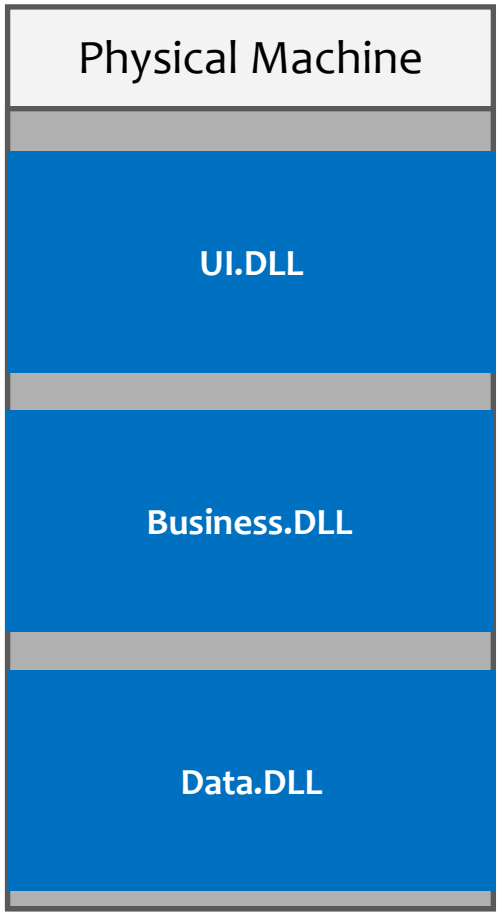


Mobile Applications

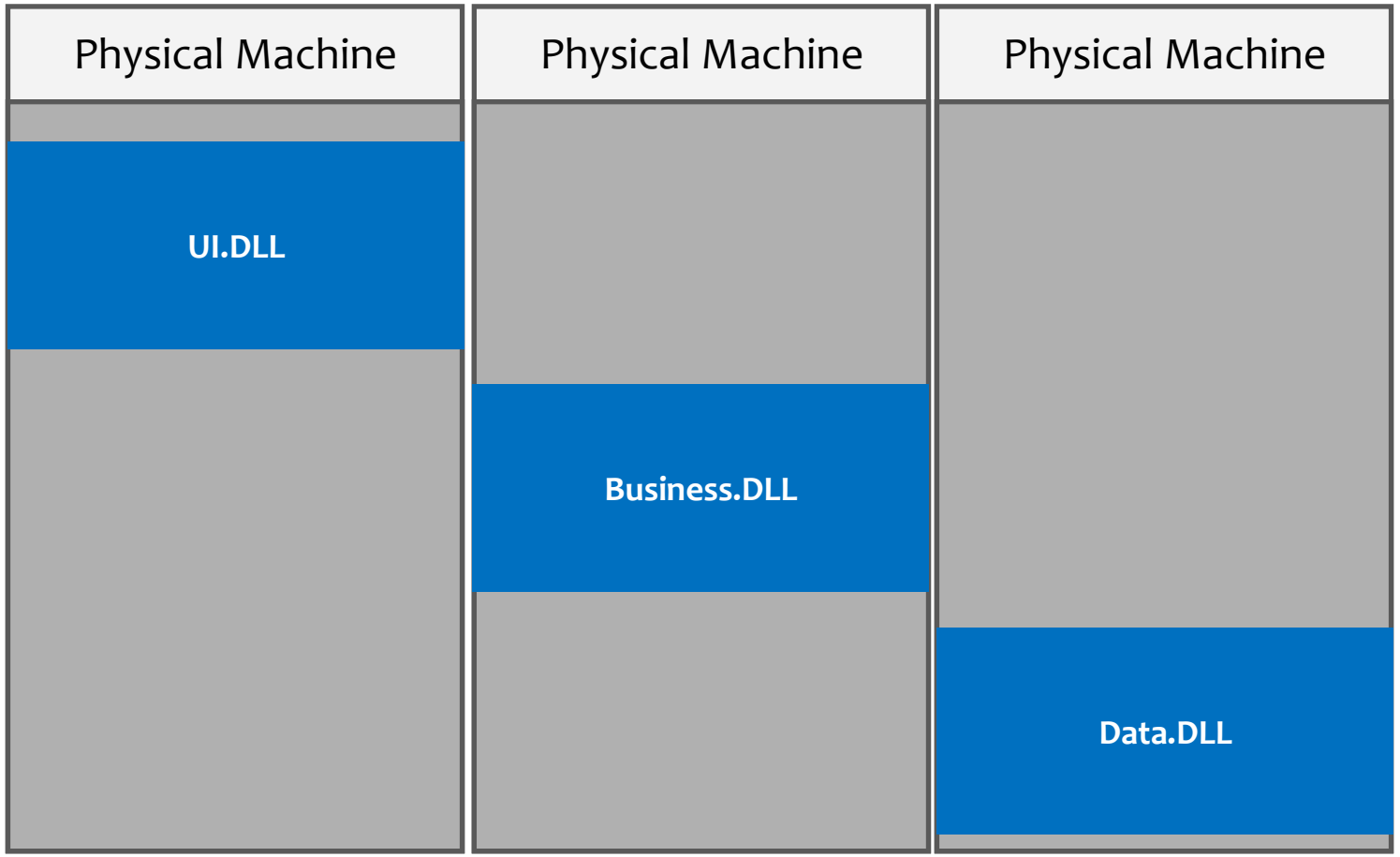


Central theme / Layers and Tiers

1 Tier, 3 Layer Architecture

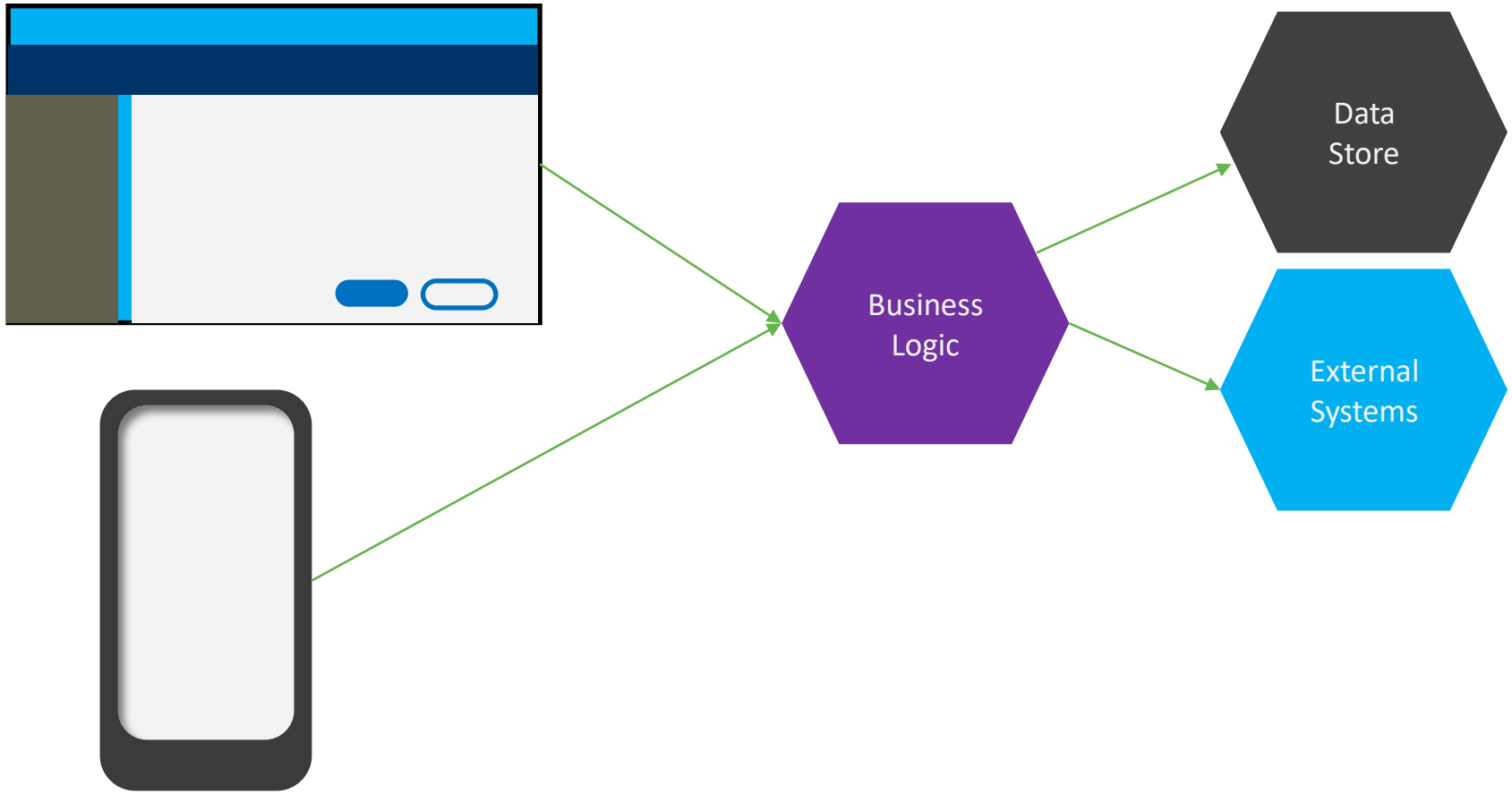


