Software Development Process

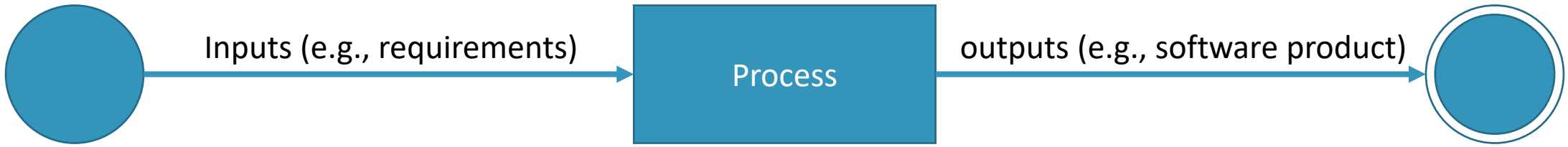
A fast overview and a practical example

Topics

- Software Development Process (SDP)
  - Why is needed?
  - Popular SDP
  - Core activities
  - Artifacts overview
- SDP throughout an example
  - From requirements to code
  - Introducing artifacts and UML
- Promoted working method

What is a process?

- A specification defining **who** does **what**, **when** and **how** in order to meet a given goal
- It comprehends a **set of interrelated activities** that transform a set of inputs in a set of outputs



Why do we need SDP for SW development?

- SW development easily becomes a chaotic activity characterized by “coding and composing”
- SW is written without an underlying plan, becoming full of short-term decisions
- This (might) work while SW is small and has little complexity
  - As SW size and complexity grows, it becomes increasingly difficult to add new features
  - Bugs become increasingly relevant and more difficult to solve

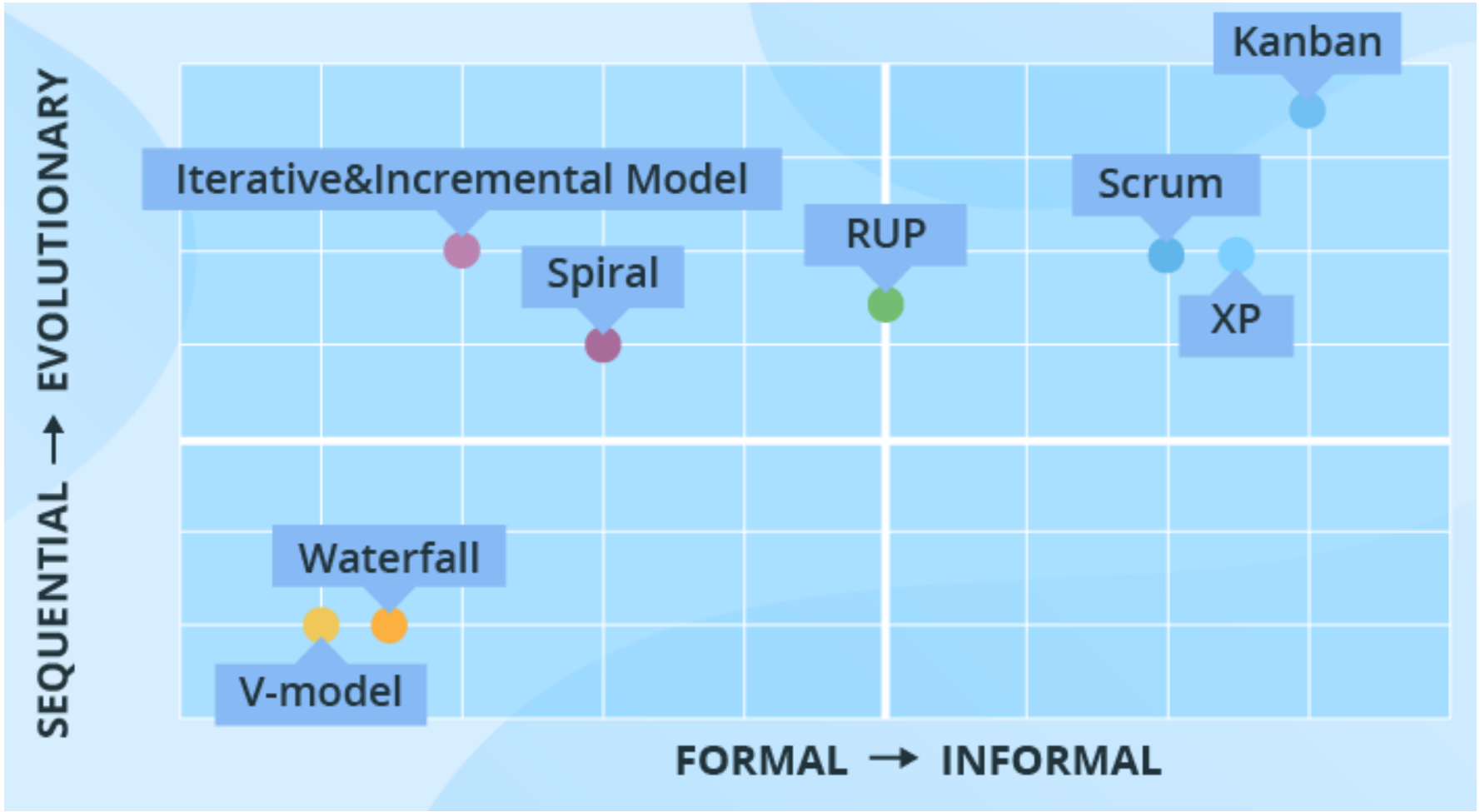
Some problems in SW development

- Misunderstood business (rules)
- Business changes
- High defect rates
- Outdated system
- Deviations in SW delivery scheduling

Software Development Process (SDP)

- Coherent sequence of practices systematizing the development or evolution of SW systems
- Set of activities, restrictions and resources that produce a desired result
  - Each activity must have a clear input and a clear output criterion
- Structures the activities by establishing an order or sequence
  - Set of principles or criteria that explain the objectives of each activity
  - Decision points in Planning
  - Synchronization points for the collaborative work of team

Some popular SDP



Extracted from [2]

Core software engineering activities

- Requirements gathering
- Feasibility study
- Analysis
- Design
- Implementation
- Testing
- Deployment
- Configuration management
- Project management
- Operations and Maintenance

Core software engineering activities studied in ESOFT

- **Requirements gathering**
- ~~Feasibility study~~
- **Analysis**
- **Design**
- **Implementation**
- ~~Testing~~
- ~~Deployment~~
- ~~Configuration management~~
- ~~Project management~~
- ~~Operations and Maintenance~~

+ Human Factors

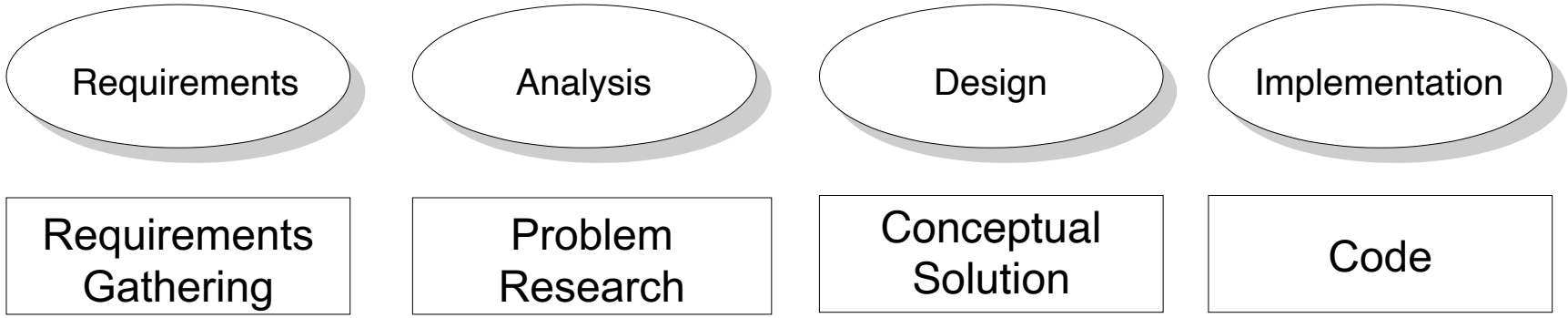
(teamwork and communication)

ESOFT: Goals

- Initial and core knowledge, capabilities and competencies of Software Engineering (SE), especially in the scope of information systems, about:
- Iterative and Incremental (I&I) Software Development Process (SDP) regarding
  - Requirements engineering
  - Analysis based on Object Oriented Paradigm (OOP)
  - Design based on Object Oriented Paradigm (OOP)
  - Implementation (prototype) of the resulting design

SW development is more than programming

- Knowing a programming language is necessary but not enough to create (good) software
- Between a good idea and good software there is much more than programming, namely



