Software Architectures Introduction

Software Engineering Seminar

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Outline

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What is a System?

- A **system** is a set of interacting components that *work* together to achieve a common goal.
- A **system** is a collection of elements that are *organized* in a specific way.
- A **system** is a structure that is designed to *perform* a specific function.

Systems Analysis Process

- **Systems analysis** is the *process* of studying a system in order to identify its components, interactions, and goals.
- **Systems analysis** is the *process* of understanding how a system works and how it can be improved.
- **Systems analysis** is the *first step* in the systems development lifecycle.

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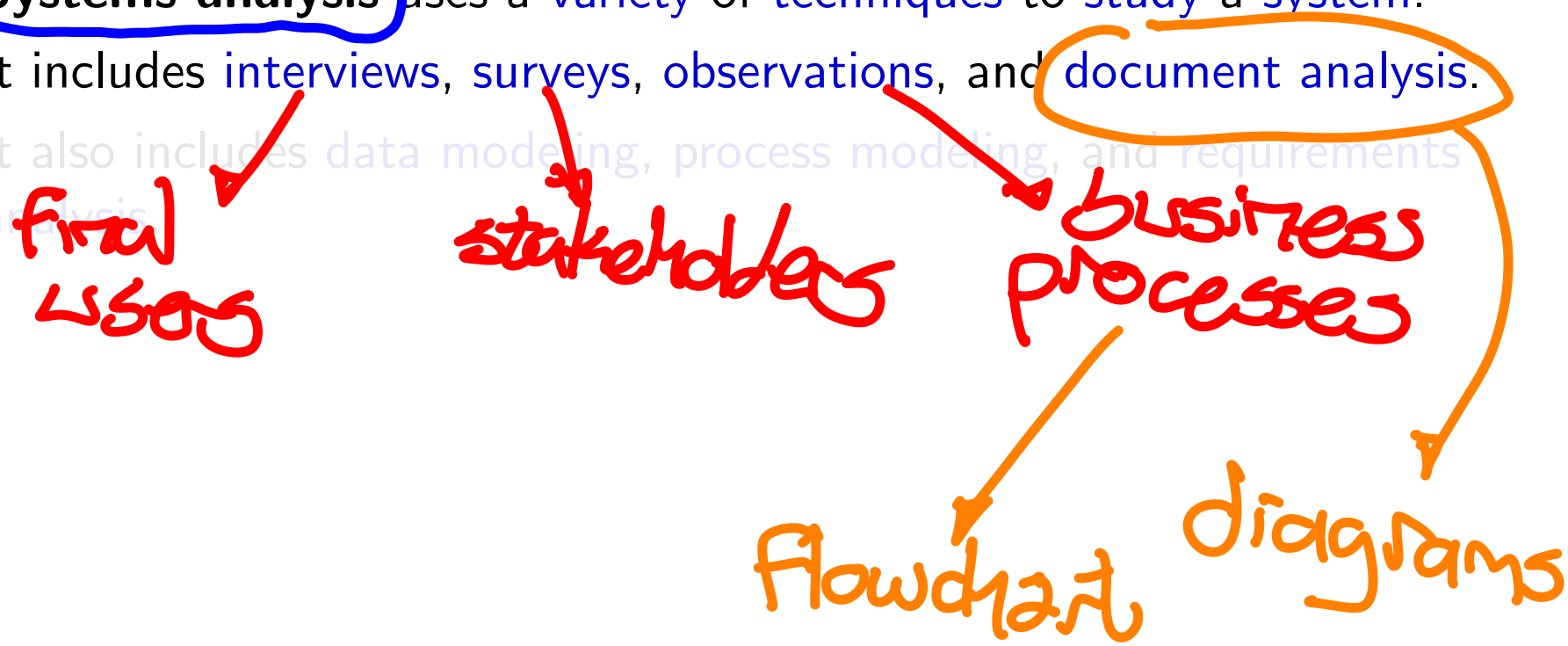
Systems Analysis Techniques

- **Systems analysis** uses a variety of techniques to study a system.
- It includes interviews, surveys, observations, and document analysis.
- It also includes data modeling, process modeling, and requirements analysis.



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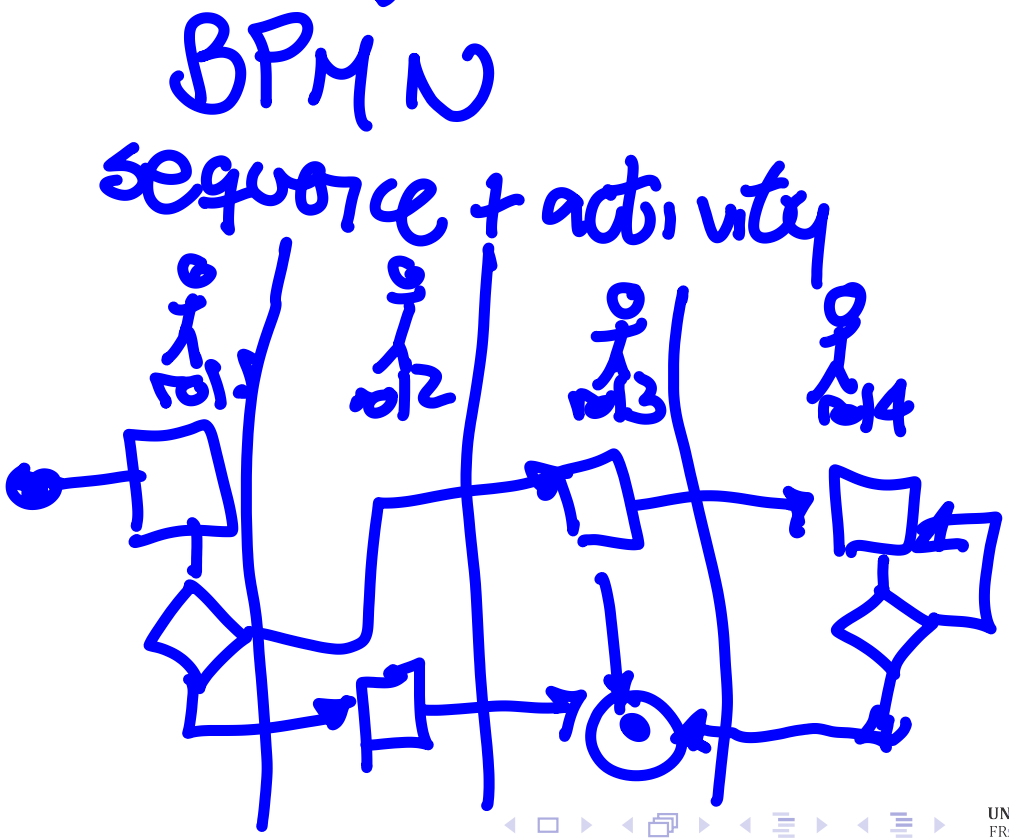
- sources
- format + structure
- understanding



Complexity and Emergence

- **Complexity** is the *degree* to which a system is difficult to understand.
- **Emergence** is the *appearance* of unexpected properties in a system that arise from the interactions of its components.
- **Complexity** and **emergence** are common in dynamic systems that are non-linear and stochastic.
- They can be *studied* and understood through systems analysis and modeling.

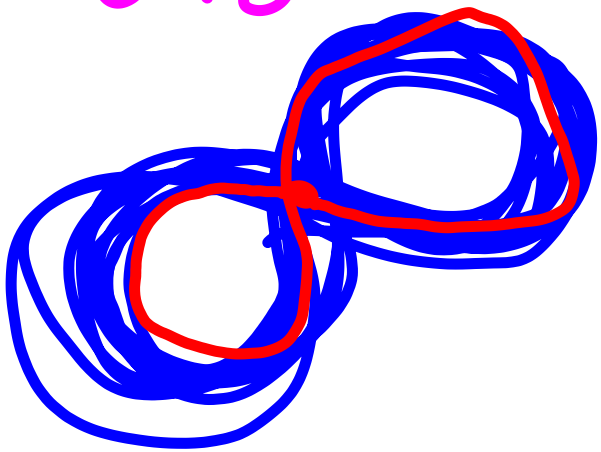
elements + relations

chaos theory

randomness (stochastic) + non-linear

chaotic attractors

Lorenz



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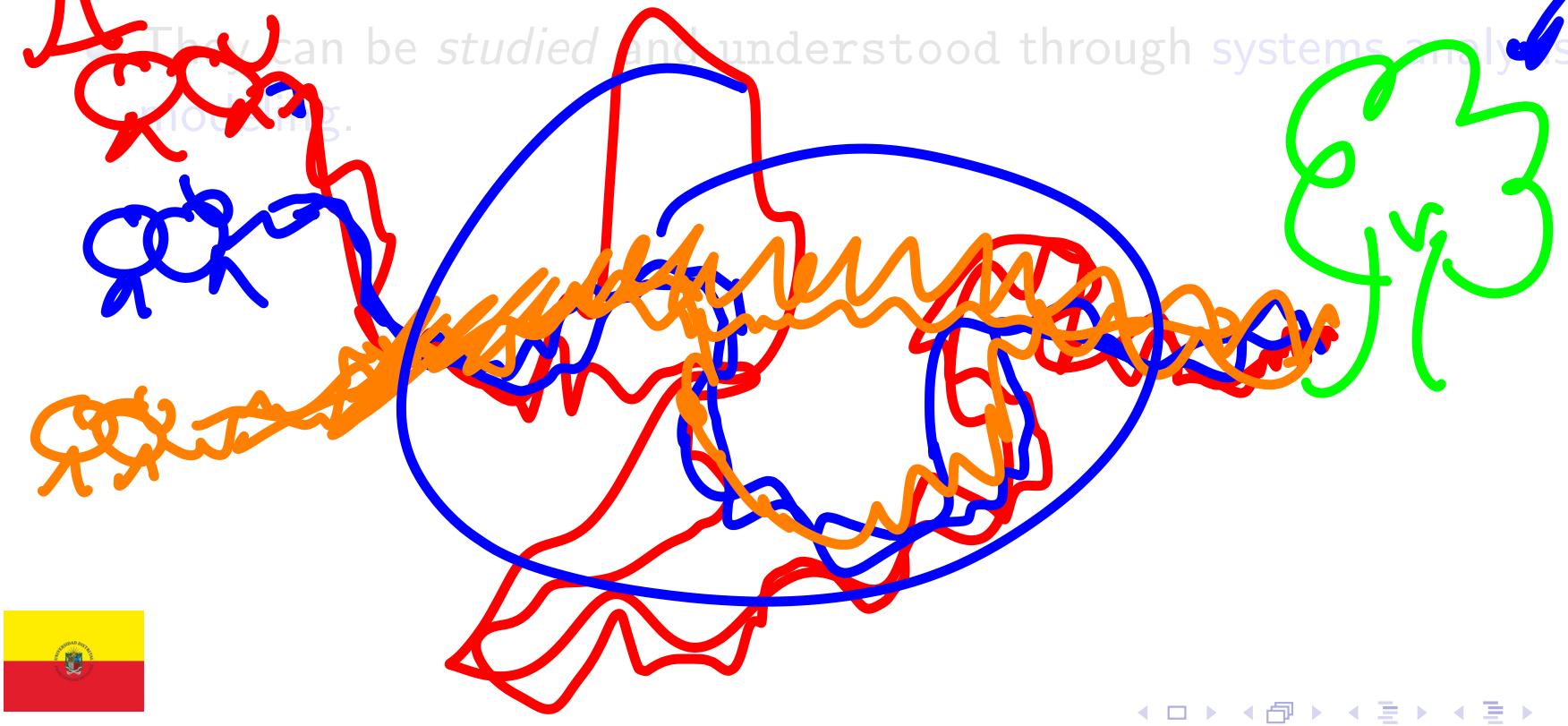