3 Tier, 3 Layer Architecture



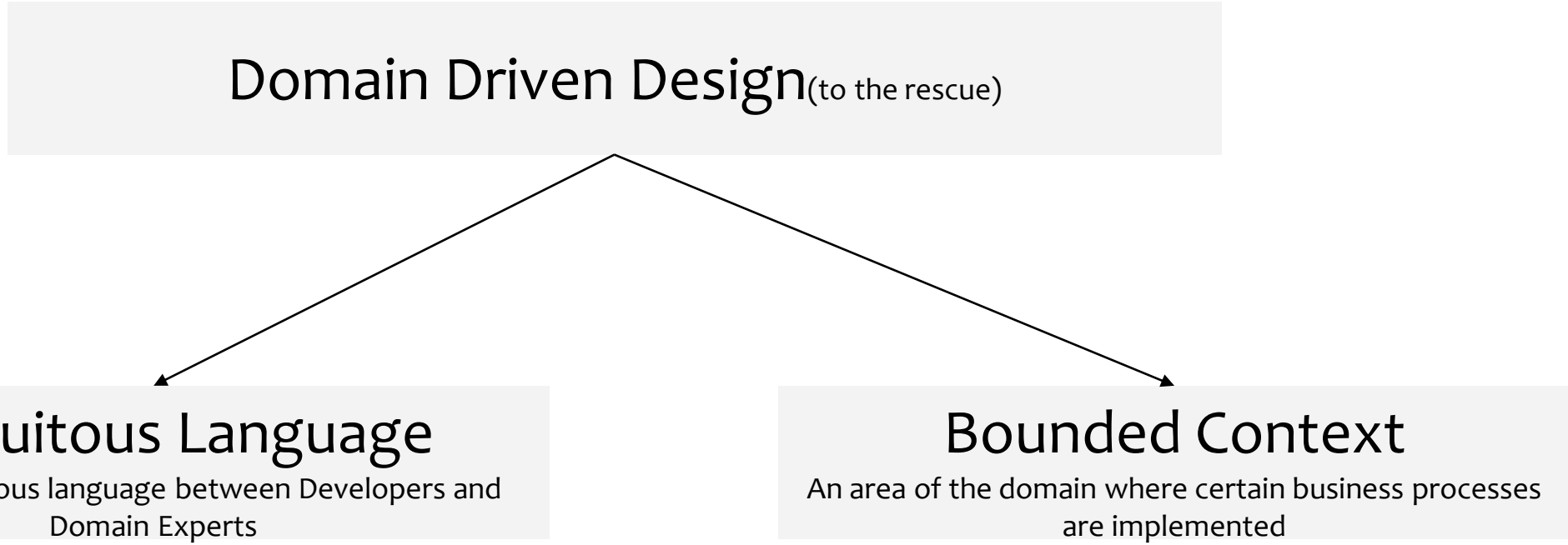
Central theme / User Interface

User Interface is just an interface between User and the Business Logic



Central theme / Business Layer (or Tier)