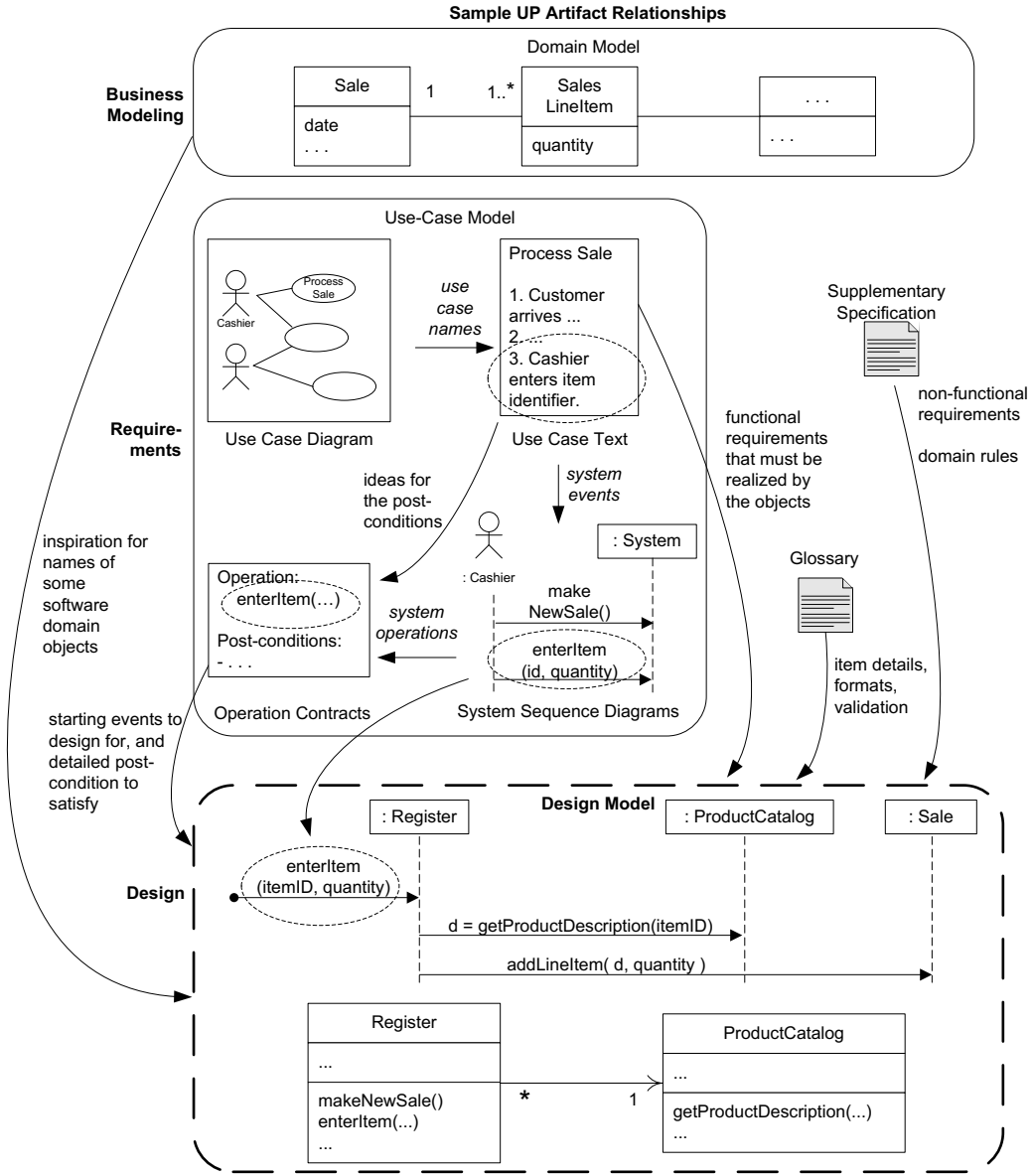
But also…

- SW development process
- Documentation and information sharing during the process (e.g., UML)
- Tests
  - Unitary
  - Functional
  - Integration
  - Acceptance
- Good practices of requirements, analysis, design, coding, …
- Human Factor/Skills:
  - Teamwork (soft skill)
  - Communication (soft skill)

Requirements vs. Analysis vs. Design

- Requirements
  - Identify what the stakeholders want
  - Clarify and record restrictions and requirements
- Analysis
  - Do the right thing
  - Problem and requirements research
  - Exploring requirements details (e.g., OO analysis)
- Design
  - Do the thing right
  - Conceptual solution that aims to fulfill the requirements
  - Lead to implementation, but it is not implementation
    - e.g., architectural design, OO use-case design, database design
- Implementation
  - Build the thing

Artifact overview



Extracted from [1]

SDP throughout an Example

(extracted/adapted from a previous project)

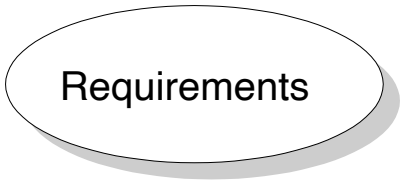
Project – Platform for Outsourcing Tasks

- Excerpts from the project's specification document:

> A startup needs to develop a software product that, on the one hand, allows any interested organization to be registered on it, in order to be able to publish tasks and manage the process of awarding those tasks to freelancers; and on the other hand, allows freelancers to easily access these tasks and be able to apply for them.

> It is expected that the product will be accessed by several users with different roles, such as:
>
> - Organization Employee: someone acting on behalf of a particular organization. Employees have the responsibility to specify and catalog tasks it for later publication by the organization;
> - Freelancers: people who propose to perform the tasks published by the organizations.

From requirements to code (1/4)



Requirements Gathering

Requirements

- Identify what stakeholders want or need
  - Which are the stakeholders and their interests?
  - What is the system purpose?
  - Which are the system boundaries?
  - Which are the system actors?

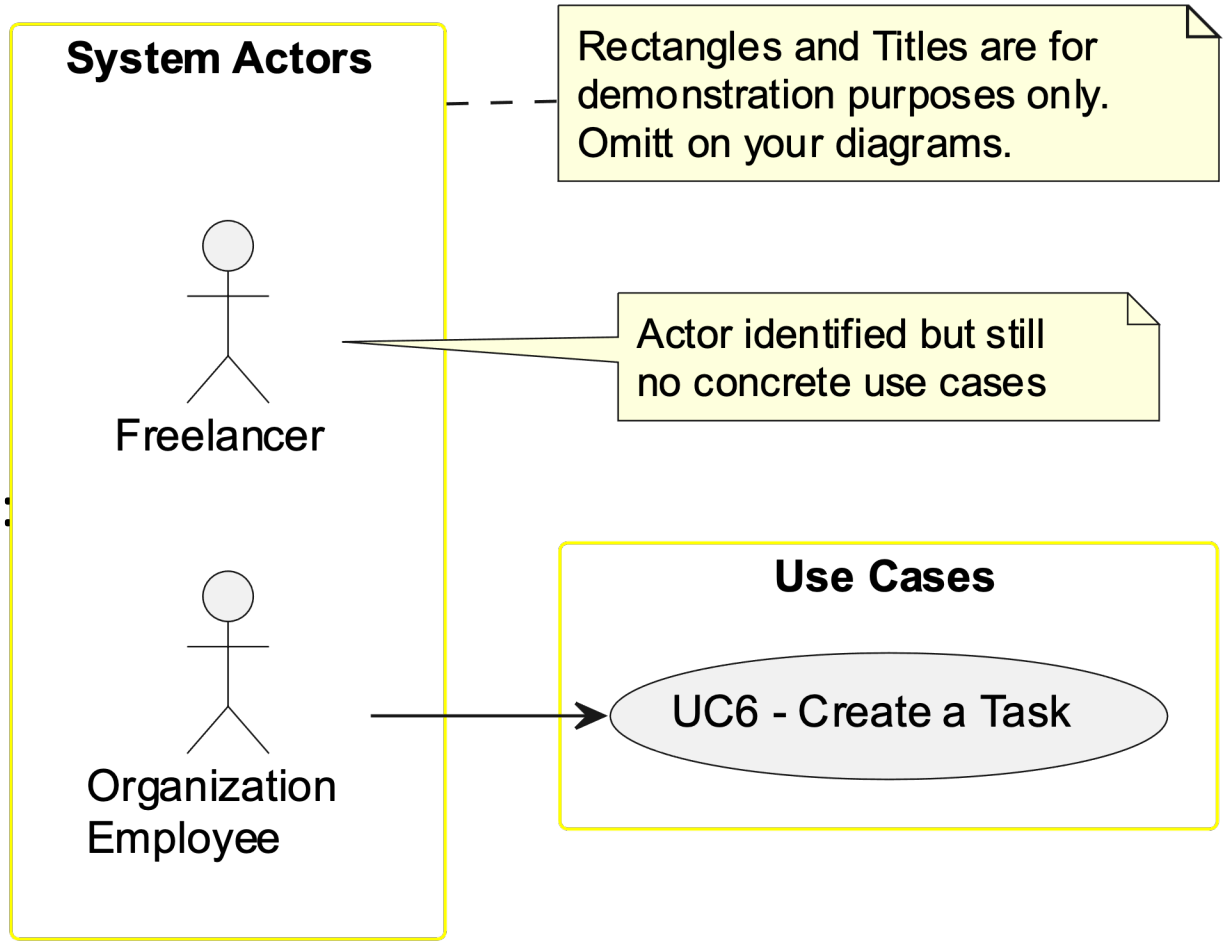
Done by:

- Documents' analysis
- Interviewing users and stakeholders
- Task observation
- Workshops
- Questionnaires

- Record restrictions and requirements
  - (In)Formal documents/artifacts
  - Forming a common understanding

Use Case Diagram (UCD)

- Identifying System Actors
  - Freelancer
  - Organization Employee
- Use Cases
  - Elementary business processes
  - Performed in the system by actors:
    - “Organization Employee” “creates a task”



Capturing Requirements

US 006 - To create a Task

1. Requirements Engineering

1.1. User Story Description

As an organization employee, I want to create a new task in order to be further published.

1.2. Customer Specifications and Clarifications

From the specifications document:

> Each task is characterized by having a unique reference per organization, a designation, an informal and a technical description, an estimated duration and cost as well as the its classifying task category.
>
> As long as it is not published, access to the task is exclusive to the employees of the respective organization.

From the client clarifications:

> **Question:** Which is the unit of measurement used to estimate duration?
>
> **Answer:** Duration is estimated in days.

> **Question:** Monetary data is expressed in any particular currency?
>
> **Answer:** Monetary data (e.g. estimated cost of a task) is indicated in POTs (virtual currency internal to the platform).

Capturing Requirements (cont.)

1.3. Acceptance Criteria

- **AC1:** All required fiels must be filled in.
- **AC2:** Task reference must have at least 5 alphanumeric chars.
- **AC3:** When creating a task with an already existing reference, the system must reject such operation and the user must have the change to modify the typed reference.

1.4. Found out Dependencies

- There is a dependency to "US003 Create a task category" since at least a task category must exist to classify the task being created.