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Complexity → elements + relations

emergence → rules + random rules

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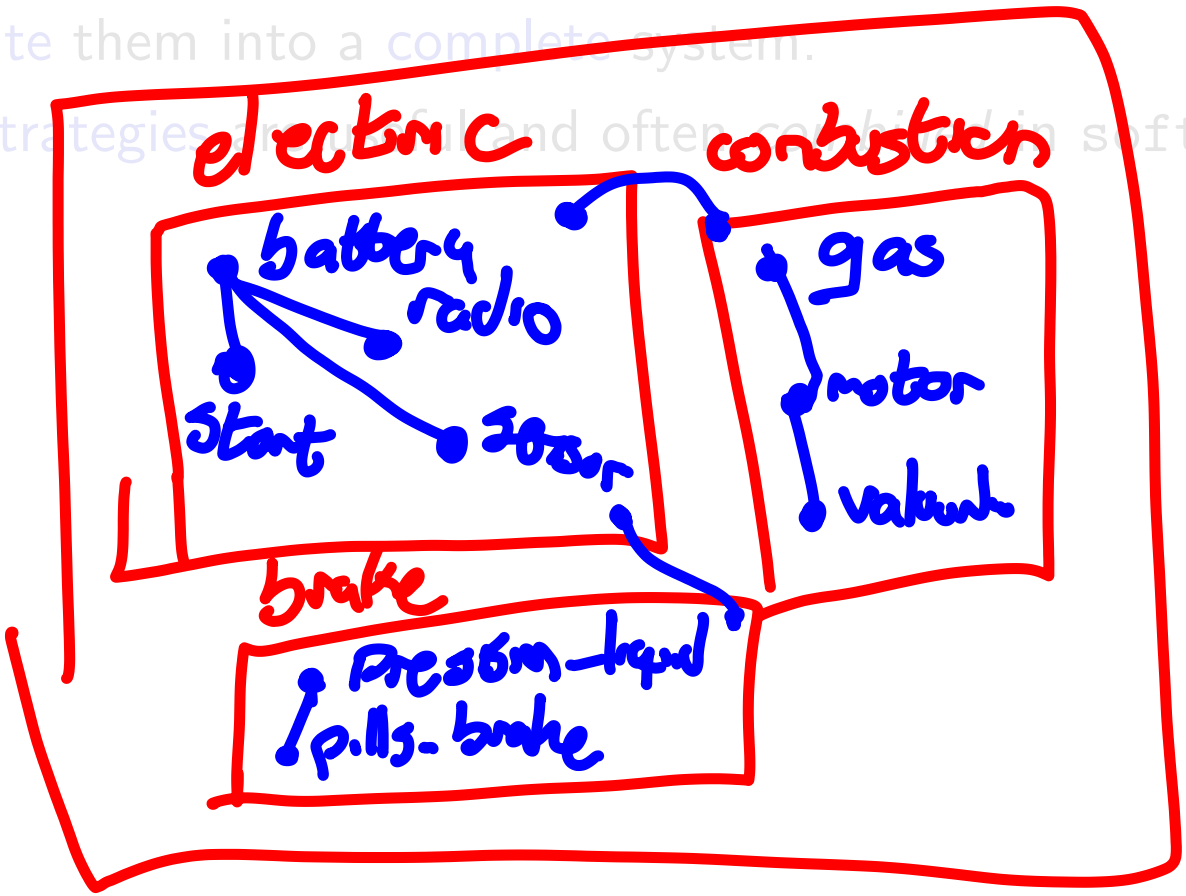
Strategies to Solve Problems

- **Top-Down**: Start from the big picture and break it down into smaller parts.
- **Bottom-Up**: Start from small, well-defined components and integrate them into a complete system.
- Both strategies are useful and often combined in software design.



Strategies to Solve Problems

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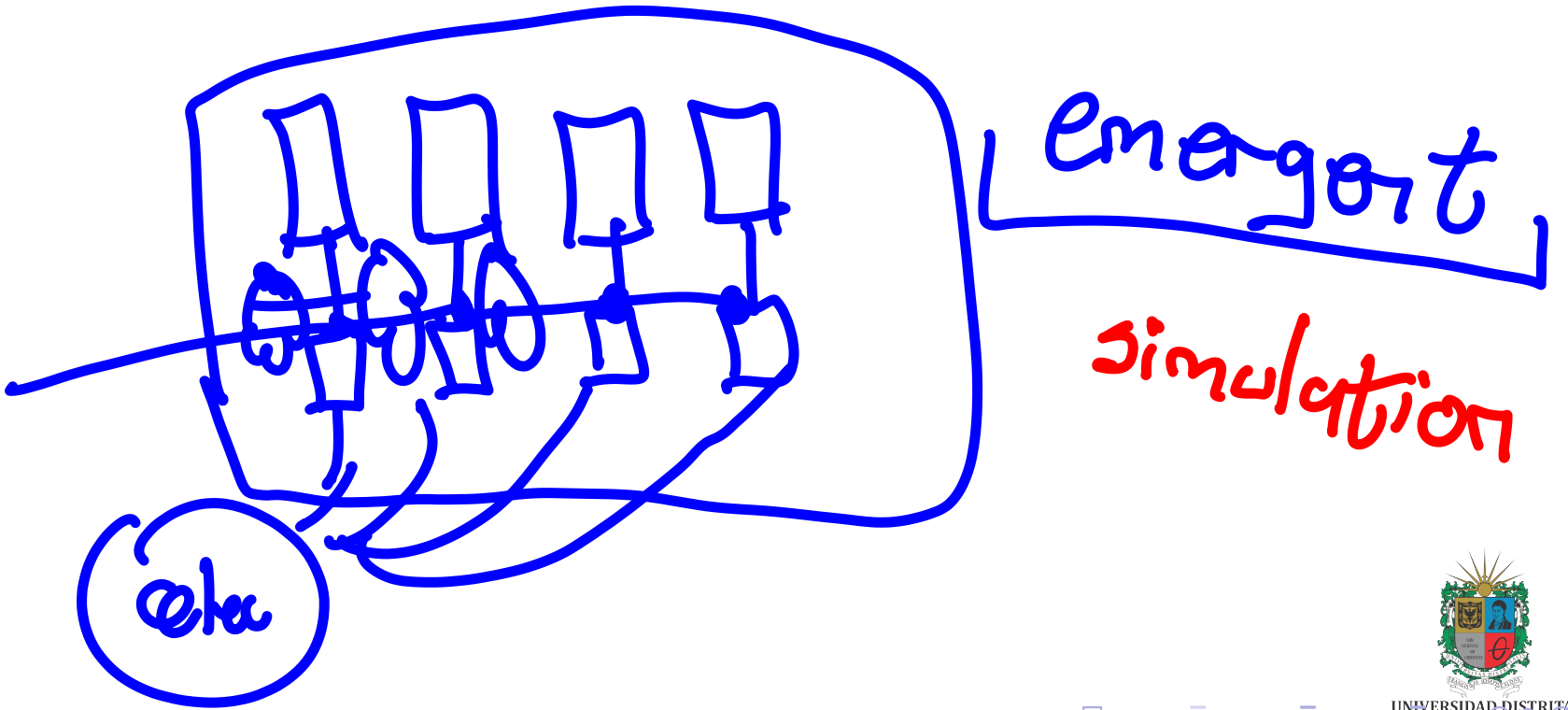
more understanding/more difficult



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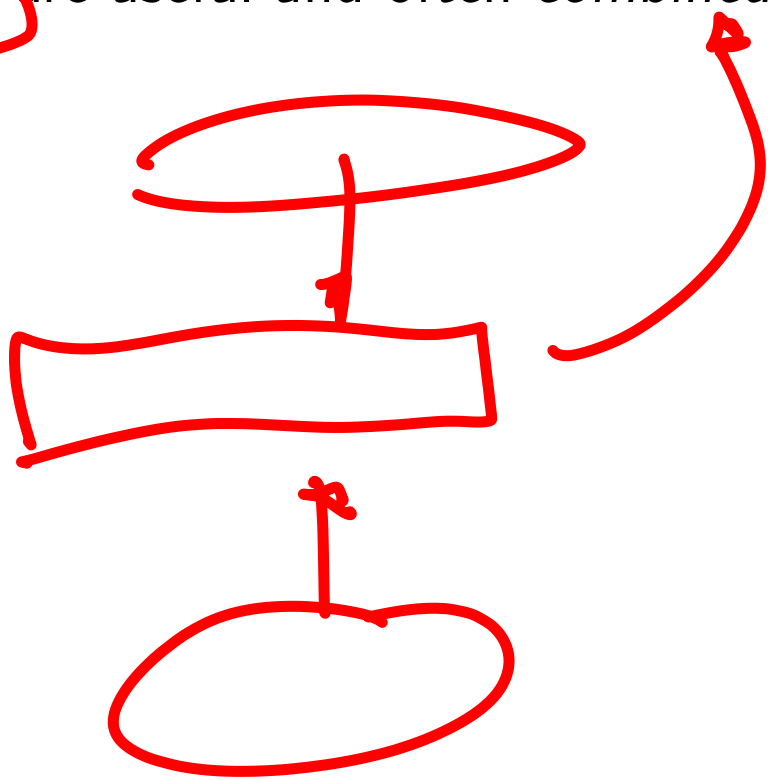
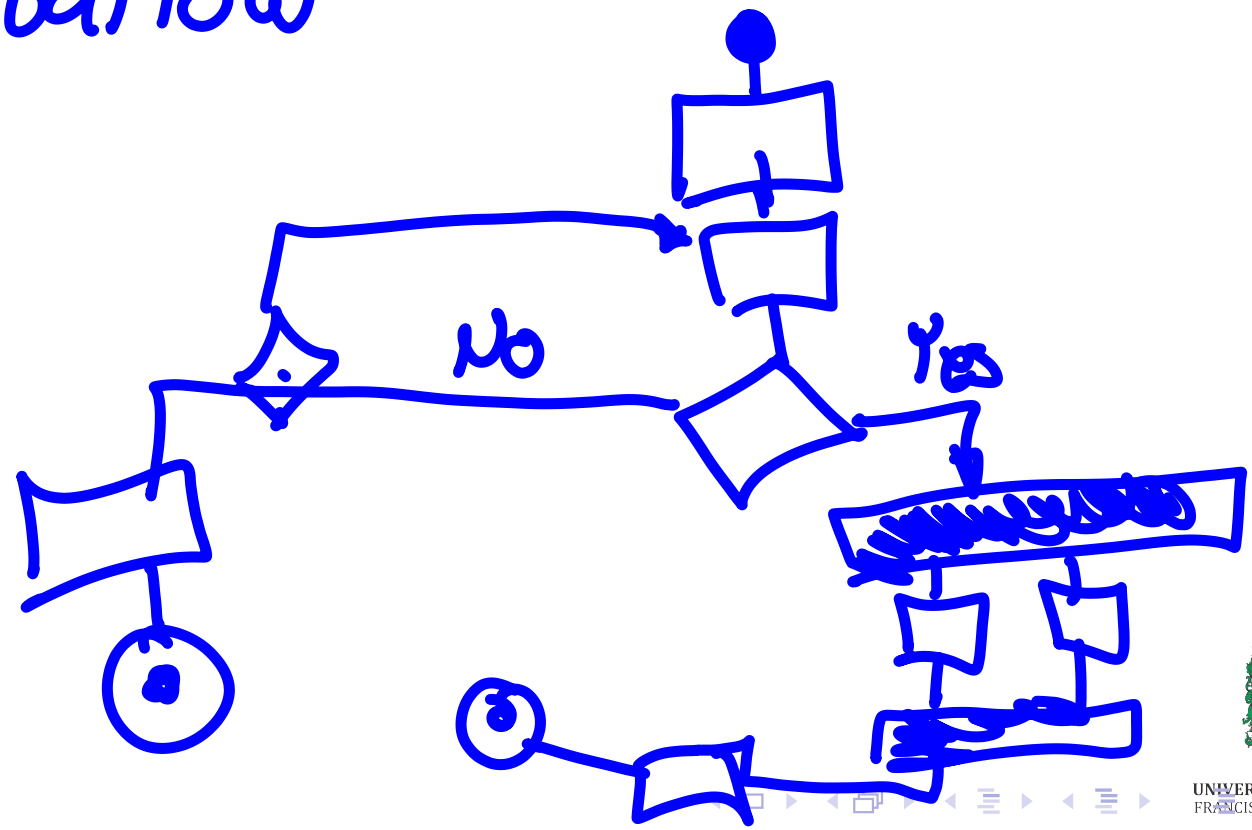


Process Definition

- A **Process** is a series of steps or actions taken to achieve a particular end.
- Processes are used to **organize** and **manage** work.

Workflows

- A **Workflow** is a series of tasks that are performed in a specific order to *achieve a goal*.
- **Workflows** are used to *automate* and *optimize* business processes.
- **Workflows** can be sequential, parallel, conditional, or repetitive.