- Business layer is purely code, and must remain testable and extensible
- Business layer is the “core” or the “brain” of the application
- Business layer interfaces with most of the external components (called the “Infrastructure”)
- Depending upon the application’s business domain, this layer can get complicated



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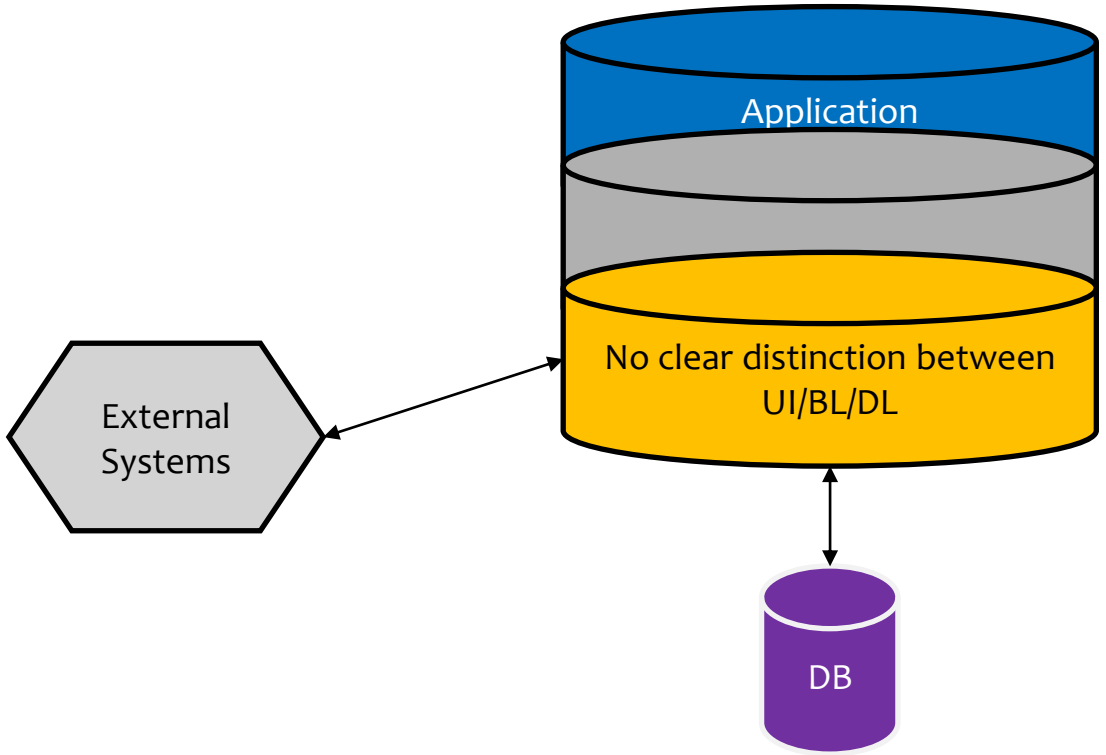
Architecture Types

Architecture Types / Index

- Monolith Architecture
- Client-Server Architecture
- Three-Layer/Tier Architecture
- N-Tier Architecture
- Microkernel Architecture
- Hexagonal Architecture
- Clean Architecture with DDD
- Event Driven Architecture
- Multi-App Architecture with Message Bus
- Multi-App Architecture with Pub-Sub
- Microservices Architecture

Architecture Types / Monolith

- Architecture where UI and Business Logic with Data Store are tightly coupled.
- Change to either one of the component will require complete re-deployment
- Requires rigorous unit testing, functional testing, systems testing, end-to-end testing before deployment
- High chances of breaking, if done incorrectly
- Typically waterfall model followed
- Low reusability and low substitutability
- Highly efficient (high performance), but not scalable horizontally [that is, not easily scalable across physical machines]

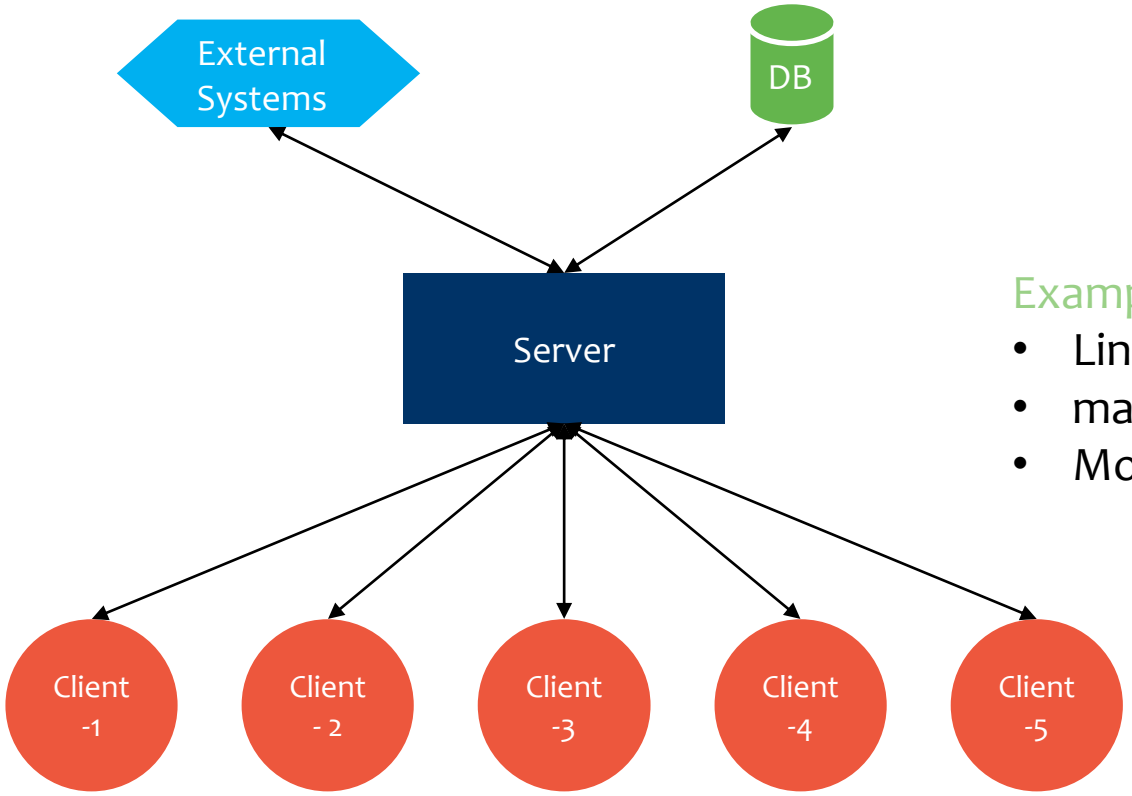


Example:

Most flight systems at NASA during 1970s-1990s … especially the Shuttle programs

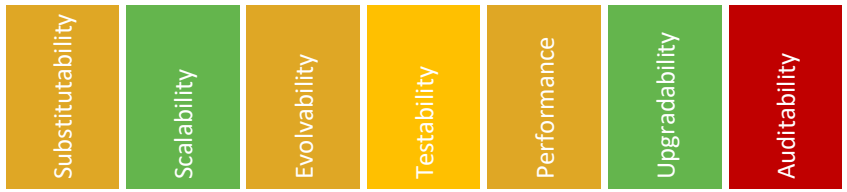
Architecture Types / Client-Server

- Two-Layer separation of concerns
- Highly scalable & efficient architecture
- Mostly achieved through OS sockets and networking, but can also be achieved via named-pipes & mailslots
- Improved testability and upgradability due to substitutability. (☺)



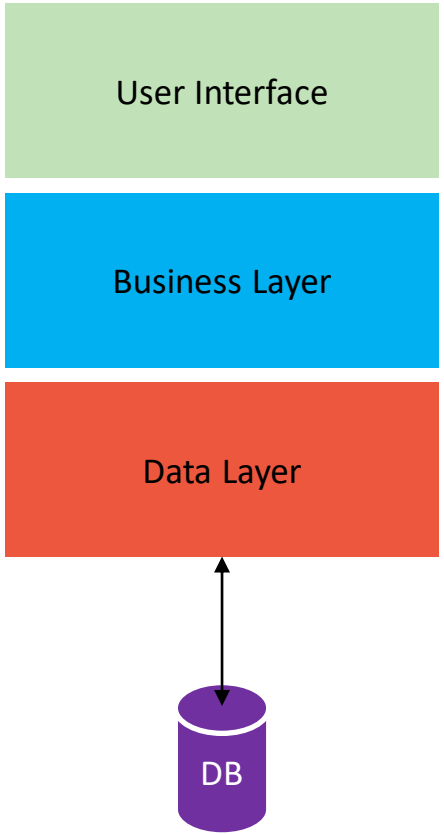
Examples:

- Linux's X.Org server, for X Windows System
- macOS's Quartz Display Engine
- Most MMORPG games



Architecture Types / Three Layer/Tier Architecture

- Enhanced separation of concerns
- User Interface Layer, Business Layer and Data Layer independently scalable
- Highly testable (but not 100% Unit-Test Automatable), maintainable and upgradable architecture, especially with Tiering
- Tiering typically achieved through WCF services

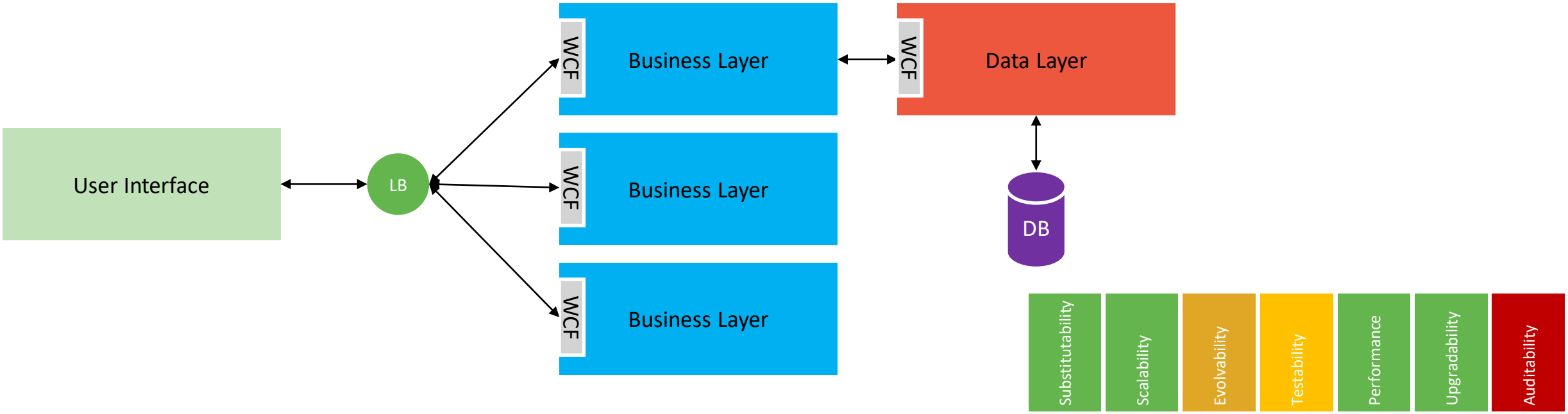


Examples:

- Most Web Applications & Desktop Applications
- Pre-Modern Mobile Applications

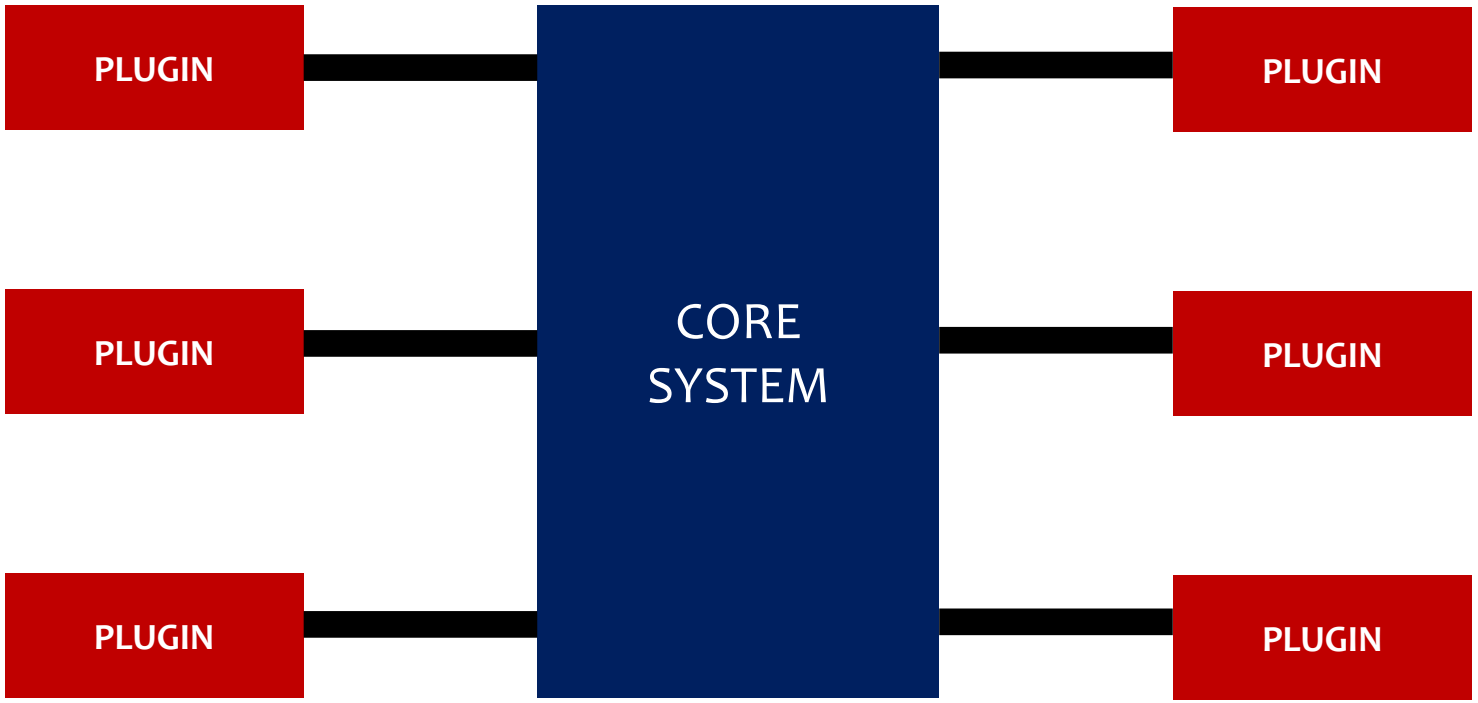
Architecture Types / N-Tier Architecture

- N-Tier Applications extend the concept of 3-Tier Architecture and allow vertical and horizontal scaling
- The multiple tiers are scaled horizontally using round-robin based resource managed load balancers
- Using Cloud technologies, these tiers can be auto-scaled vertically to handle peak loads
- Independent development possible, code for each tier can be written by separate team with focused technical knowledge
- For example, data tier can be managed and programmed by Data experts while UI and UX experts can simultaneously work on the UI tier



Architecture Types / Microkernel Architecture

- In Microkernel architecture, application logic is divided between two types of architecture components:
  - Core System
  - Plugin Modules
- Provides extensibility, flexibility and isolation of application features & custom processing
- Core system is usually the general business logic without custom code for special cases, special rules or complex conditional processing
- Core system can exist without the additional plugin modules, but the plugin modules can be hot-loaded without downtime

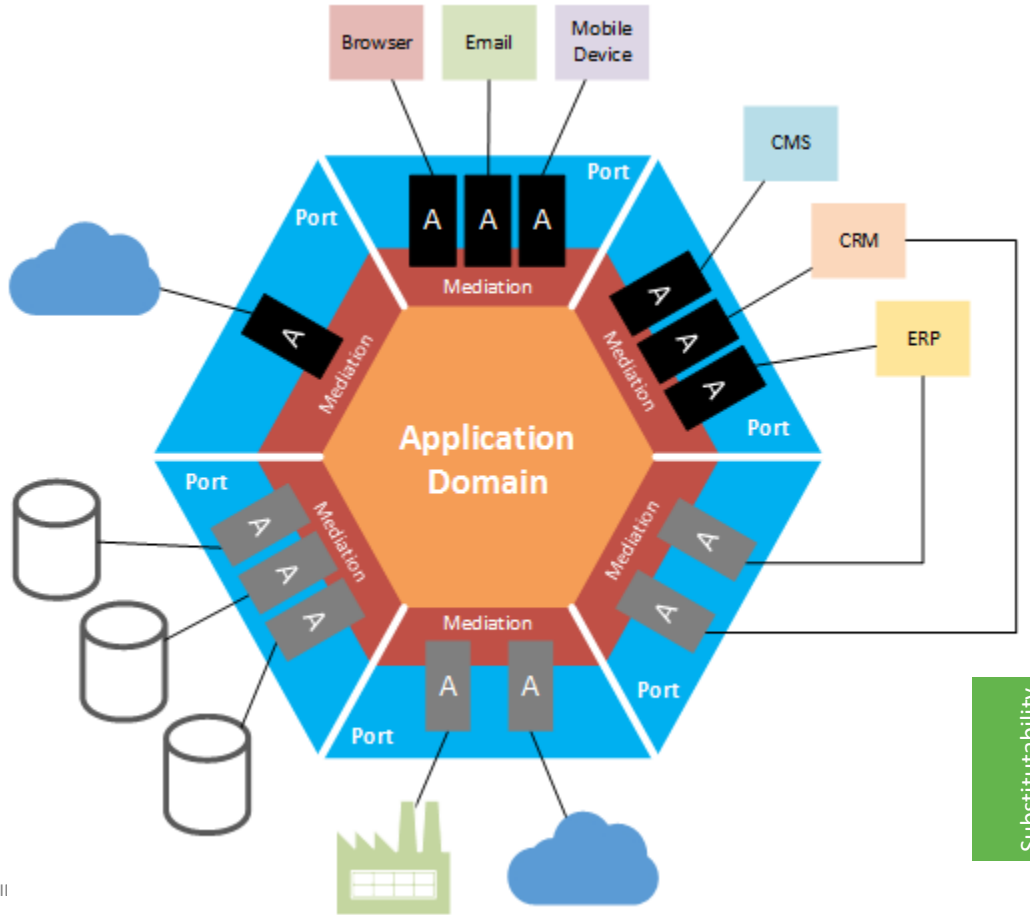


Examples:

- Most Operating System kernels
- Adobe Photoshop, Illustrator etc.
- Autodesk Maya, 3DSMax
- C# Roslyn Compiler
- Mozilla Firefox & Google Chrome
- Game Engines

Architecture Types / Hexagonal Architecture

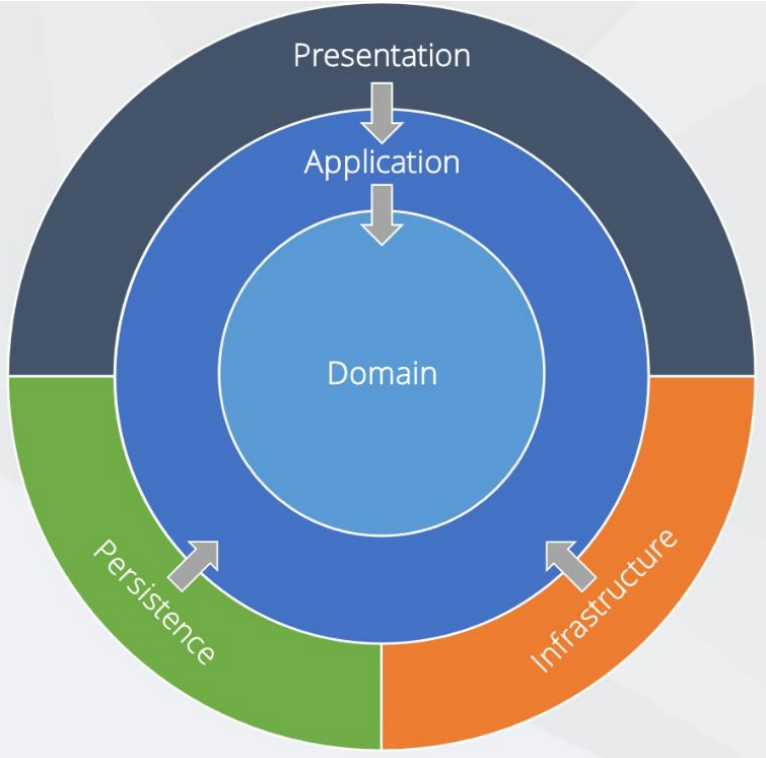
- Major goal of Hexagonal architecture is to separate the input and output boundaries from the core business logic of the application
- Improved testability as all the inputs to the business layer and the outputs from the business layer are isolated behind clean, well defined interfaces
- “Fakes” and “Mocks” can be used during development & unit testing – in case the production database is not up
- Development strategies such as TDD can be used – providing high quality code



Substitutability
Scalability
Evolvability
Testability
Performance
Upgradability
Auditability

Architecture Types / Clean Architecture with DDD

- Clean Architecture was proposed by Robert Cecil Martin
- It is independent of frameworks
- Independent of UI
- Independent of the database (does not even assume a database)
- All the dependencies direct inwards
- Highly testable