1.5 Input and Output Data

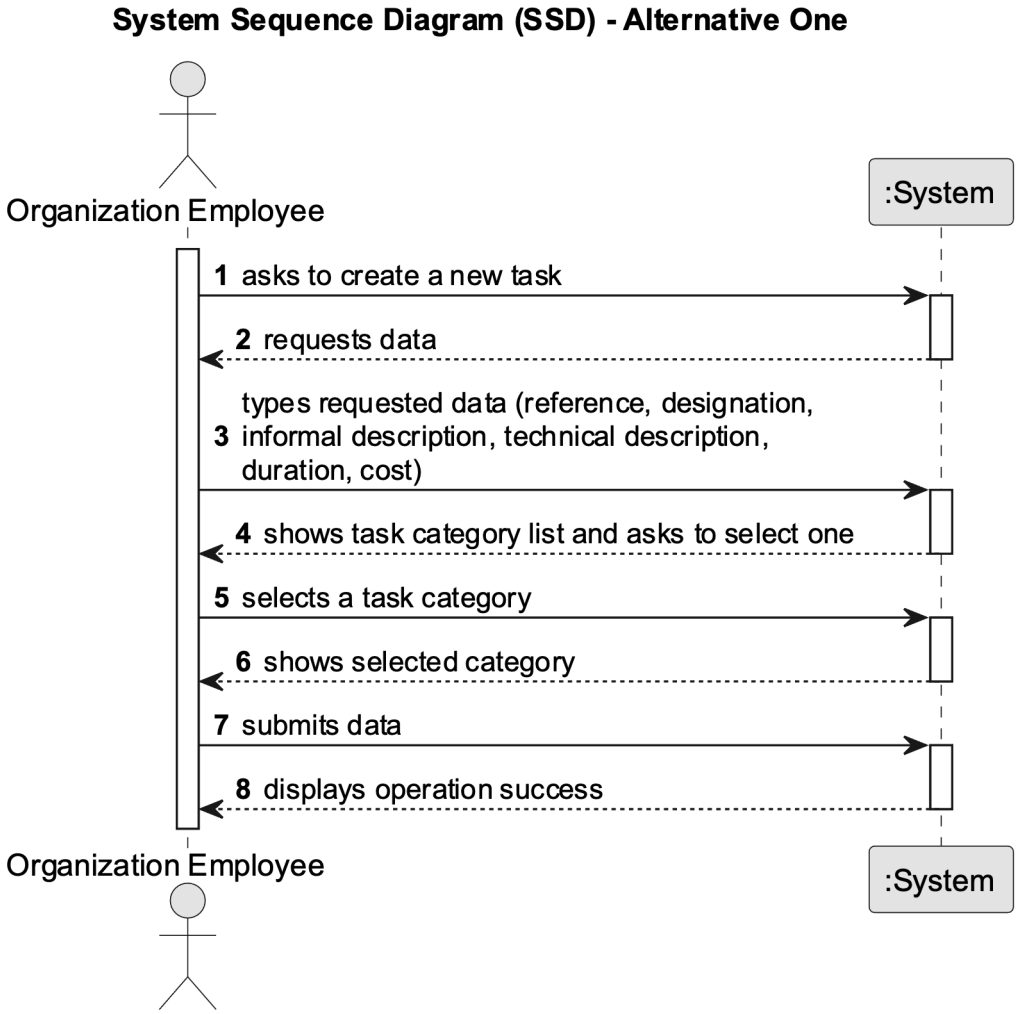
Input Data:

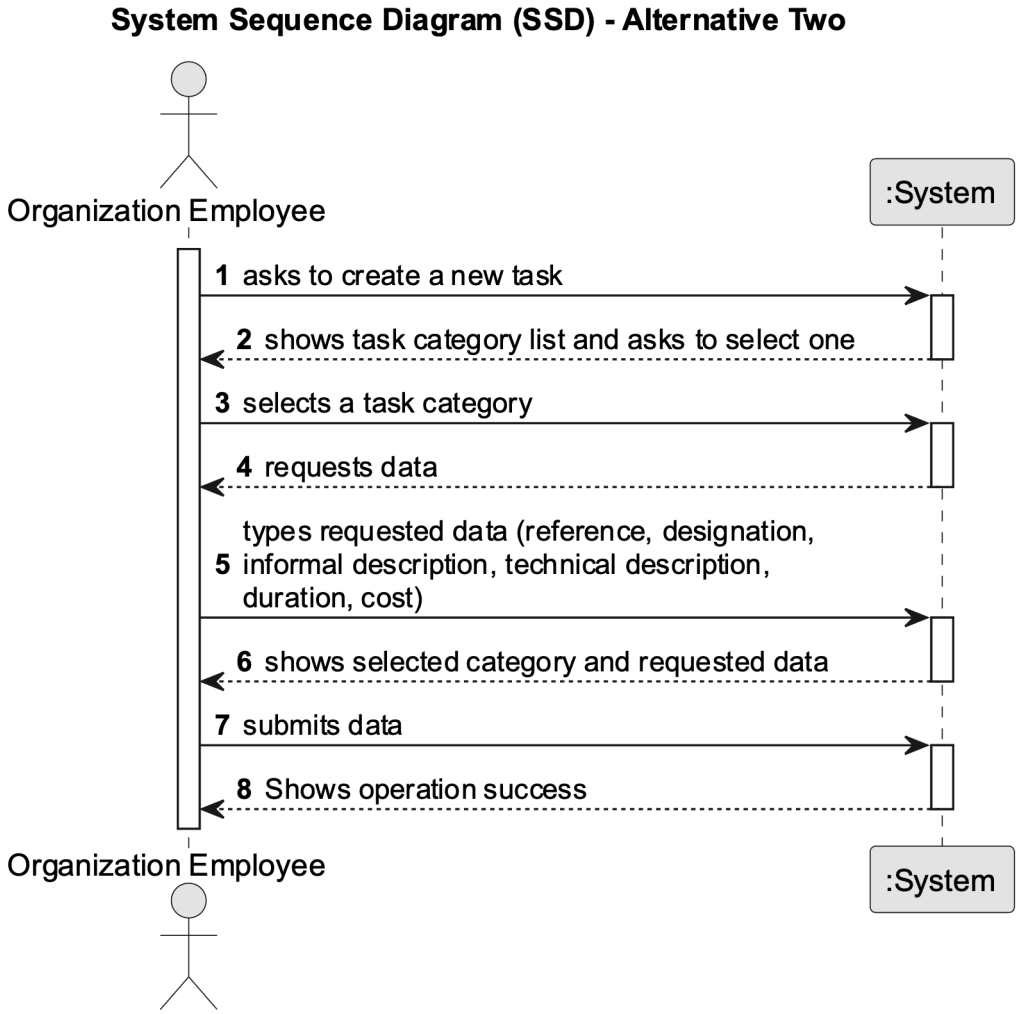
- Typed data:
  - a reference,
  - a designation,
  - an informal description
  - a technical description
  - an estimated duration
  - an estimated cost
- Selected data:
  - Classifying task category

Output Data:

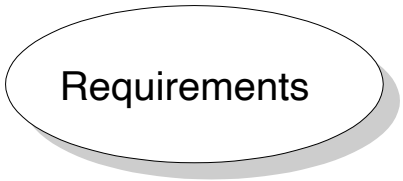
- List of existing task categories
- (In)Success of the operation

Capturing Requirements (cont.)



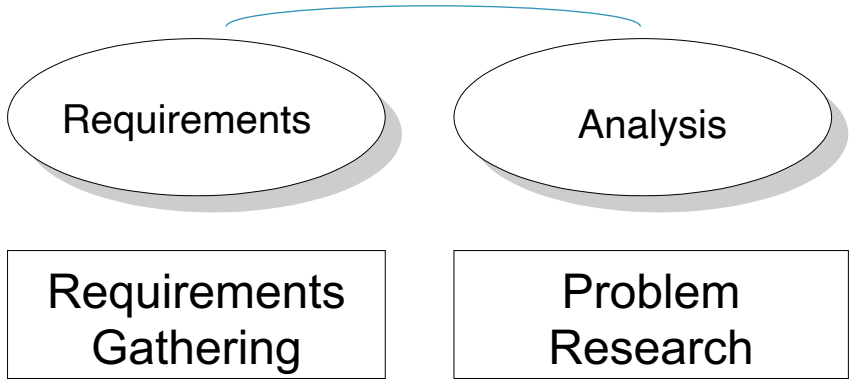


From requirements to code (2/4)



Requirements Gathering

From requirements to code (2/4)