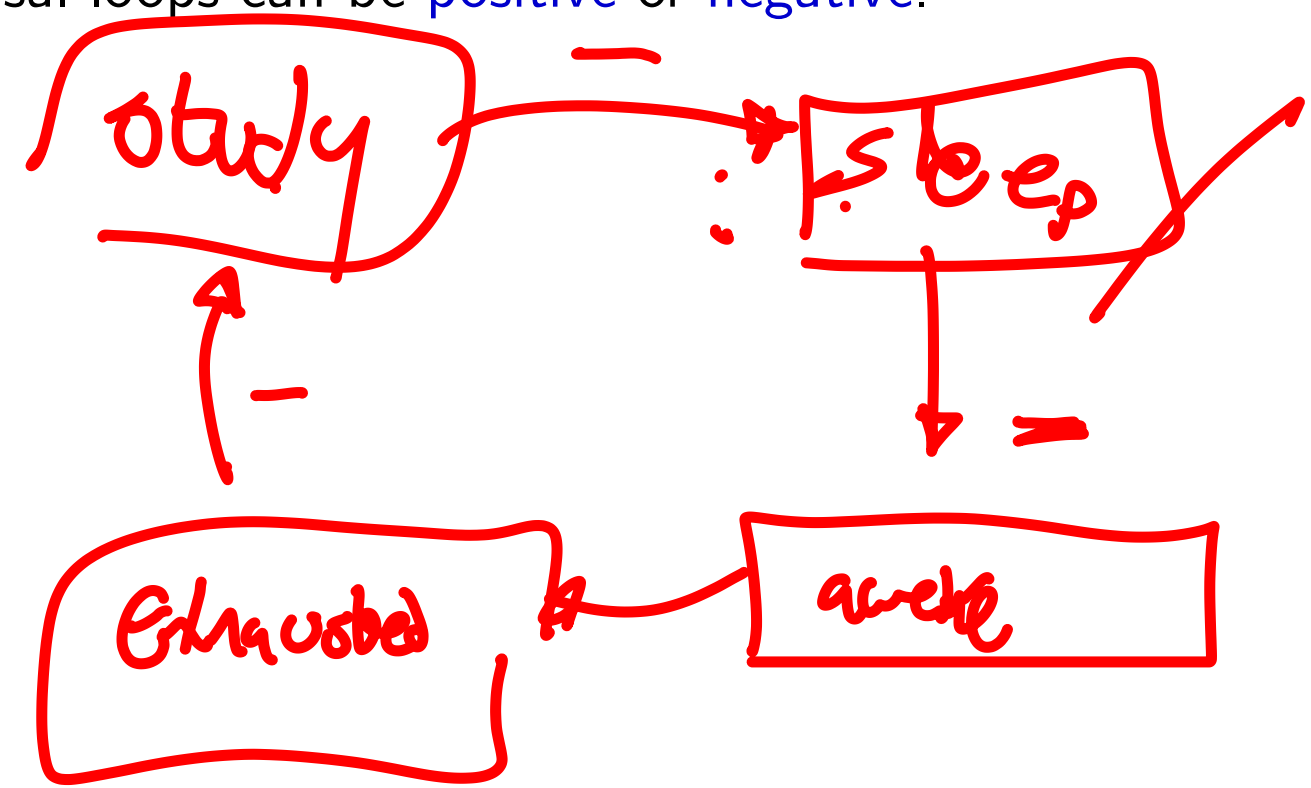


Process Models

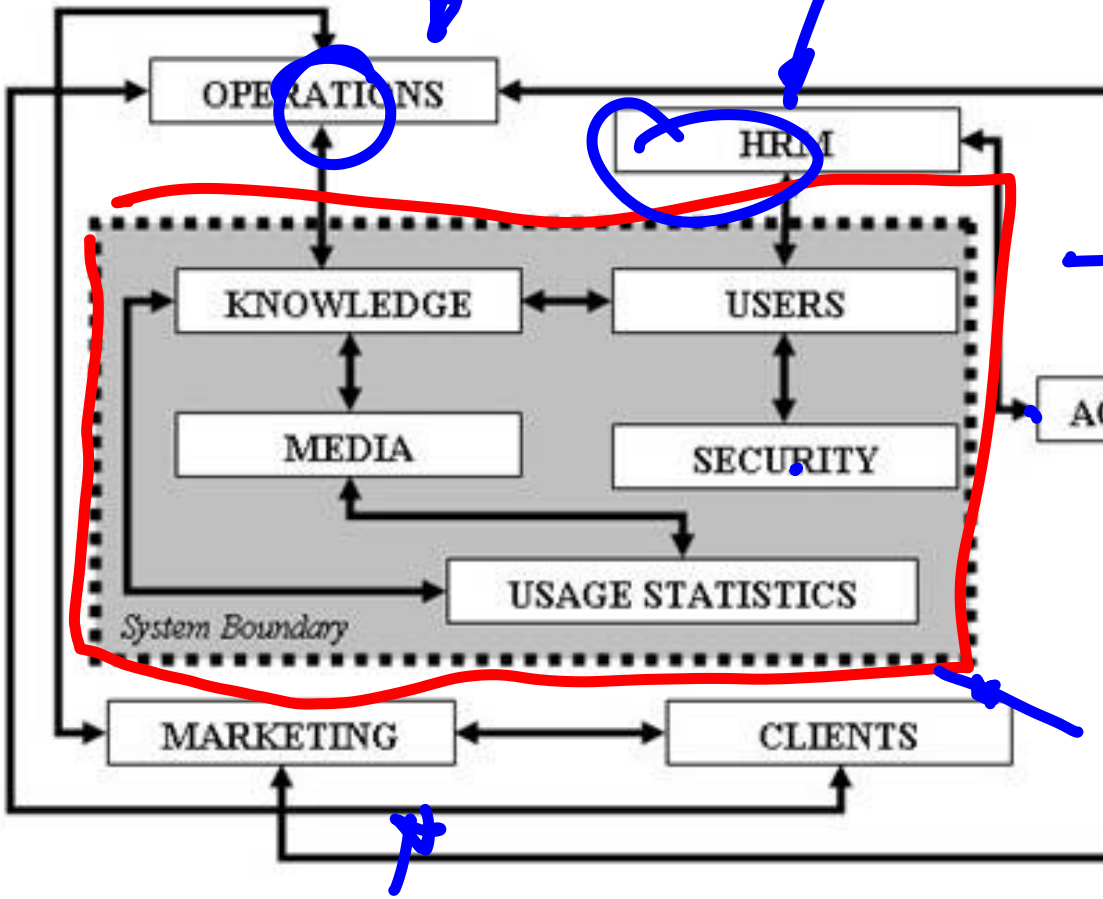
- A **Process Model** is a representation of a process that shows the sequence of steps and the relationships between them.
- **Process models** are used to analyze, design, and improve processes.
- Examples of process models include `flowcharts`, `data flow diagrams`, `activity diagrams`, `business process model and notation (BPMN)`, `petri nets`, `state diagrams`, among others.

Causal Loops

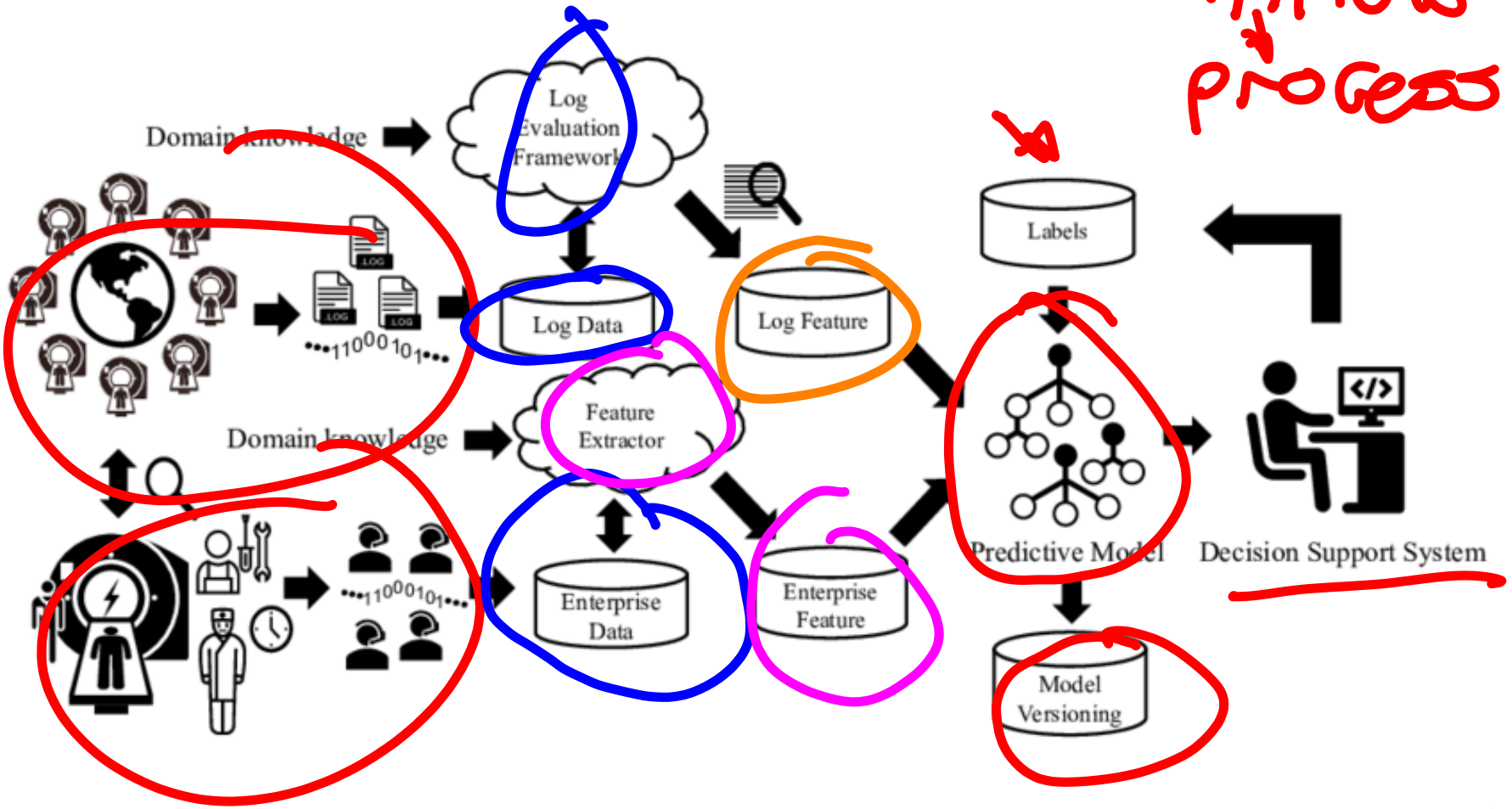
- A **Causal Loop** is a diagram that shows the relationships between different variables in a system.
- Causal loops are used to analyze and understand the dynamics of a system.
- Causal loops can be positive or negative.



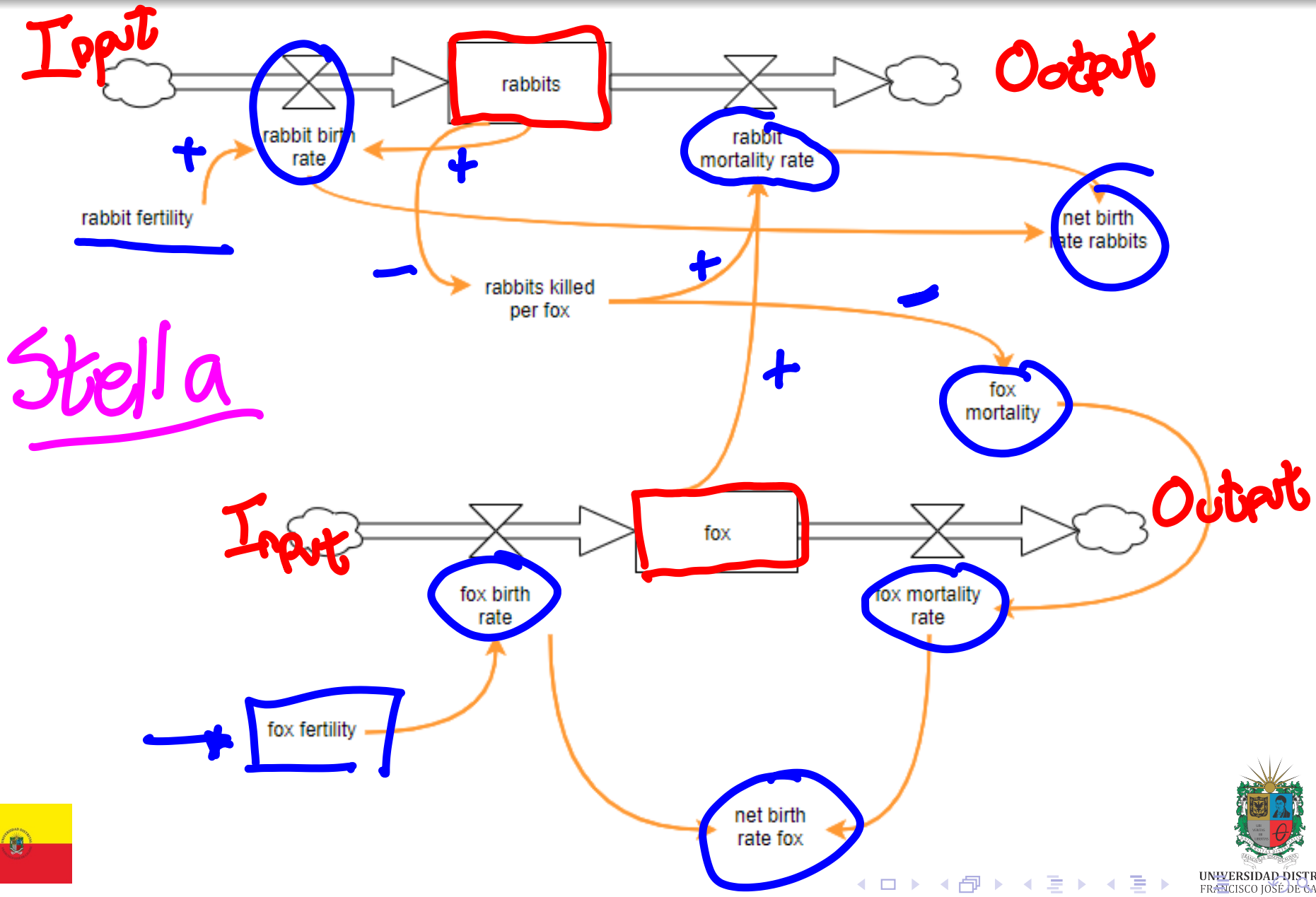
System Schema Example: Company Structure