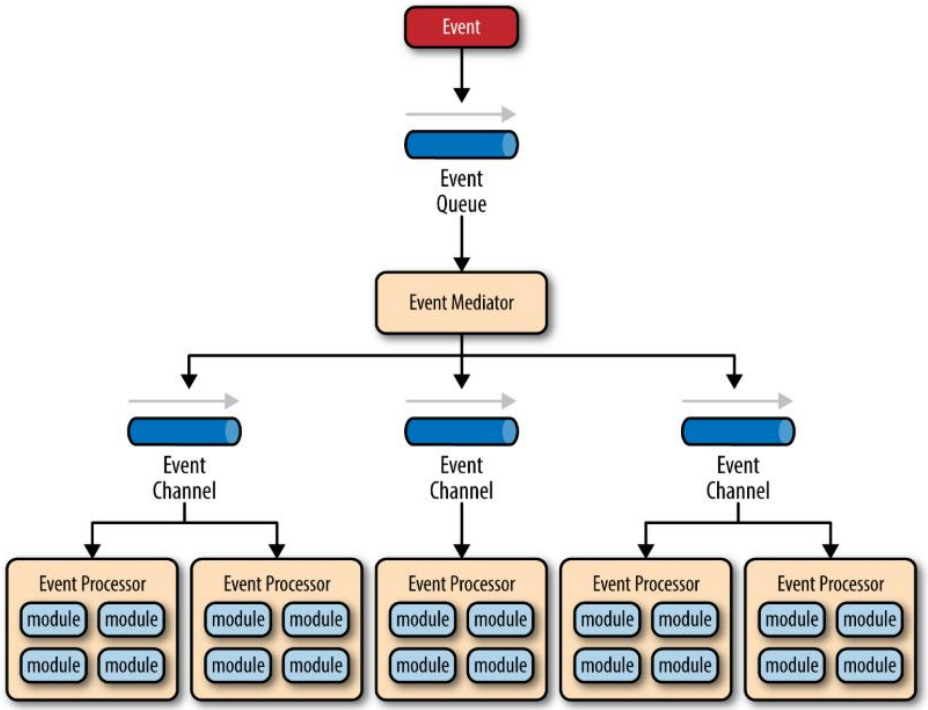


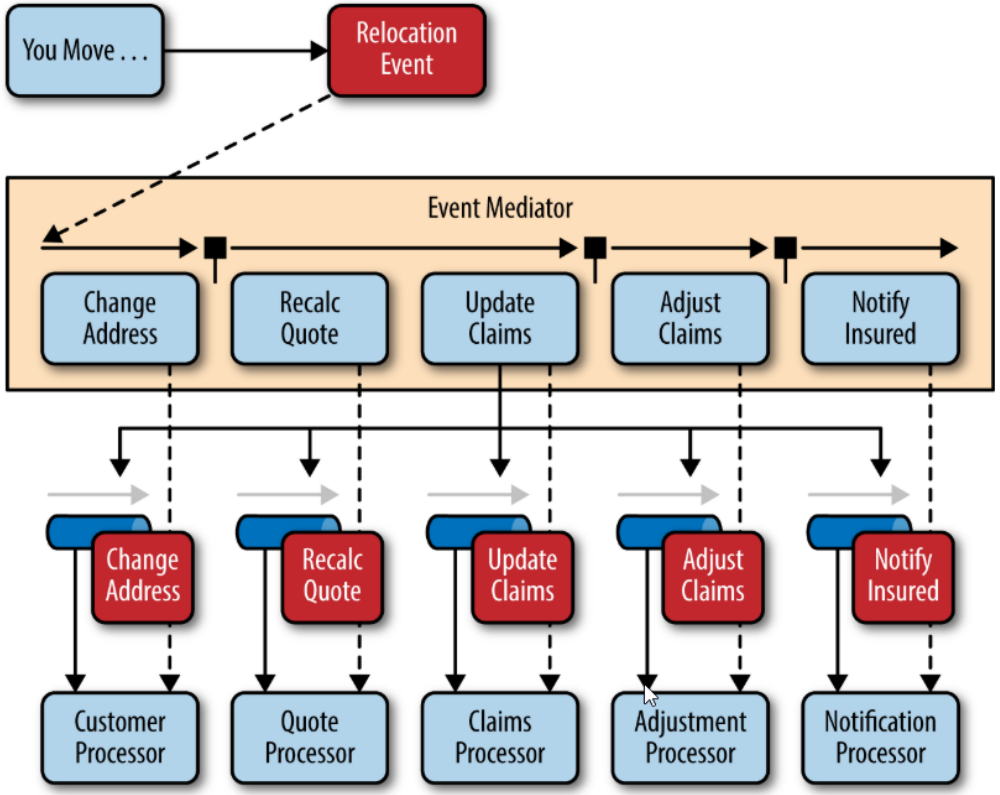
Examples:

- Fitness Test Suite

Architecture Types / Event Driven Architecture

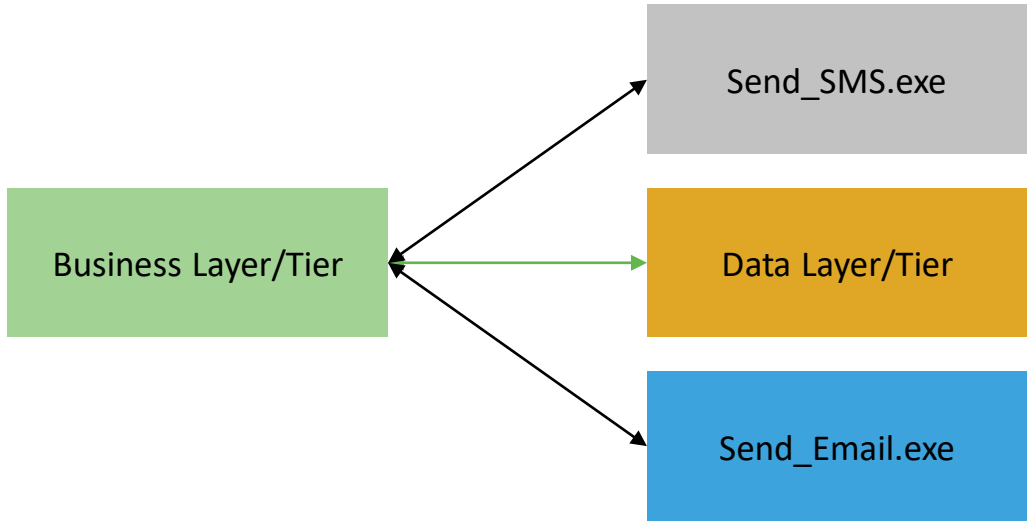
- Popular distributed asynchronous architecture pattern used to produce highly scalable applications
- Can be used for small applications as well as large, complex ones
- The architecture is made of highly decoupled, single-purpose event processing components that receive and process events
- Consists of two major topologies: “Mediator” and “Broker” making it highly **Auditable**
- Mediator topology is used when you want to orchestrate multiple steps for a single event through a single mediator
- Broker topology is used when you want to chain events together without the use of a single central mediator





Architecture Types / Multi-App Architecture

- Multiple single-purpose applications are used to orchestrate a business flow
- E.g. A business process registers an order in the database, sends invoice to the user over email using a separate process connected via some form of communication medium (PubSub or Message Bus), sends a SMS to the user confirming the order in another process that is also connected via the communication medium
- The independent processes can scale, can reside on different machines with different process-address spaces and if the independent processes crash, they do not take the entire system down
- Allows for asynchronous processing that does not clog the business flow
- Inherently improves performance(responsiveness) of the system