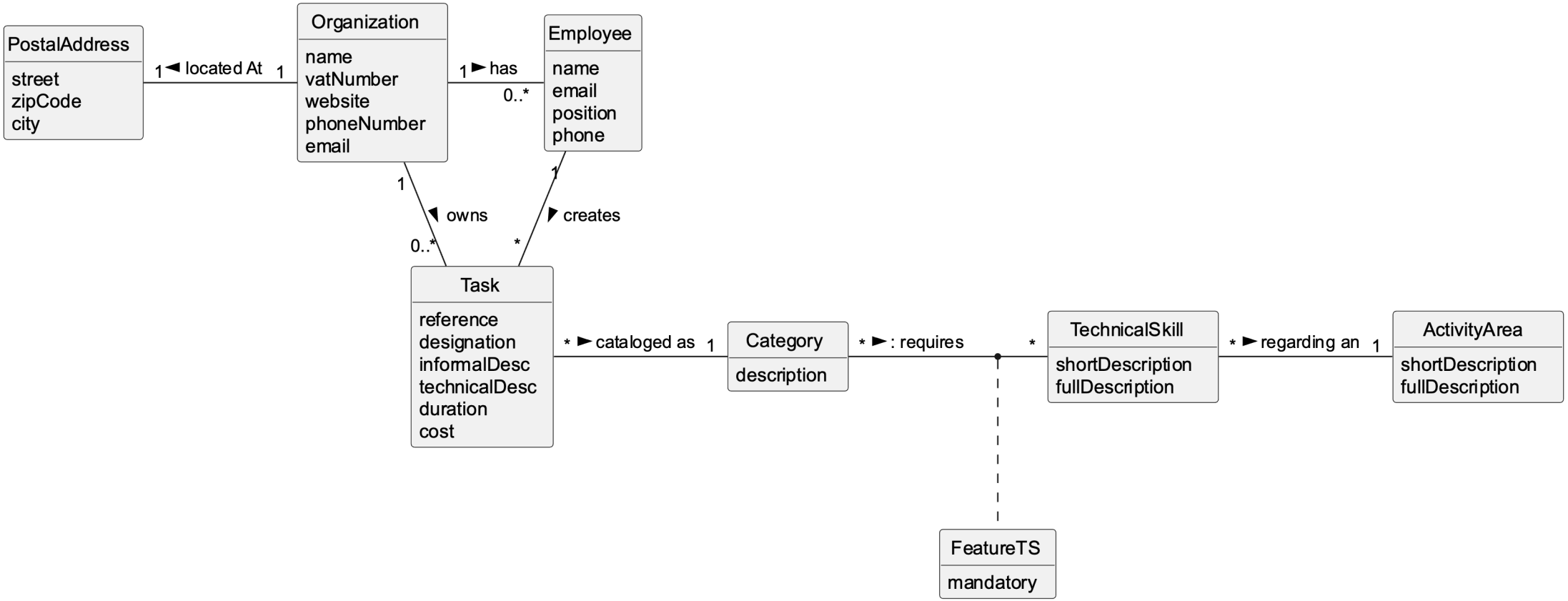


Analysis

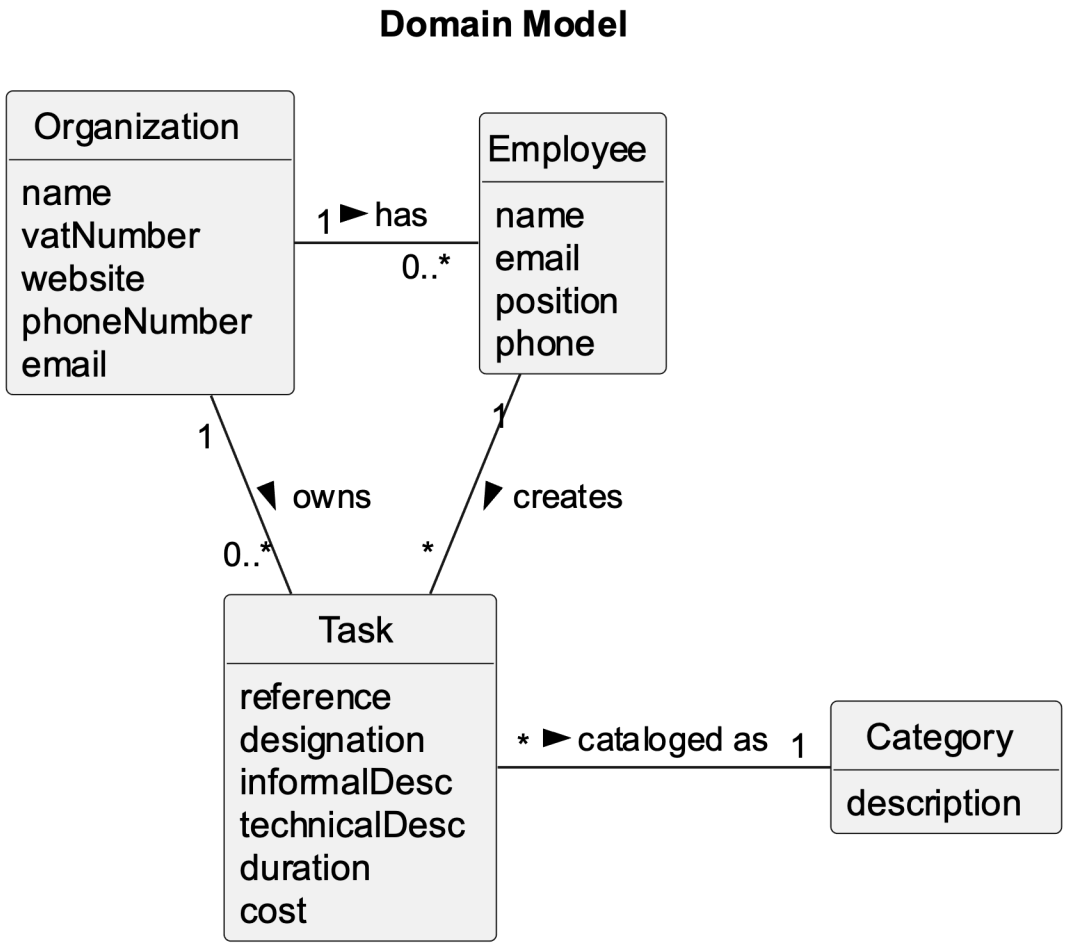
- It implies:
  - Acquiring domain/business knowledge
  - Understanding the domain/business
  - Reasoning about domain/business

- Analysis oriented by:
  - Objects → OO Analysis → Domain (Object) Model
    - Classifying domain elements/concepts
    - Finding relationships between domain concepts
  - Processes or Activities

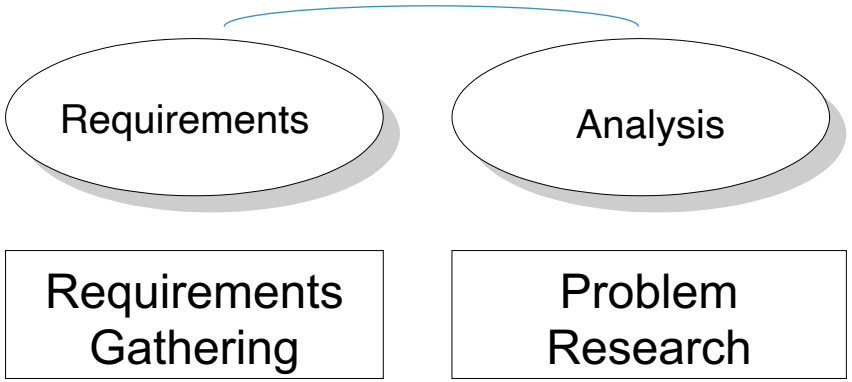
Domain Model (for the Project)



Domain Model Excerpt Relevant for US 006



From requirements to code (3/4)



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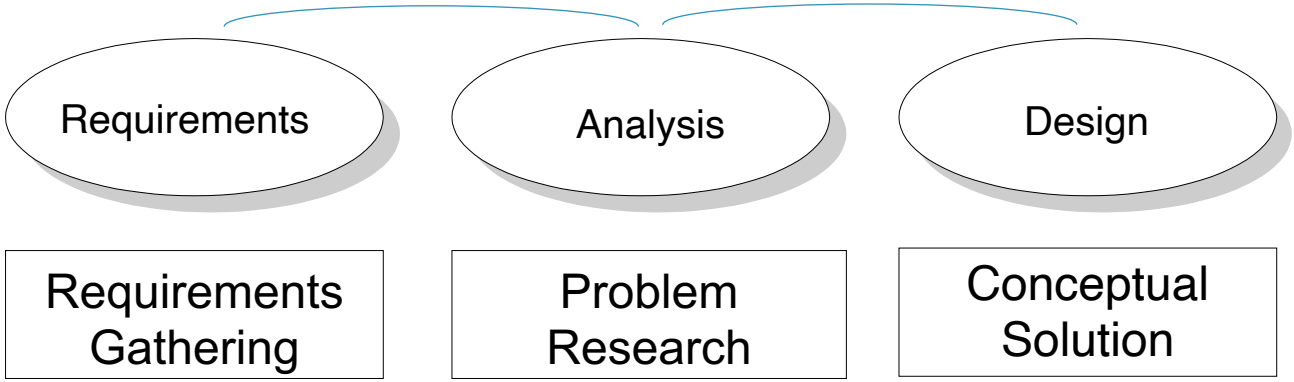


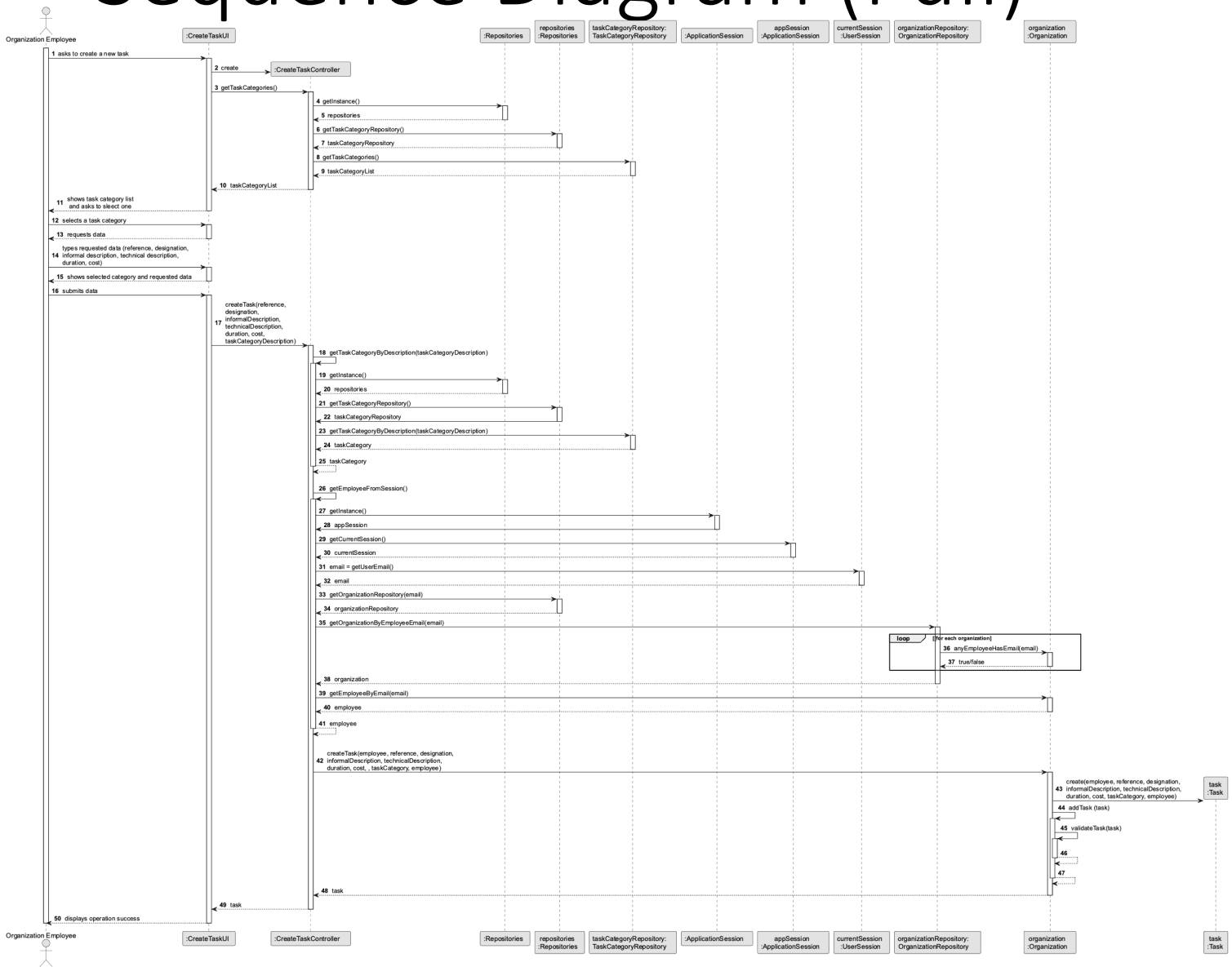
Design – User Story Realization

- Which pieces constitutes the software being developed?
  - Classes, their attributes and methods
  - But which classes?

