Monolithic and Distributed Systems

This article provides an in-depth comparative analysis of **Monolithic and Distributed Systems** in the context of system design, touching upon their architecture, benefits, disadvantages, and associated challenges like race conditions. Below is a structured summary of key points covered in the article:

System Analysis vs System Design

- **System Analysis:** Focuses on gathering functional and non-functional requirements, identifying business logic, and ensuring error removal in an existing model.
- **System Design:** Involves creating or updating business logic, planning architecture, and dealing with errors as they occur.

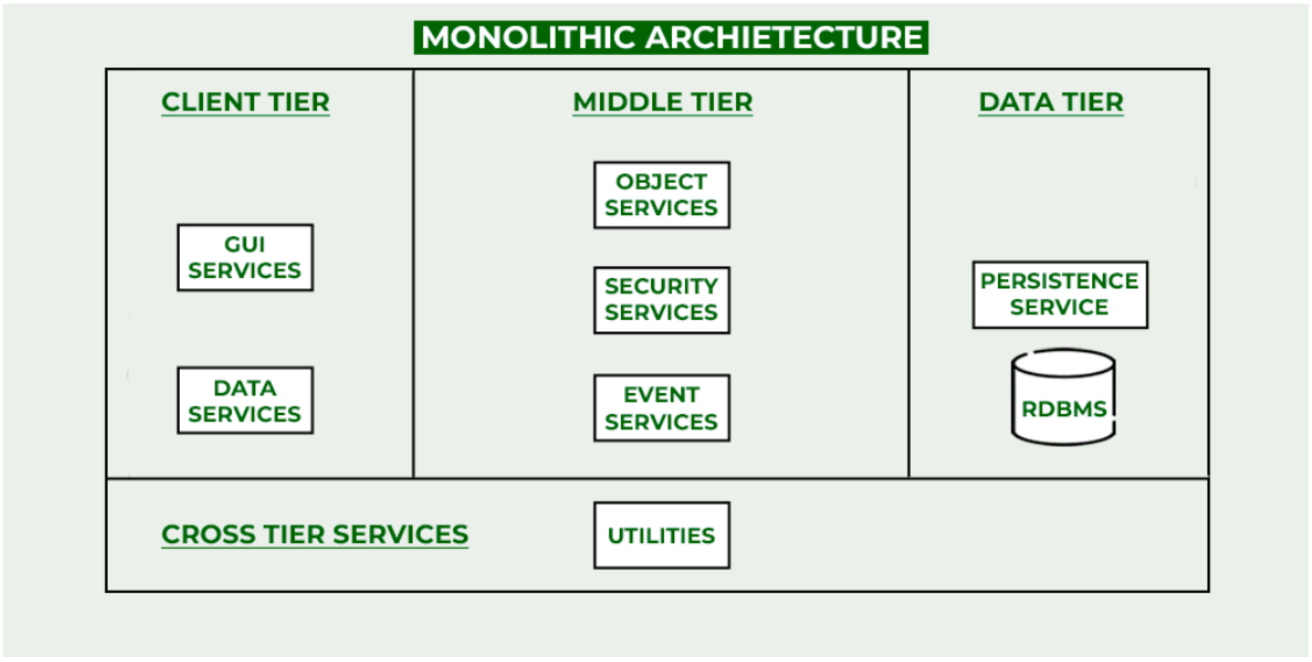
Parameters	System Analysis	System Design
Time	Shorter	Longer
Process	Long but simple	Short but complex
Configurations	Requires high system configurations	Low configurations for smaller tasks
Focus	Fixing errors	Managing errors post-deployment
Programmer Role	Field-specific expertise	Broad conceptual knowledge