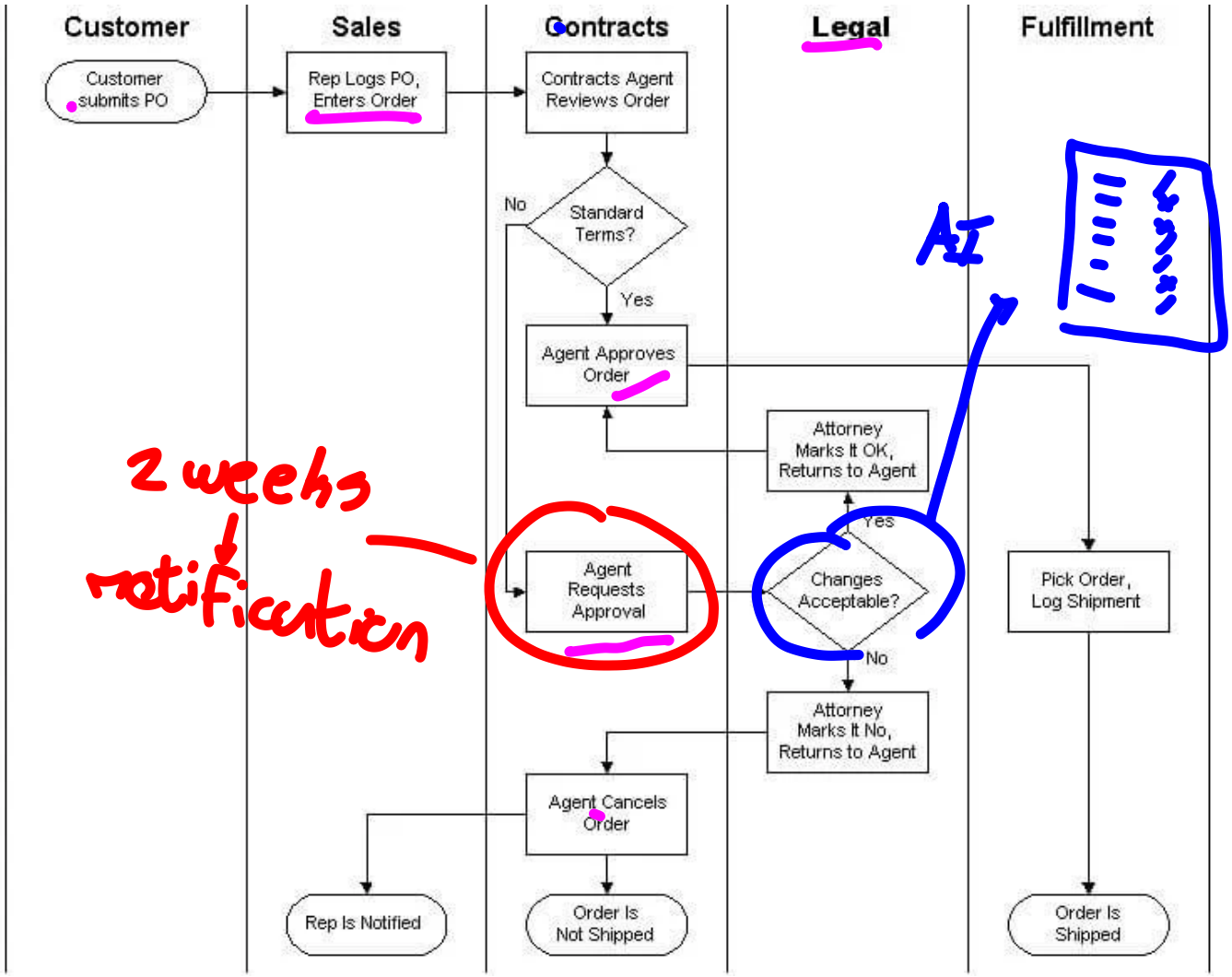
System Schema Example: Processing Pipeline



Stock and Flow Diagram



Business Process Model and Notation (BPMN)



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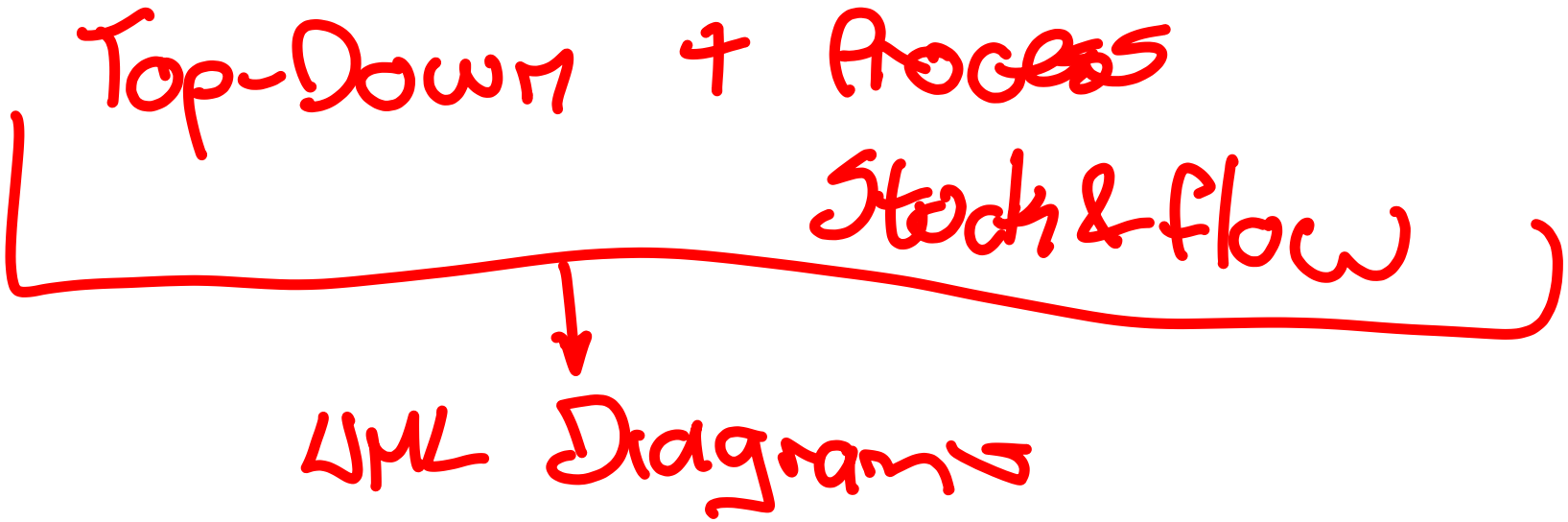
Design Before Code

- **Design** should come before coding.
- Jumping into *code without a plan* leads to confusion and rework.
- **Good design** clarifies the `problem` and guides the `solution`.



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Understanding the Requirements

- **Requirements** must be well understood before design.
- `Ask questions clarify ambiguities and document all requirements.`
- Requirements define the scope and direction of the design.

Implications - Trade-offs

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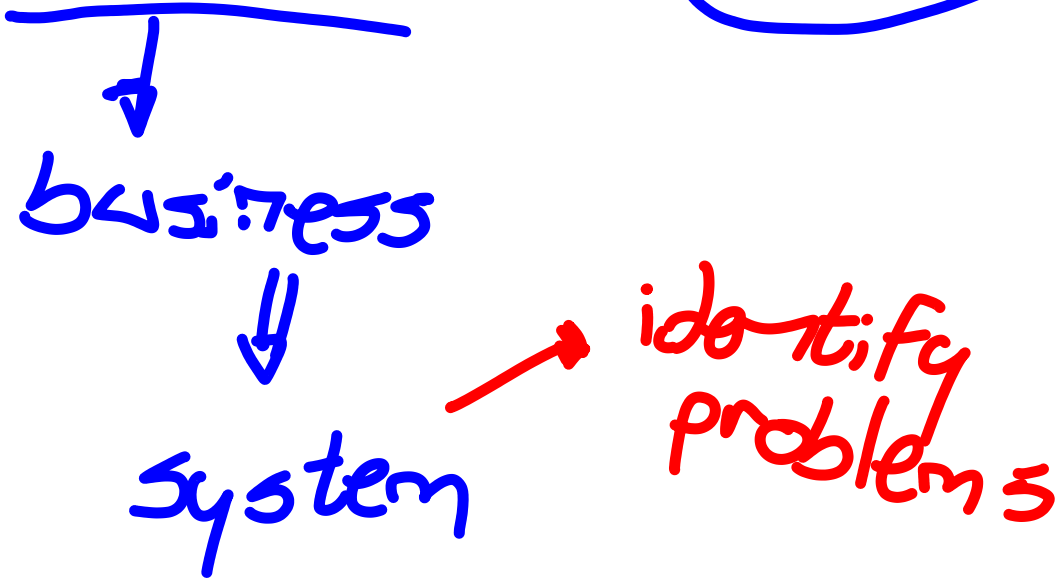
Design Based on the Problem

- **Design** should be driven by the problem, not by `technology`.
- Focus on what needs to be solved, *not just* how to implement it.
- Use the **problem statement** to identify key objects and their *relationships*.



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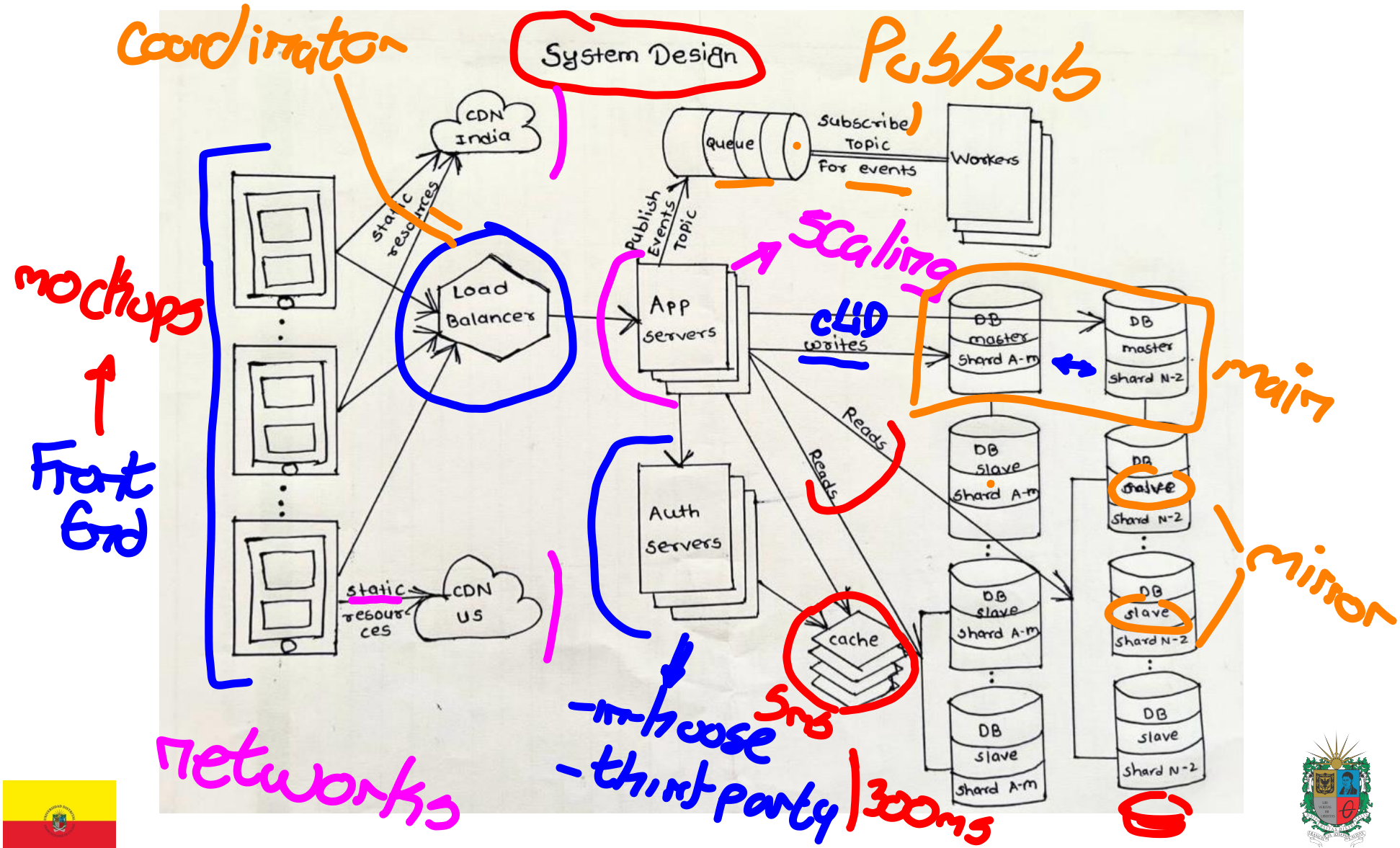
Systems Design applied to Software Architectures