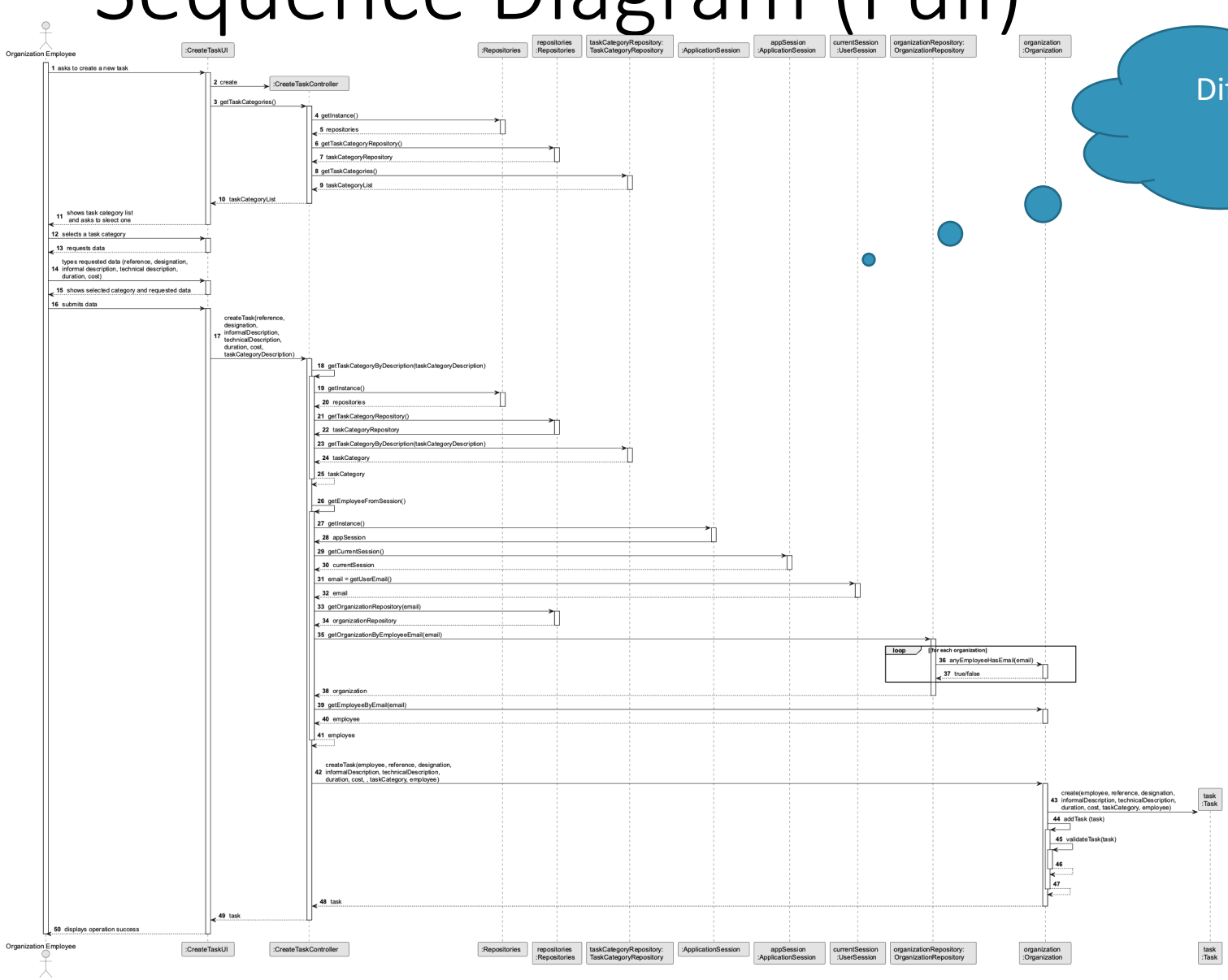
- Rationale to determine which classes
  - Oriented by responsibilities assignment
  - Promoting domain concepts to software classes
  - Fabrication of pure software classes

- Design Model
  - Sequence diagram (SD) – Dynamic View
  - Class diagram (CD) – Static View
  - SD and CD are developed together (at the same time)

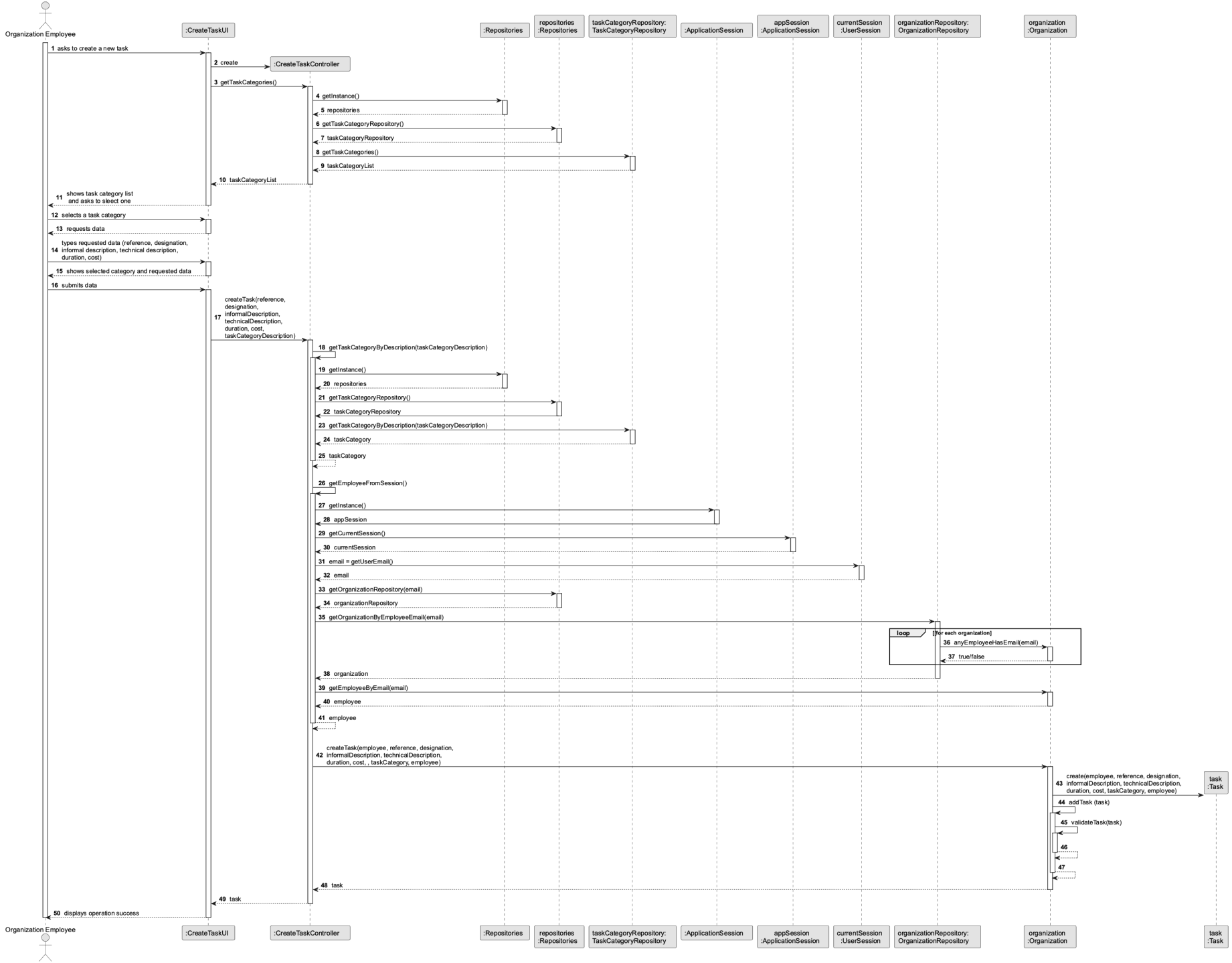
US 006 – Sequence Diagram (Full)

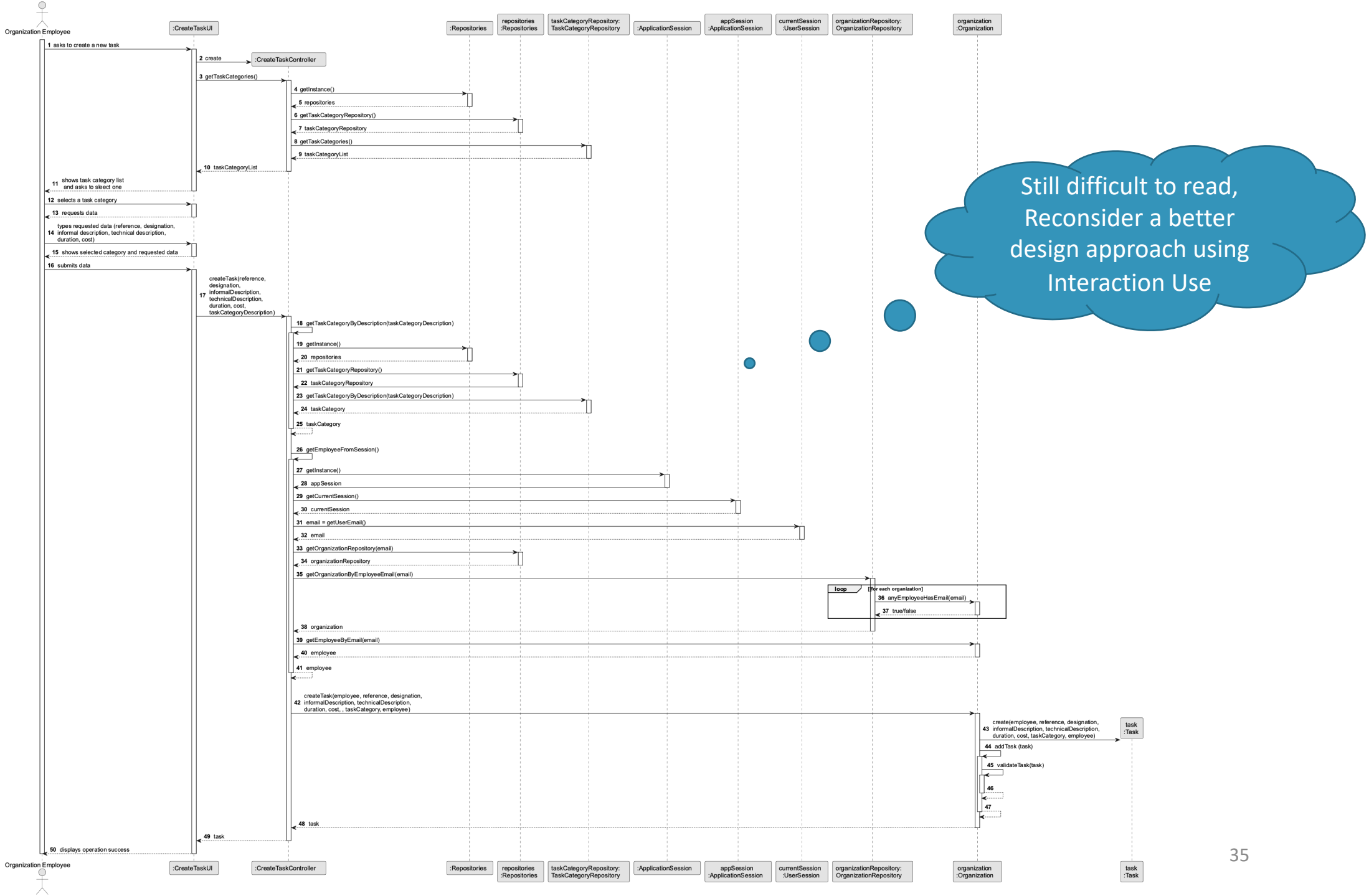


US 006 – Sequence Diagram (Full)