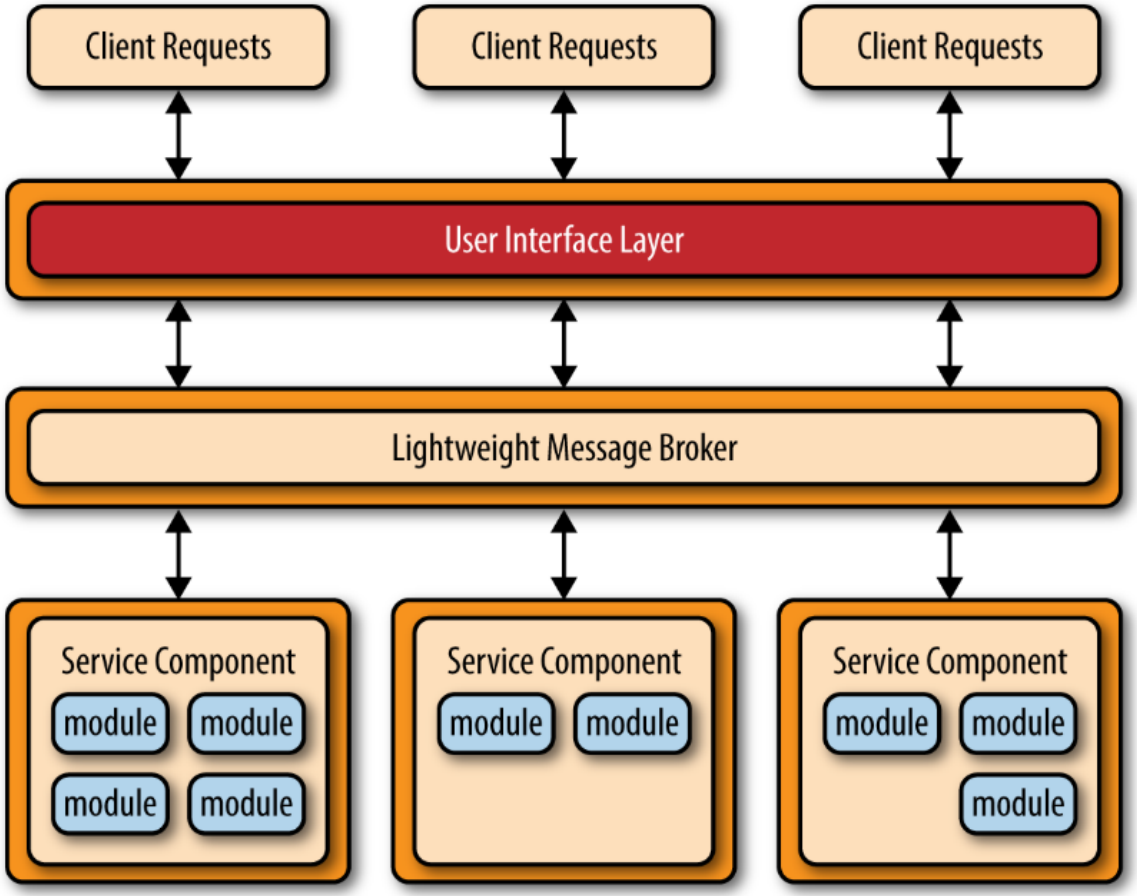


Examples:

- Most E-Commerce Applications
- TF's Beyond Measurements IoT System

Architecture Types / Microservices Architecture

- Microservices are independently deployed, self-contained RESTful Services that divide the application on the concept of "Bounded Context".
- Usually 1 Microservice for 1 bounded context
- Highly scalable, but not inherently performant – due to distributed nature of the services. These can be made performant



Examples:

- NetFlix
- Amazon PrimeVideo
- Hotstar

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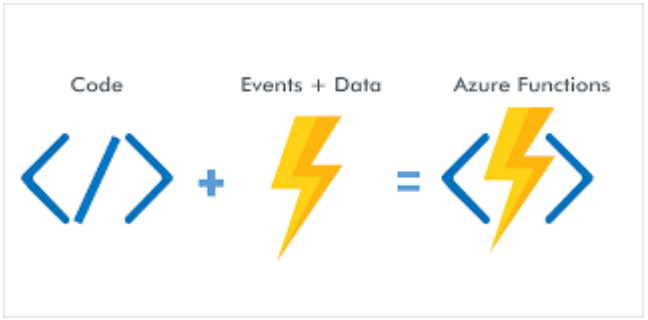
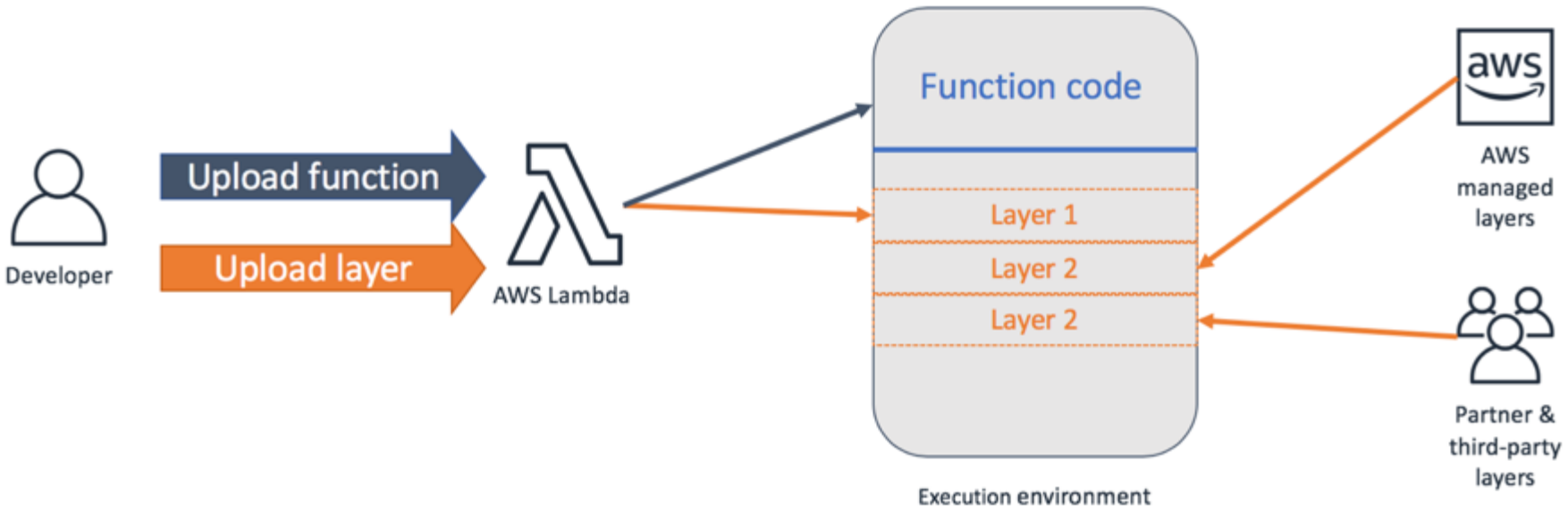
Future

Future

- Two major architectures coming up are “Stream Processing” architectures and “Serverless” architectures
- In Stream Processing architecture, data flows in a stream – business components co-ordinate and react to the data flow, modifying the data as it flows
- In Serverless architectures, applications are hosted by a third-party service, eliminating the need for a server-software, hardware management by the developer
- Application can be broken into individual functions that can be invoked and scaled individually.
- Top two “Serverless” Architecture Providers (Also called Function as a Service (FaaS)) are AWS Lambda and Azure Functions
- FaaS typically use HTTP based API end-points(RESTful) to invoke the functions, and produce output





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Q & A?

THANK YOU

Aniket Inge

Associate Technical Architect

+91 99012 26007

aniket.inge@thoughtfocus.com

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