Conceptual Design and Technical Design

- **Conceptual Design**: What the system should do, using `high-level models`.
- **Technical Design**: How the system will be implemented, using `detailed diagrams` and specifications.
- Both are essential for a successful software project.

understand goals + scope

all stake-holders

- Mockups
- CRC cards
- Business Process BPMN

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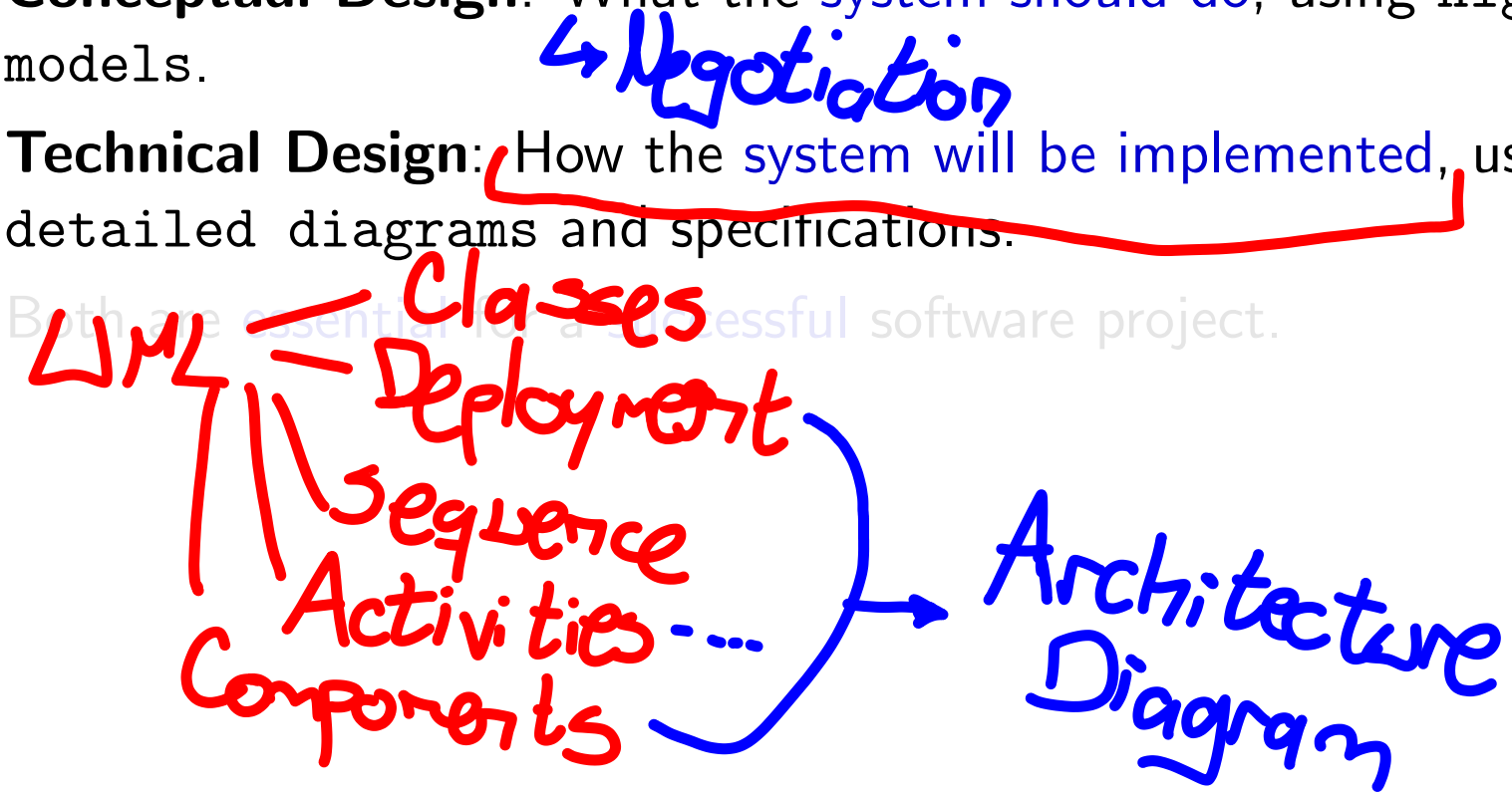

- DataBase System Design

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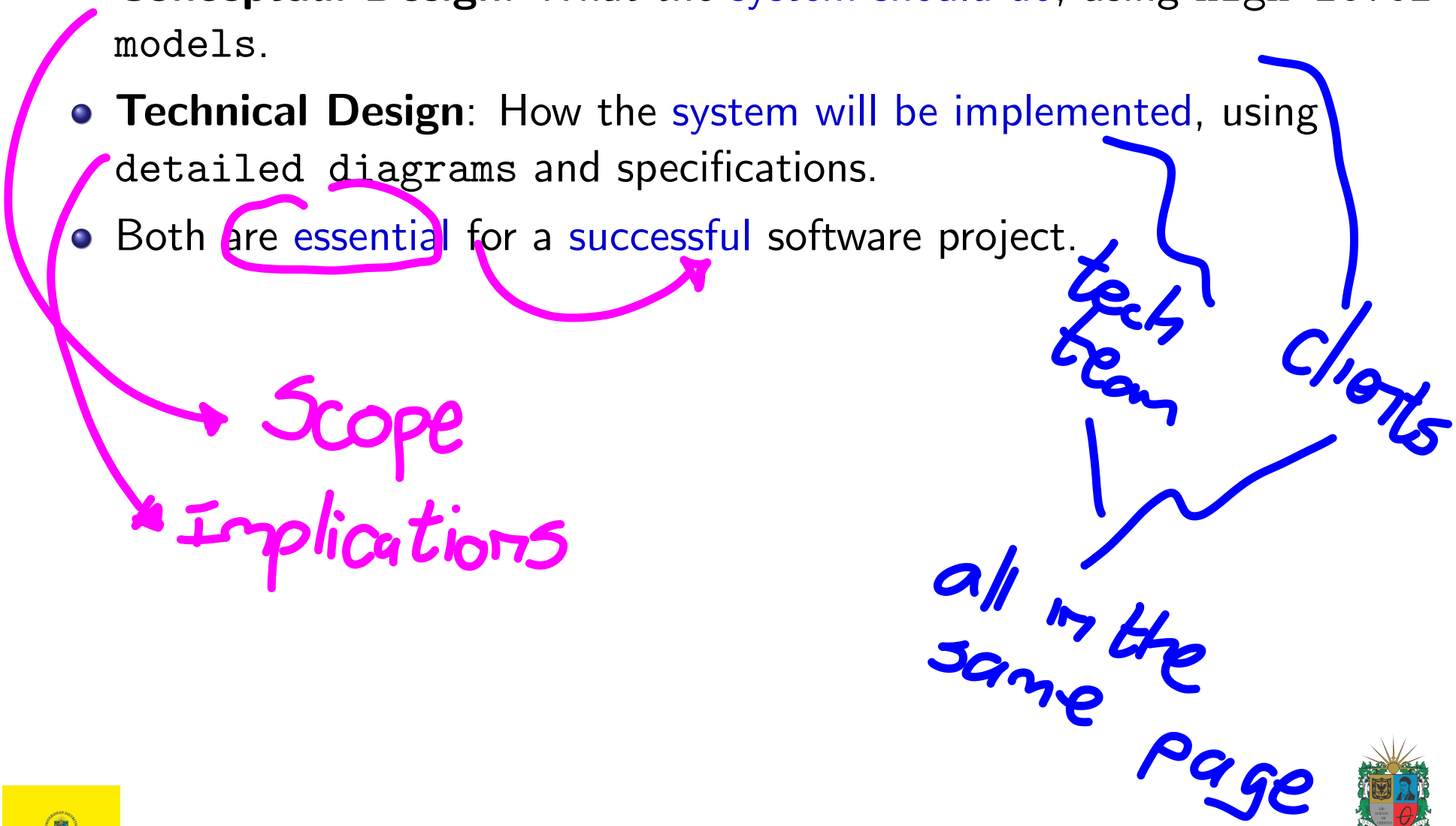

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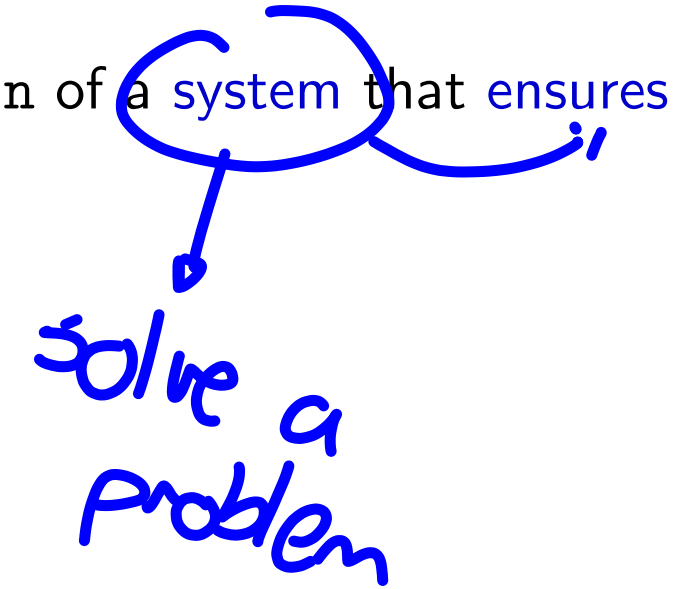
What is a System Architecture?

- A **system architecture** is the *structure* of a `system` that *defines* its components, interactions, and relationships.
- A **system architecture** is the *blueprint* of a `system` that *guides* its development and implementation.
- A **system architecture** is the `foundation` of a system that ensures that it meets the needs of its users.



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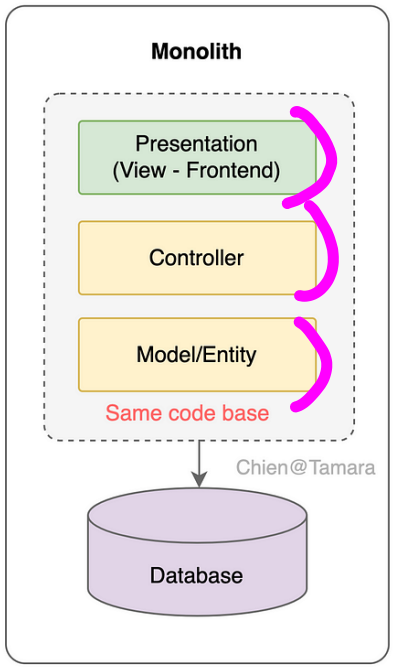
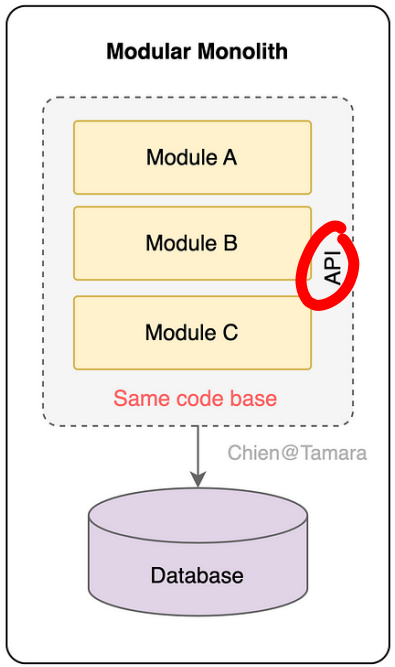
Types of System Architectures

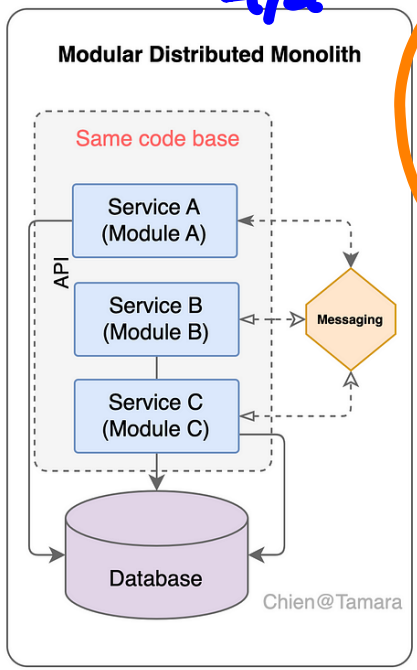
- There are *several types* of system architectures that are *used* in `systems development`.
- They include monolithic, client-server, peer-to-peer, and distributed architectures.
- Each *type* of architecture has its own advantages and disadvantages that *depend* on the `specific requirements` of the system.

Monolithic System Architecture

- A **monolithic system architecture** is a single-tier architecture that consists of a single unit that performs all the functions of the system.
- It is simple, easy to develop, and maintain, but it is **not** scalable and flexible. It is typically used for small systems that do not require high performance or reliability.