Difficult to read, zoom it


Organization Employee
:CreateTaskUI
:CreateTaskController
:Repositories
repositories :Repositories
taskCategoryRepository: TaskCategoryRepository
:ApplicationSession
appSession :ApplicationSession
currentSession :UserSession
organizationRepository: OrganizationRepository
organization :Organization
task :Task
1 asks to create a new task
2 create
3 getTaskCategories()
4 getInstance()
5 repositories
6 getTaskCategoryRepository()
7 taskCategoryRepository
8 getTaskCategories()
9 taskCategoryList
10 taskCategoryList
11 shows task category list and asks to sleect one
12 selects a task category
13 requests data
14 types requested data (reference, designation, informal description, technical description, duration, cost)
15 shows selected category and requested data
16 submits data
17 createTask(reference, designation, informalDescription, technicalDescription, duration, cost, taskCategoryDescription)
18 getTaskCategoryByDescription(taskCategoryDescription)
19 getInstance()
20 repositories
21 getTaskCategoryRepository()
22 taskCategoryRepository
23 getTaskCategoryByDescription(taskCategoryDescription)
24 taskCategory
25 taskCategory
26 getEmployeeFromSession()
27 getInstance()
28 appSession
29 getCurrentSession()
30 currentSession
31 email = getUserEmail()
32 email
33 getOrganizationRepository(email)
34 organizationRepository
35 getOrganizationByEmployeeEmail(email)
loop
[for each organization]
36 anyEmployeeHasEmail(email)
37 true/false
38 organization
39 getEmployeeByEmail(email)
40 employee
41 employee
42 createTask(employee, reference, designation, informalDescription, technicalDescription, duration, cost, , taskCategory, employee)
43 create(employee, reference, designation, informalDescription, technicalDescription, duration, cost, taskCategory, employee)
44 addTask (task)
45 validateTask(task)
46
47
48 task
49 task
50 displays operation success


Organization Employee
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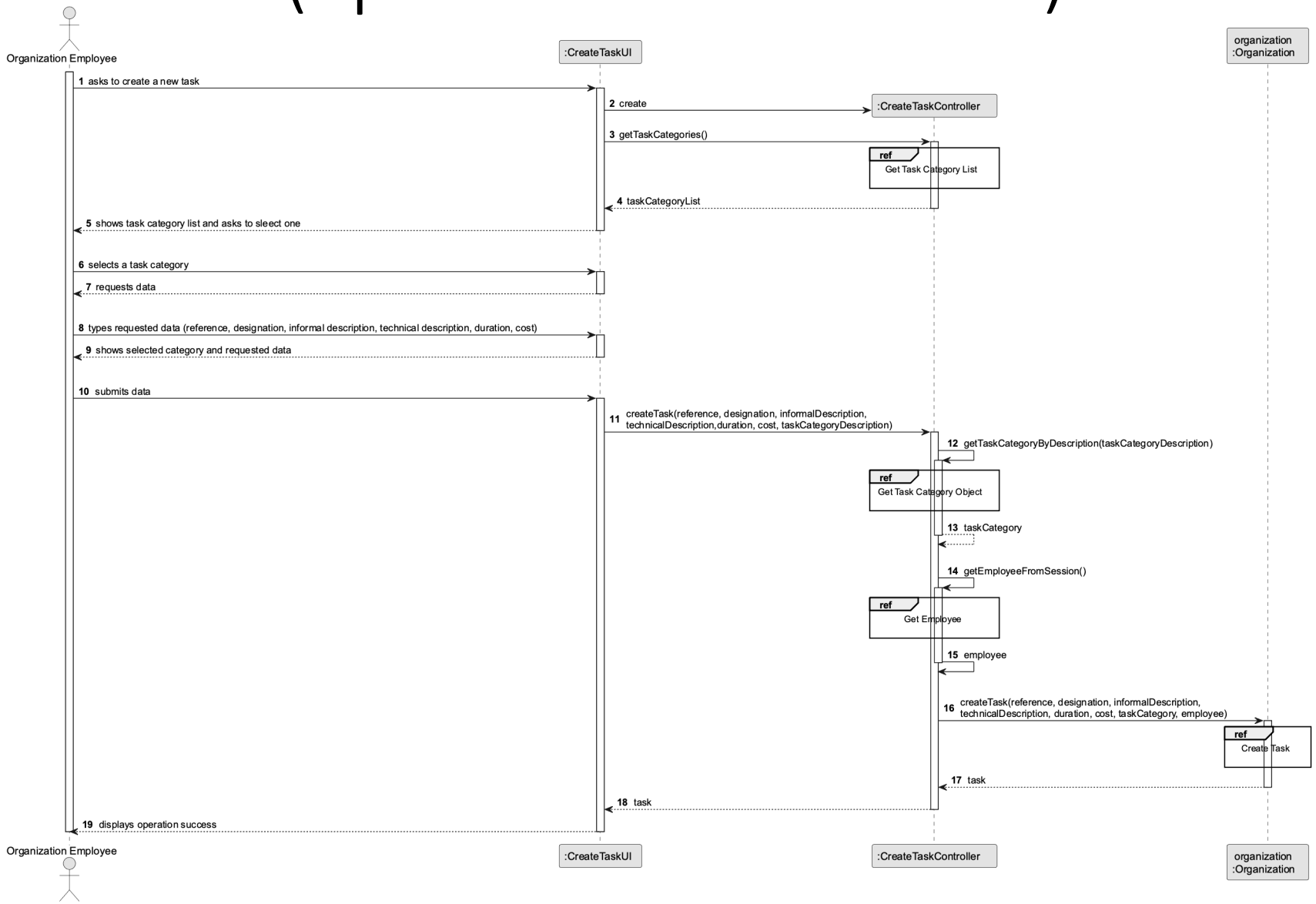
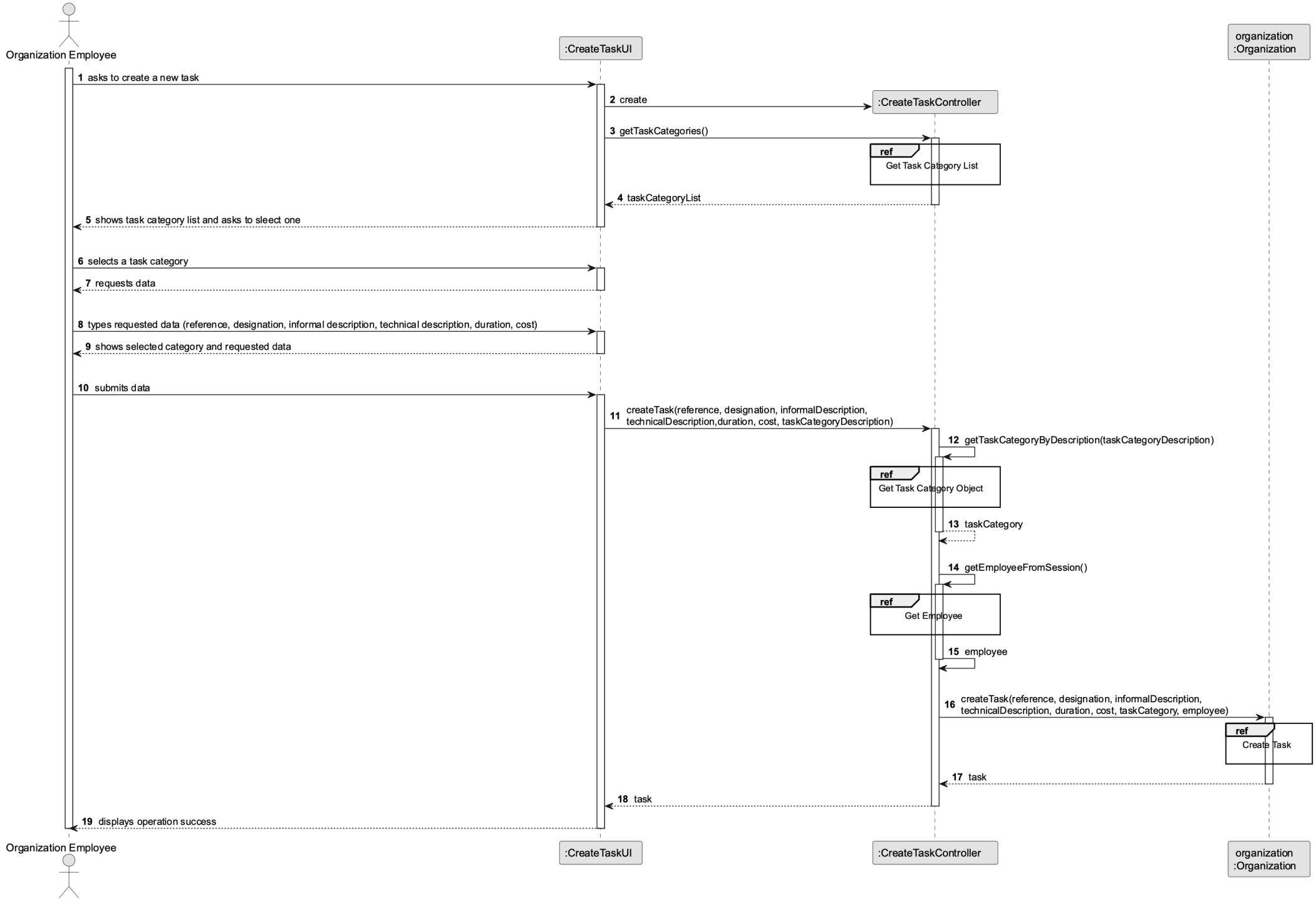
19 getInstance()
20 repositories
21 getTaskCategoryRepository()
22 taskCategoryRepository
23 getTaskCategoryByDescription(taskCategoryDescription)
24 taskCategory
25 taskCategory
26 getEmployeeFromSession()
27 getInstance()
28 appSession
29 getCurrentSession()
30 currentSession
31 email = getUserEmail()
32 email
33 getOrganizationRepository(email)
34 organizationRepository
35 getOrganizationByEmployeeEmail(email)
loop
[for each organization]
36 anyEmployeeHasEmail(email)
37 true/false
38 organization
39 getEmployeeByEmail(email)
40 employee
41 employee
42 createTask(employee, reference, designation, informalDescription, technicalDescription, duration, cost, , taskCategory, employee)
43 create(employee, reference, designation, informalDescription, technicalDescription, duration, cost, taskCategory, employee)
44 addTask (task)
45 validateTask(task)
46
47
48 task
49 task
50 displays operation success
Still difficult to read, Reconsider a better design approach using Interaction Use