Types of Systems in Design

1. Monolithic Systems

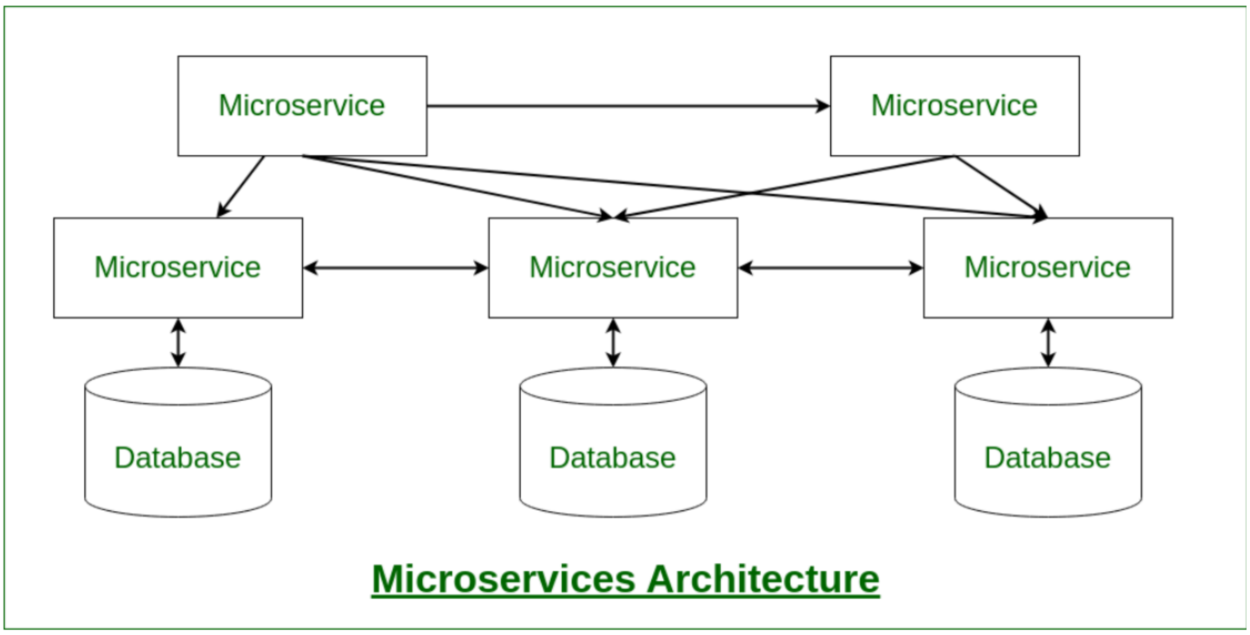
- **Definition:** A single-unit application where all functionalities exist within one codebase.
- **Architecture:**
  - **Client Tier (Presentation Layer):** Front-end for user interaction.
  - **Middle Tier (Service Layer):** Business logic and request handling.
  - **Data Tier (Persistence Layer):** Database and messaging mechanisms.
- **Advantages:**
  - Easy development, deployment, and testing.
  - Ideal for small-scale applications and startups.
- **Disadvantages:**

- Limited scalability.
- Difficult to update and maintain as it grows.
- High coupling leads to challenges in modular updates.

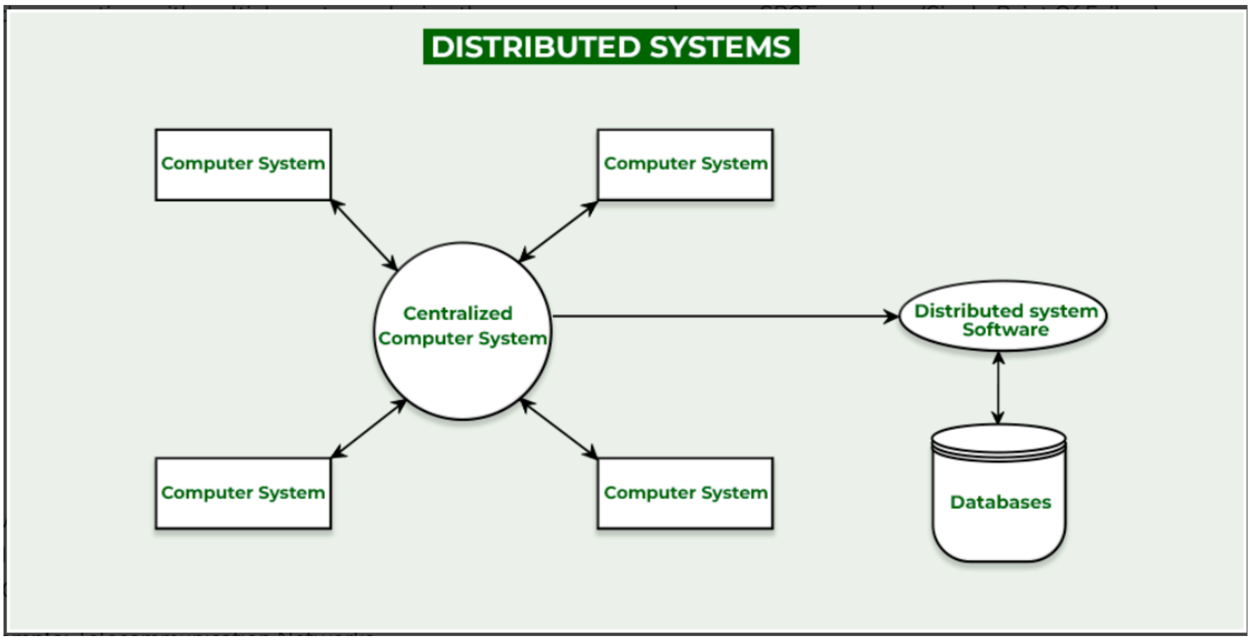


2. Distributed Systems (Including Microservices)

- **Definition:** A collection of independent systems (nodes) connected via a network, designed for modularity and scalability.
- **Microservices:**
  - Applications split into smaller, independent services communicating via lightweight protocols (e.g., HTTP).
  - **Key Benefits:**
    - Scalability and flexibility.
    - Resilience and technology heterogeneity.
  - **Challenges:**
    - Testing complexity and network overhead.
    - Requires skilled developers familiar with distributed design.