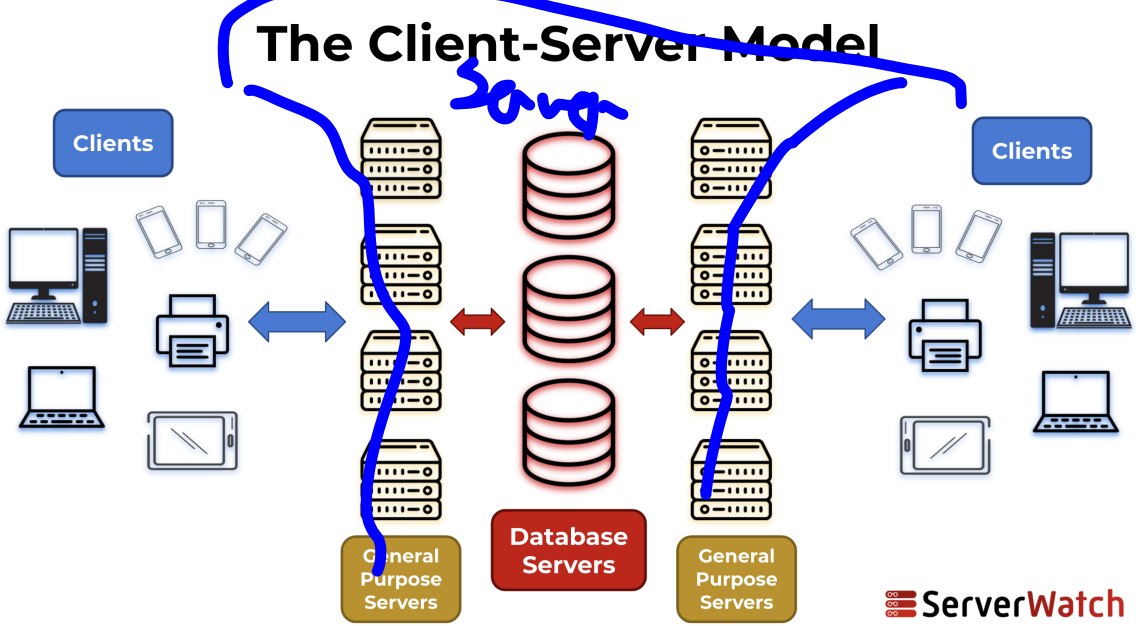






Client-Server System Architecture

- A **client-server system architecture** is a two-tier architecture that consists of a client and a server that communicate with each other over a network.
- It is scalable, flexible, and efficient, but it is complex and difficult to develop and maintain. It is used for medium to large systems that require high performance and reliability.



Peer-to-Peer System Architecture

- A **peer-to-peer system architecture** is a two-tier architecture that consists of a network of peers that communicate with each other directly.
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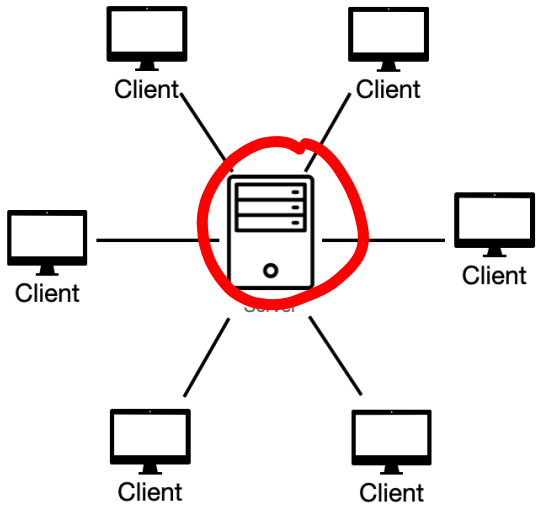
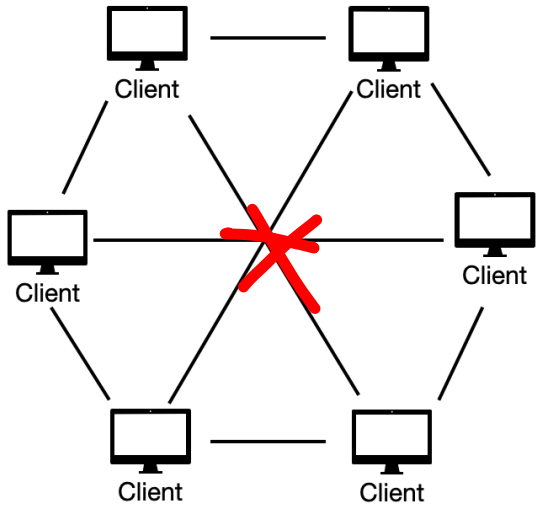


Client Server Architecture



P2P Architecture

Distributed System Architecture

- A **distributed system architecture** is a multi-tier architecture that consists of a network of nodes that communicate with each other over a network.
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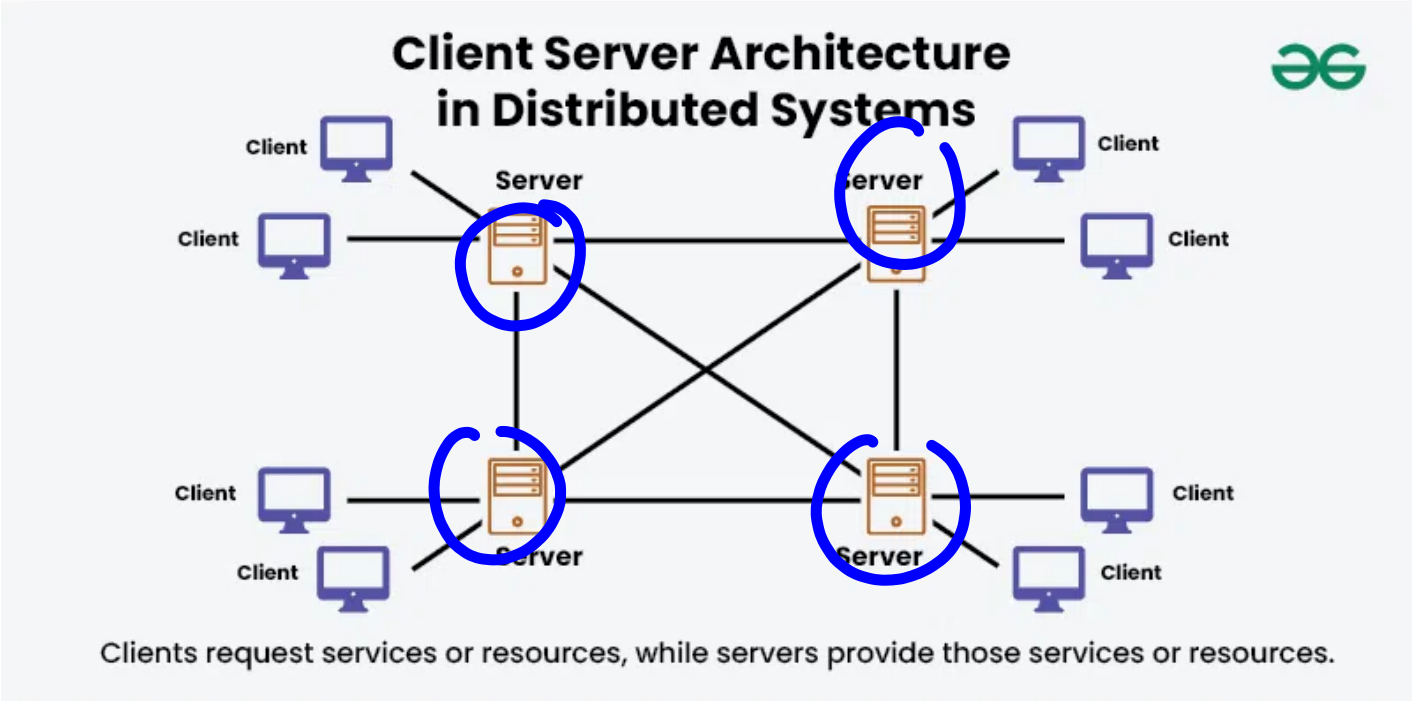

Software Architectures

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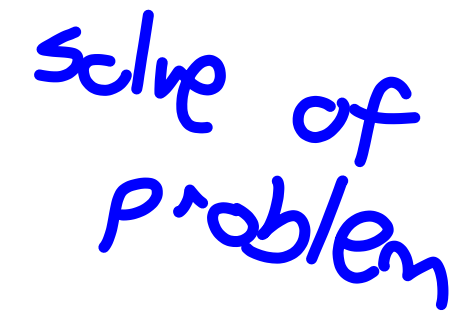