US 006 – SD (Split Interaction Use)




Organization Employee
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8 types requested data (reference, designation, informal description, technical description, duration, cost)
9 shows selected category and requested data
10 submits data
11 createTask(reference, designation, informalDescription, technicalDescription,duration, cost, taskCategoryDescription)
12 getTaskCategoryByDescription(taskCategoryDescription)
ref
Get Task Category Object
13 taskCategory
14 getEmployeeFromSession()
ref
Get Employee
15 employee
16 createTask(reference, designation, informalDescription, technicalDescription, duration, cost, taskCategory, employee)
ref
Create Task
17 task
18 task
19 displays operation success
Organization Employee
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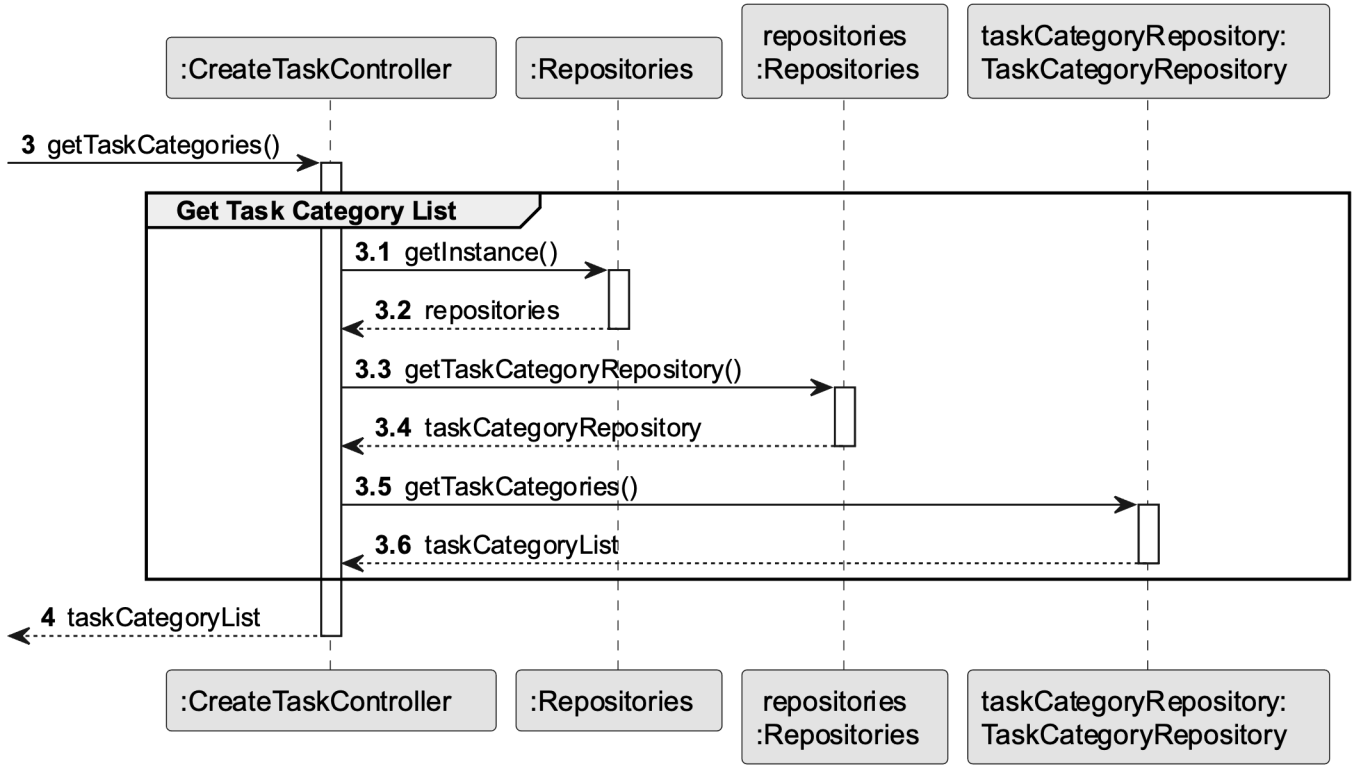
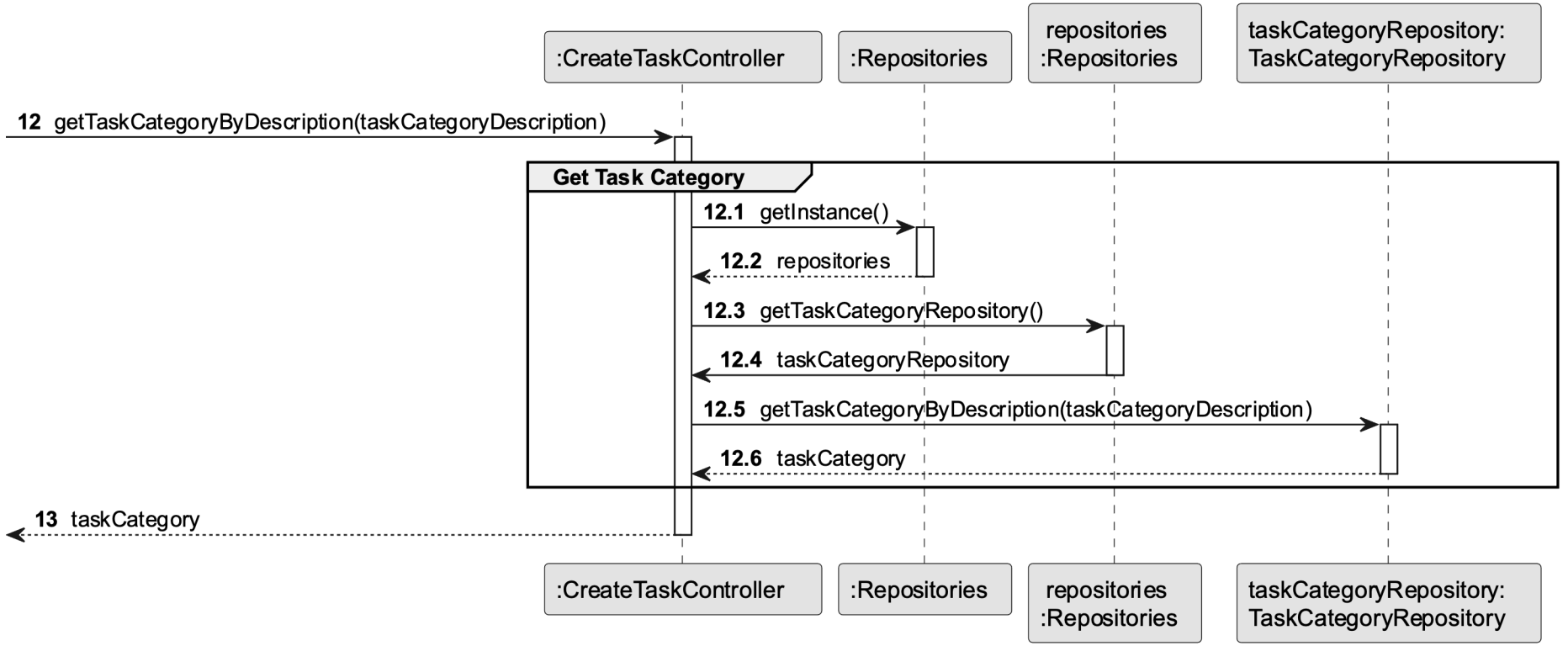
:CreateTaskController
organization :Organization

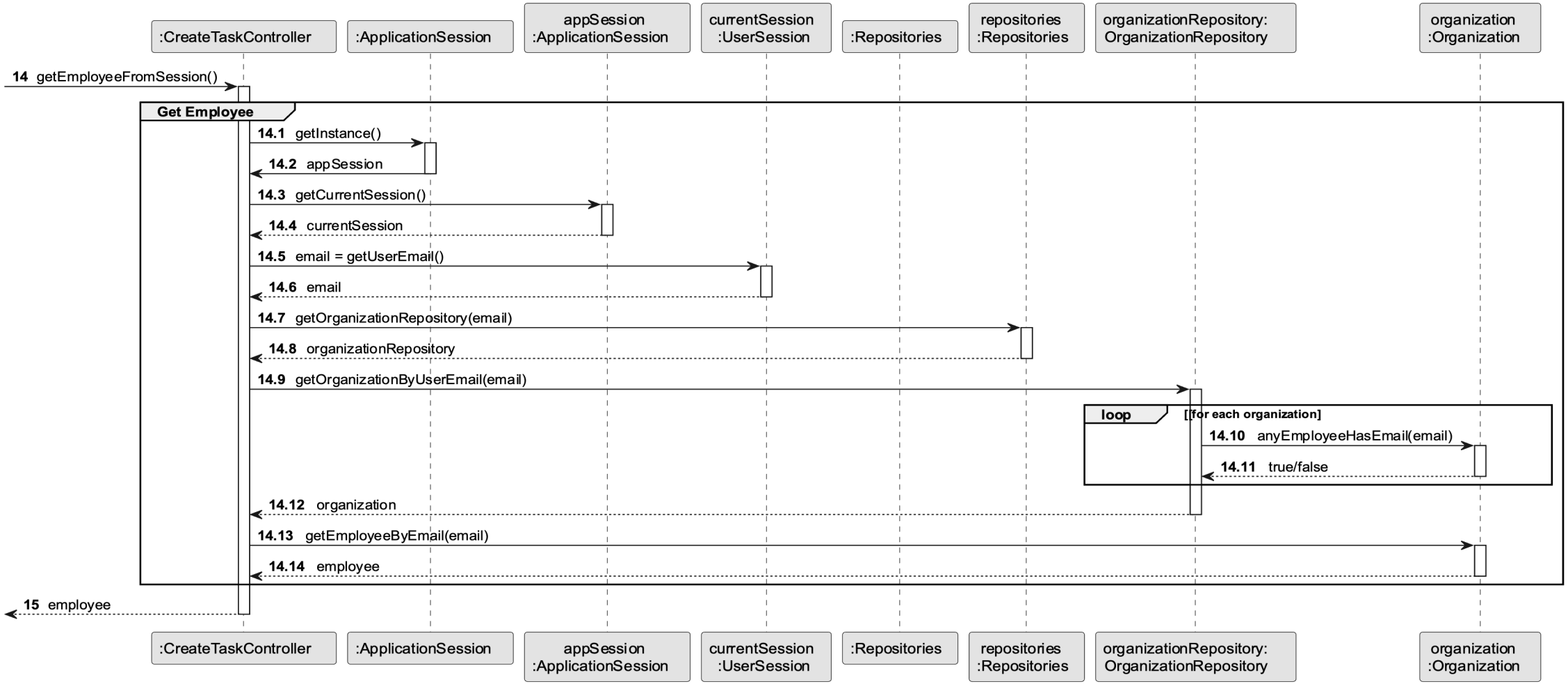
US 006 – SD: ref: Get Task Category List