- **Distributed Systems:**
  - A broader implementation involving geographically dispersed systems to share resources and achieve high scalability and reliability.
  - **Advantages:**
    - Scalability through horizontal scaling.
    - Reliability via redundancy and replication.
    - Low latency by proximity to users.
  - **Disadvantages:**
    - Complexity in integration and synchronization.
    - Vulnerability to network failures.

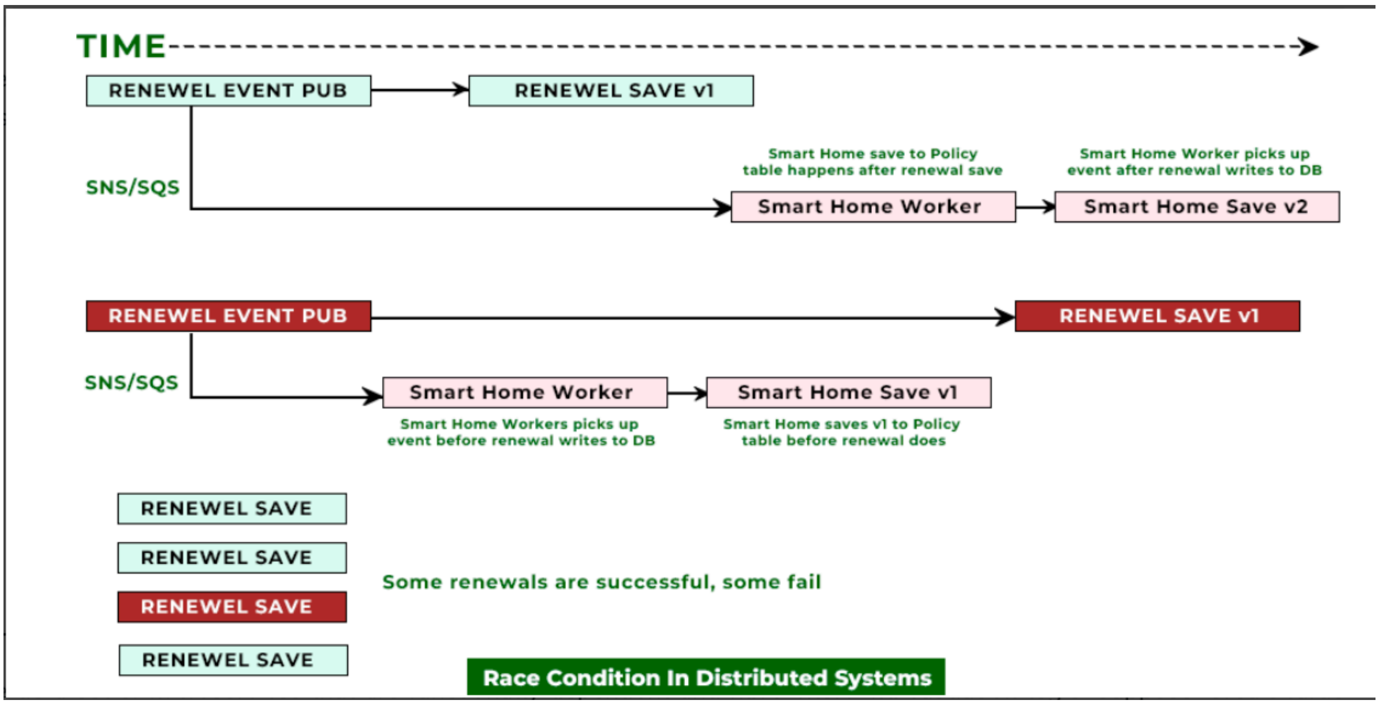


Race Conditions

- **Definition:** A bug caused by timing mismatches in execution orders, often in distributed systems where parallelism exists.
- **Examples:** Banking systems where validation logic for processes (e.g., credit card approval) faces conflicting parallel requests.

Solutions to Handle Race Conditions:

1. **Simple Approach:** Combine validation and change requests into one operation.
2. **Advanced Approach:** Refactor validation logic into dedicated services, ensuring parallelism is managed efficiently.


TIME
RENEWEL EVENT PUB
RENEWEL SAVE v1
SNS/SQS
Smart Home save to Policy table happens after renewal save
Smart Home Worker picks up event after renewal writes to DB
Smart Home Worker
Smart Home Save v2
RENEWEL EVENT PUB
RENEWEL SAVE v1
SNS/SQS
Smart Home Worker
Smart Home Save v1
Smart Home Workers picks up event before renewal writes to DB
Smart Home saves v1 to Policy table before renewal does
RENEWEL SAVE
RENEWEL SAVE
RENEWEL SAVE
RENEWEL SAVE
Some renewals are successful, some fail
Race Condition In Distributed Systems

Summary

- Monolithic systems are suitable for simpler, smaller applications, particularly for startups, due to ease of handling and deployment.
- Distributed systems, especially those based on microservices, offer scalability and reliability for larger, complex applications but come with higher complexity and operational overhead.
- Addressing challenges like race conditions and maintaining system performance requires strategic design and development practices.

Would you like further details on any specific section, such as implementation examples or tools for designing these architectures?