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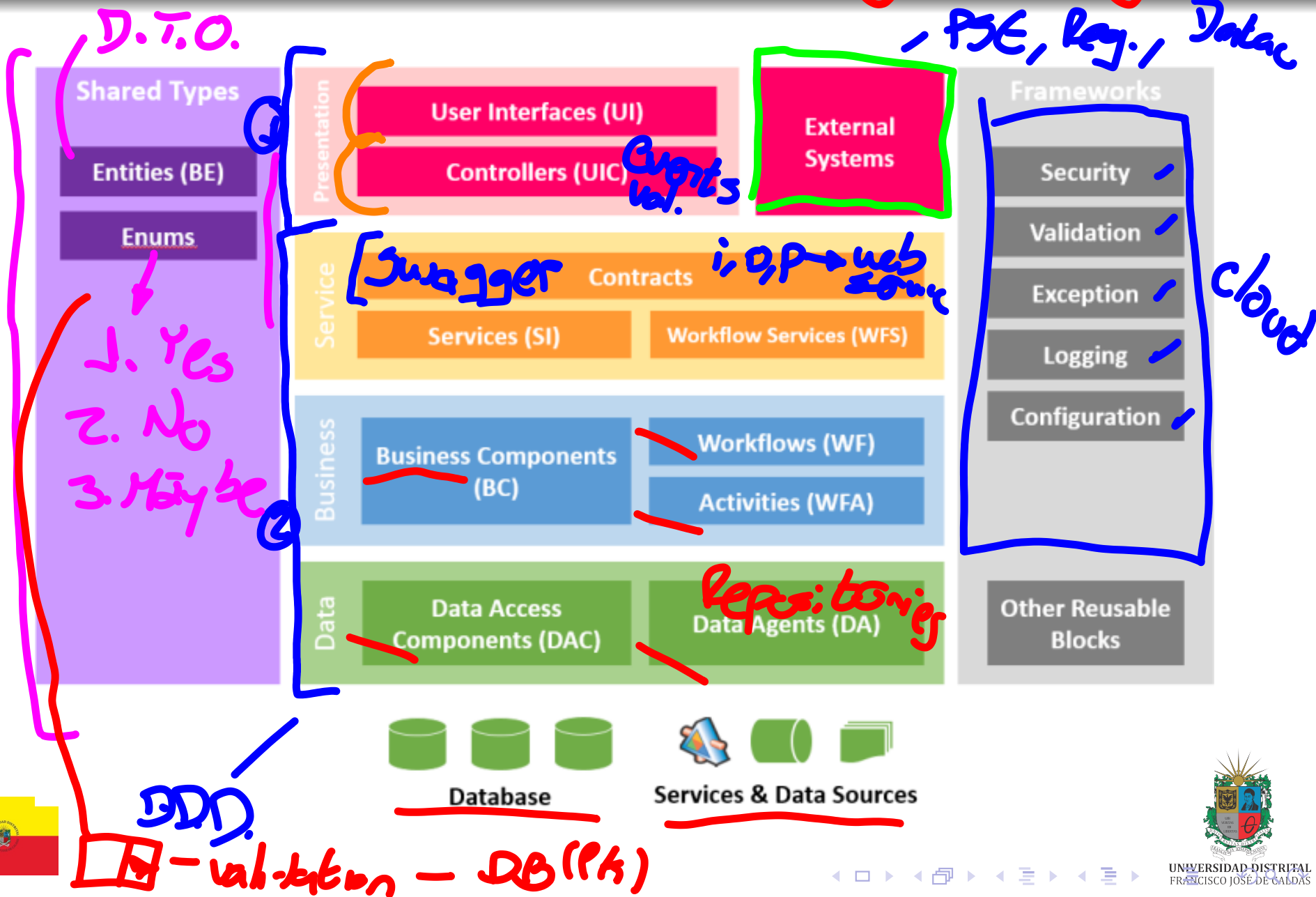
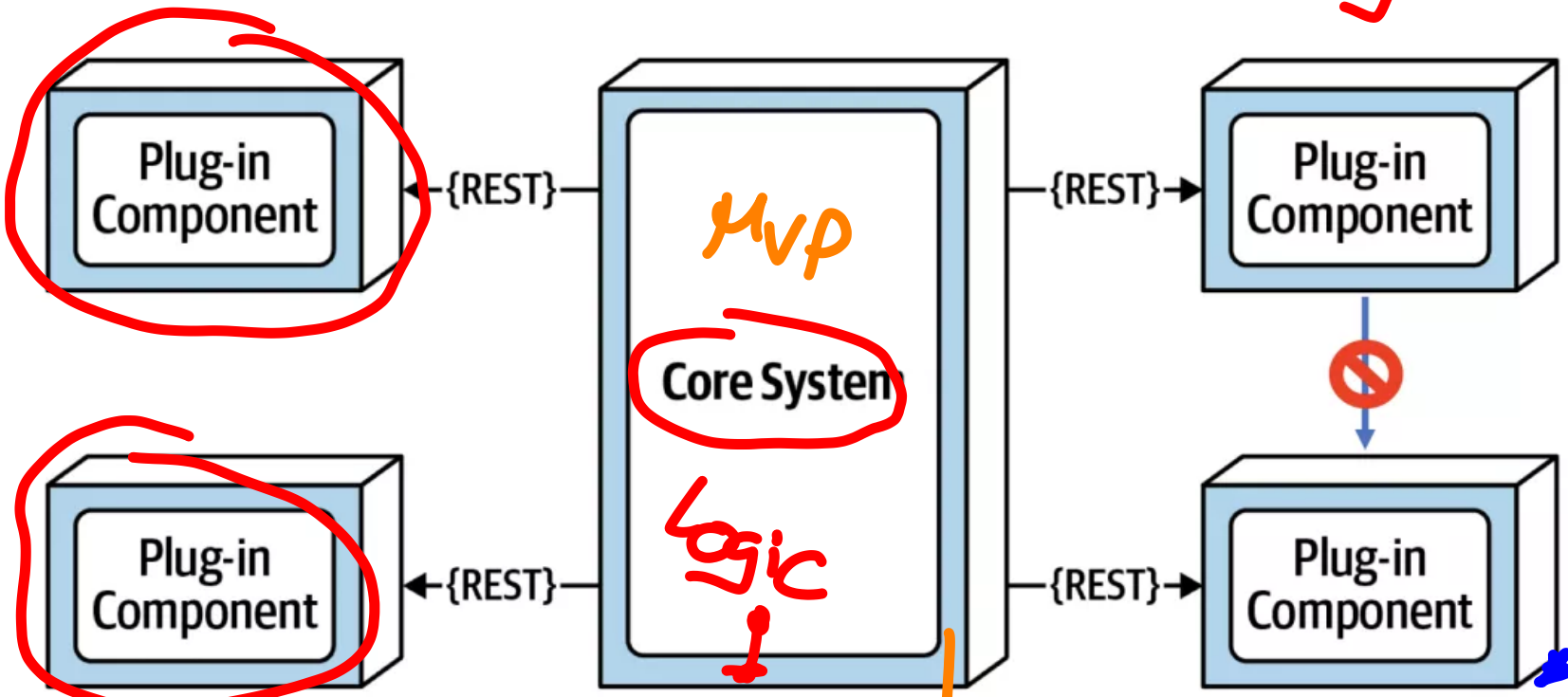
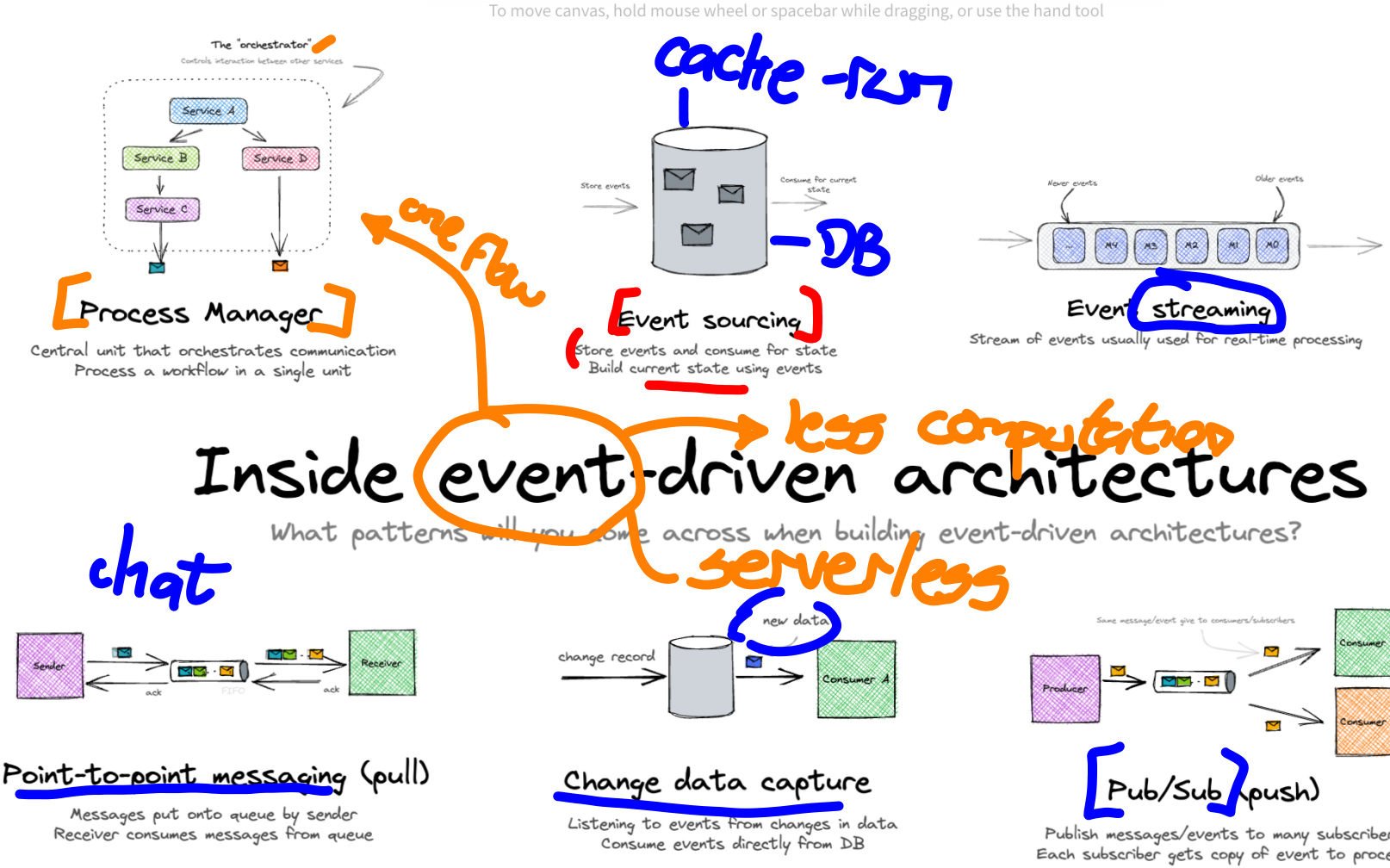
Layered Architecture Pattern



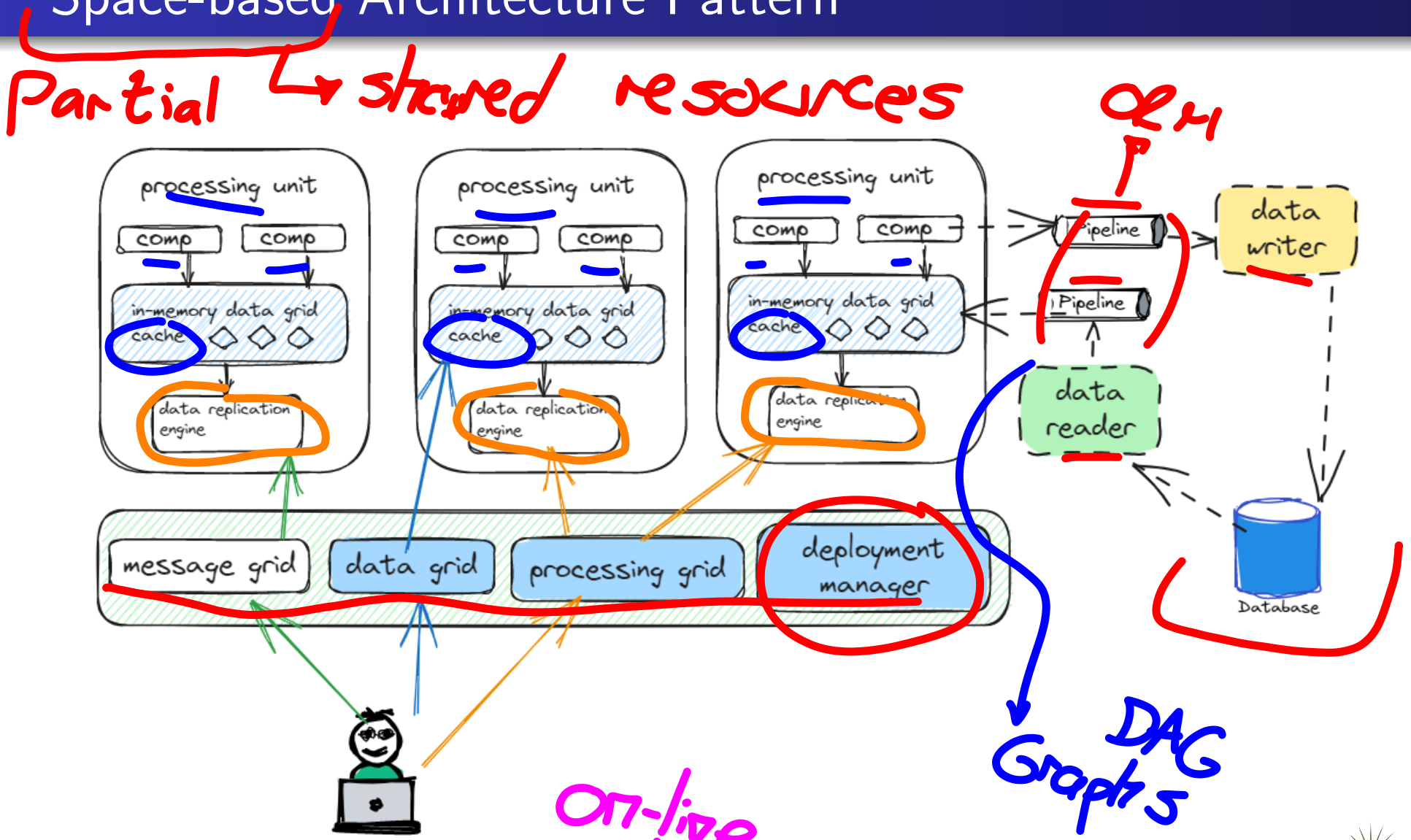
Microkernel Architecture Pattern



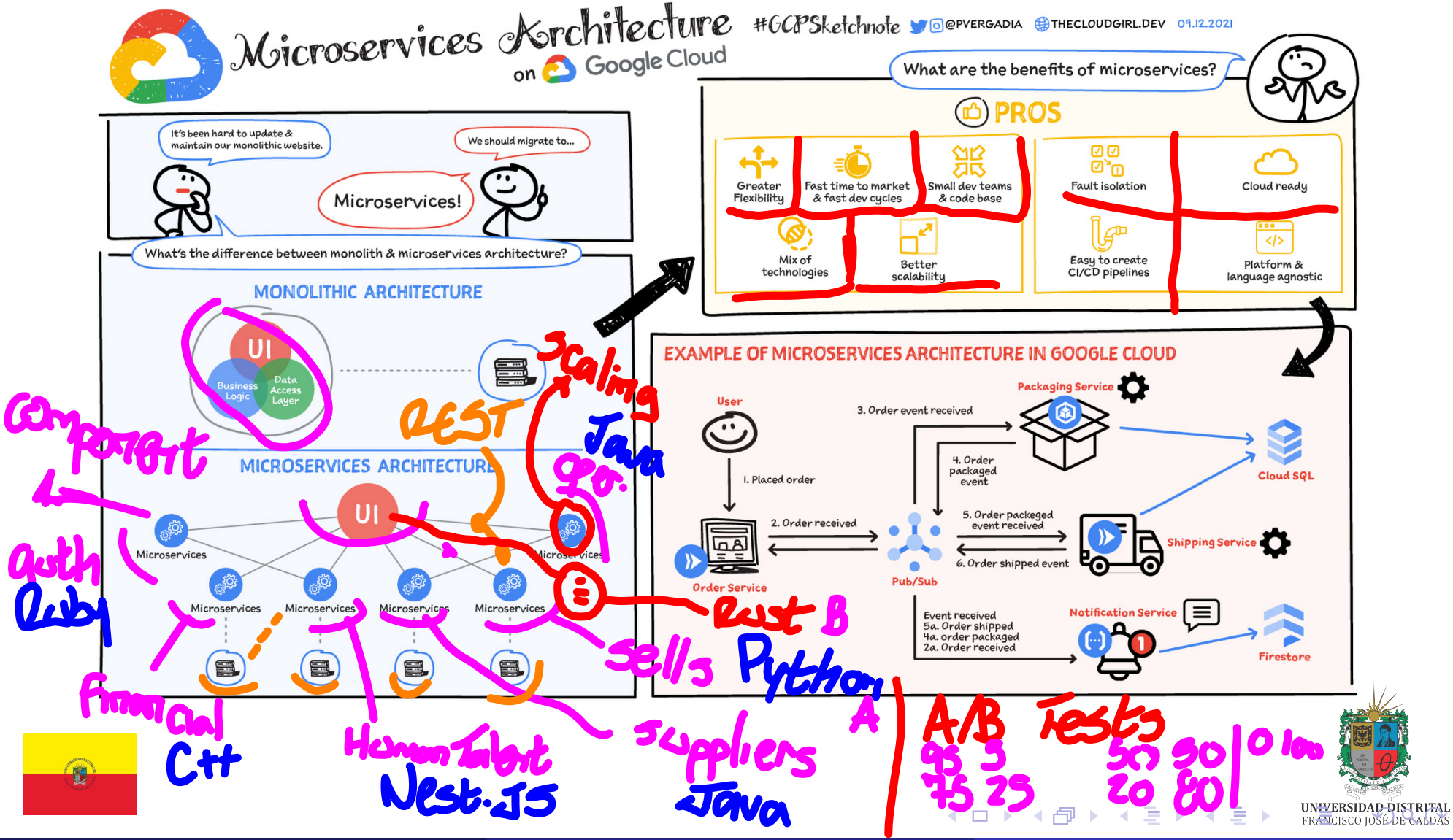
Event-based Architecture Pattern



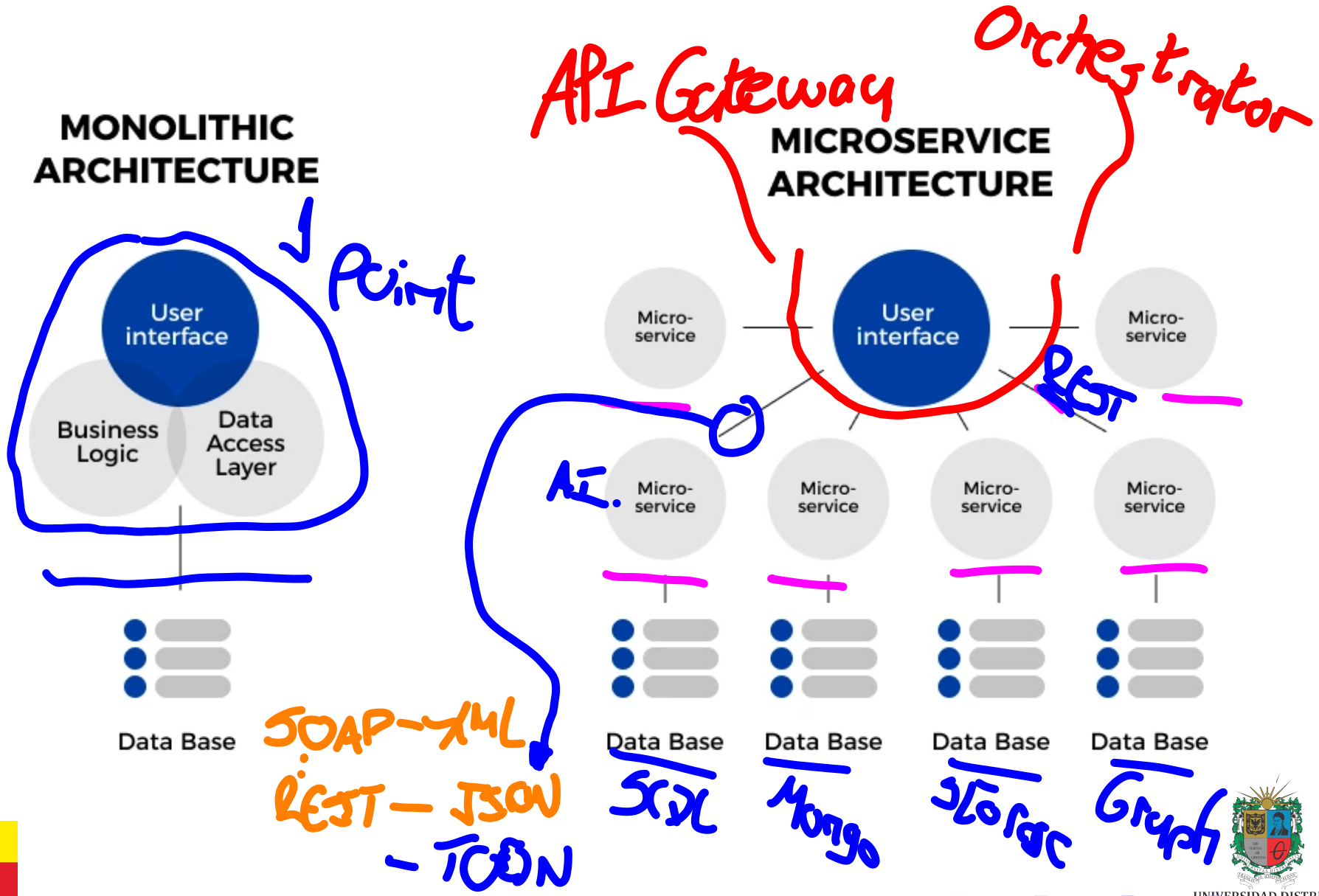
Space-based Architecture Pattern



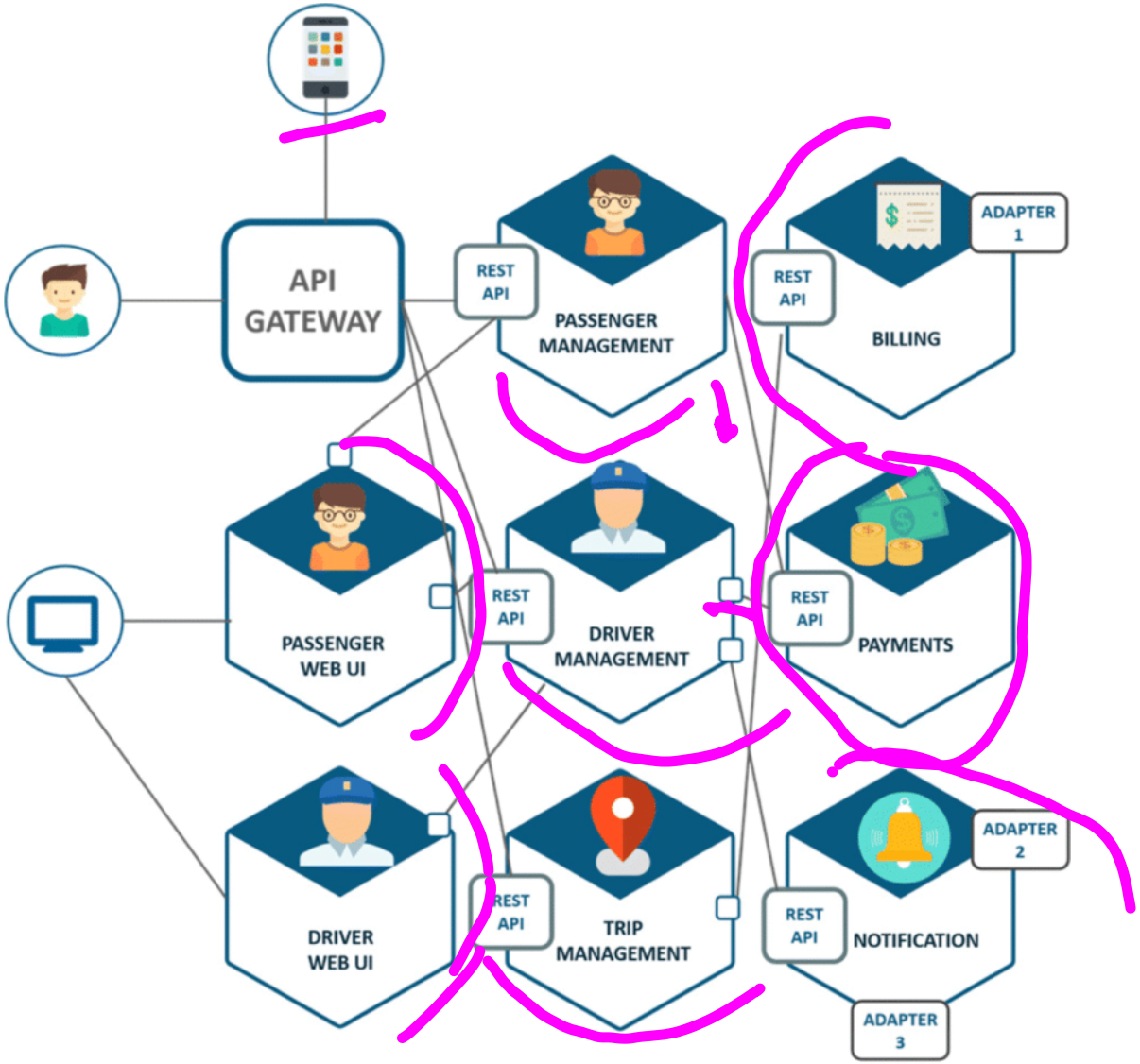
Microservices Architecture Pattern



Monolithic vs. Microservices Architectures



Case Study: Uber Microservices



Source: Kappagantula 2018

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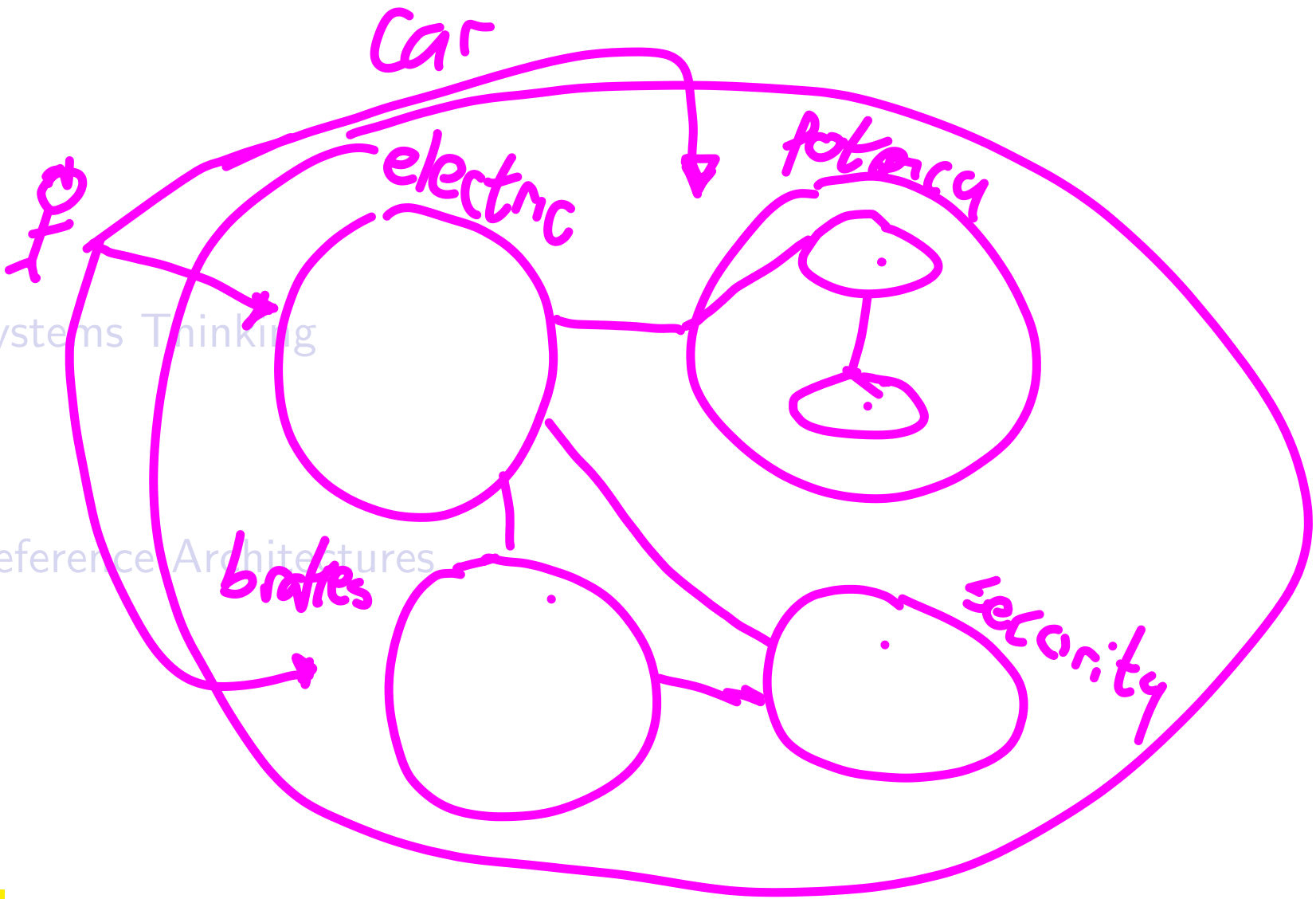

Thanks!

Questions?

Repo: *www.github.com/EngAndres/ud-public/tree/main/courses/software_engineering_seminar*

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