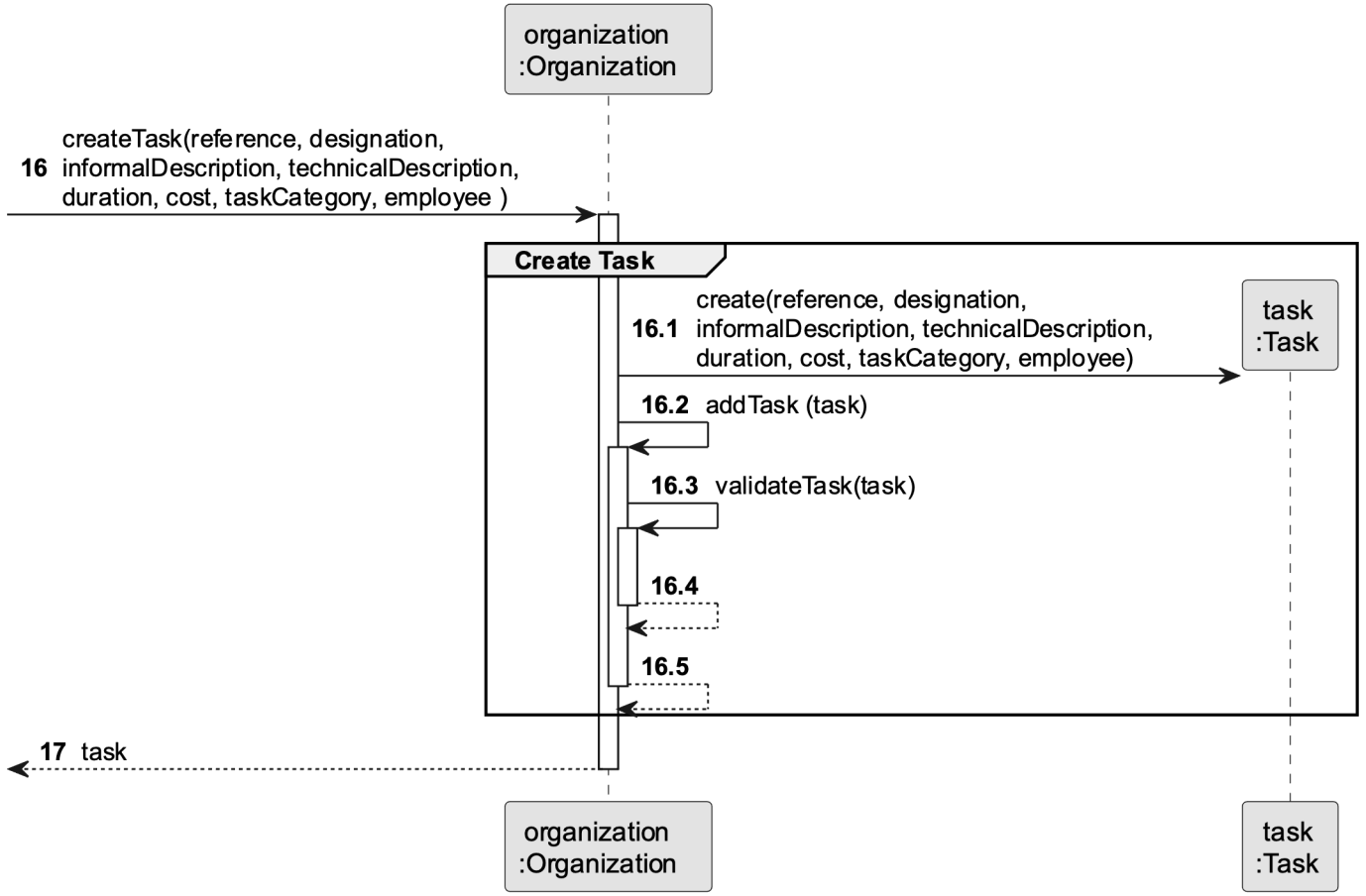
US 006 – SD: ref: Get Task Category



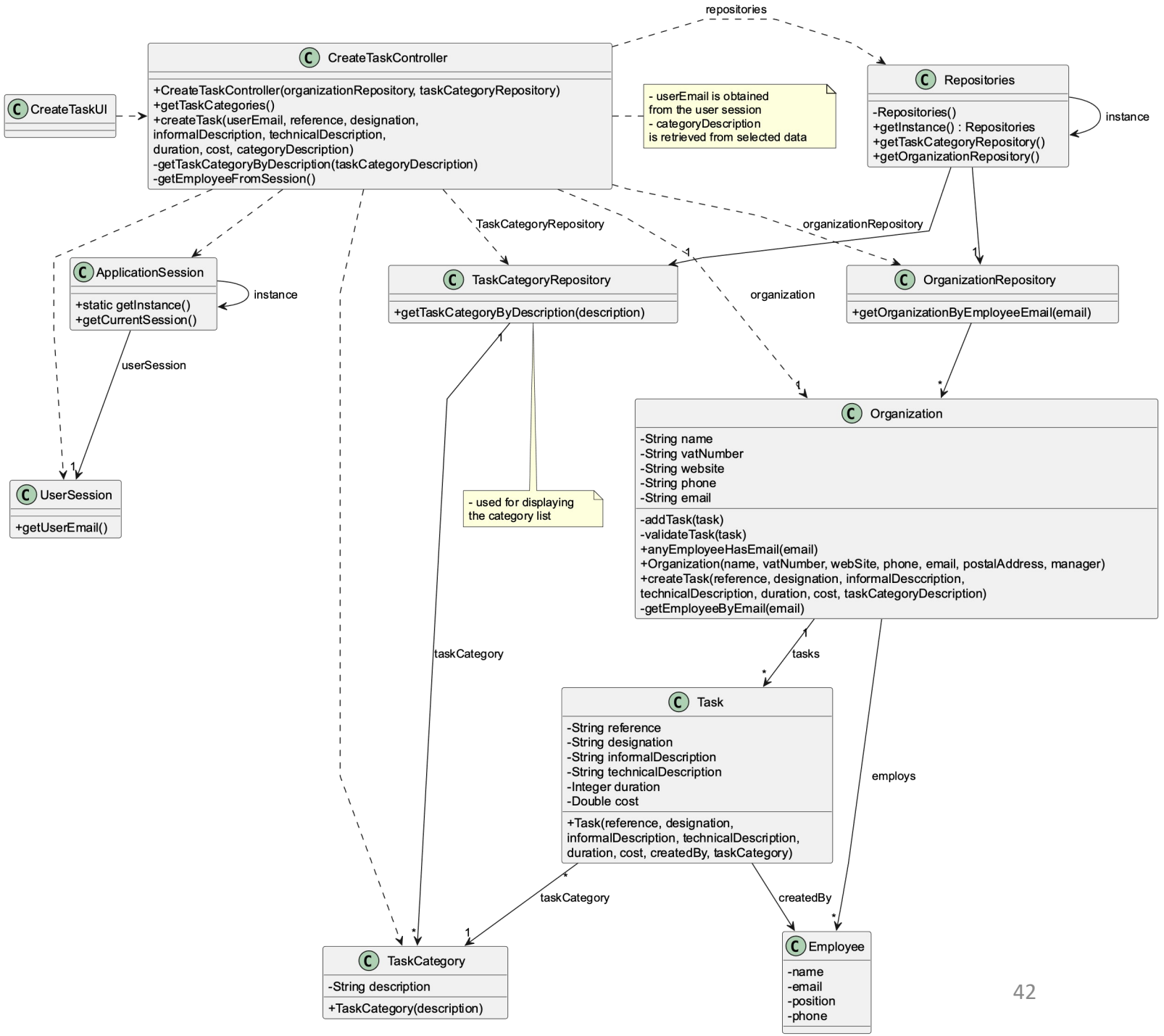
US 006 – SD: ref: Get Employee



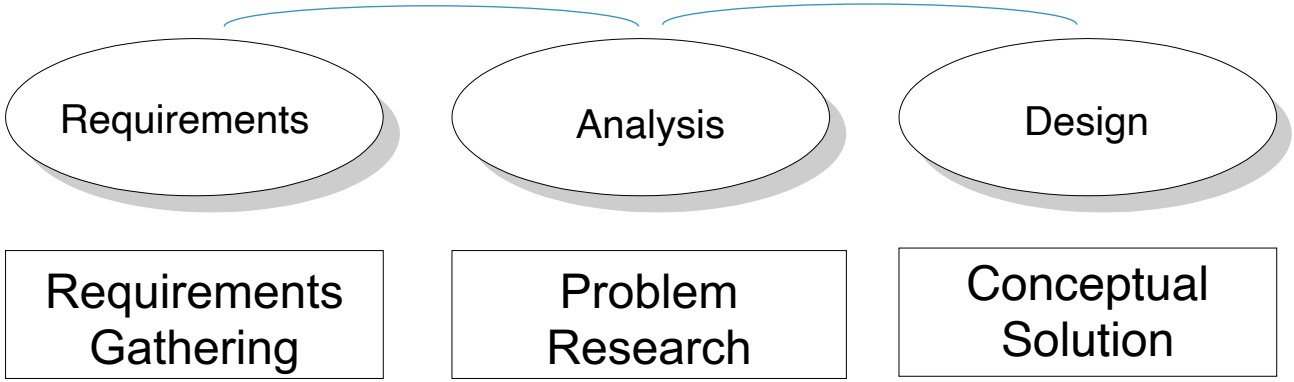
US 006 – SD: ref: Create Task



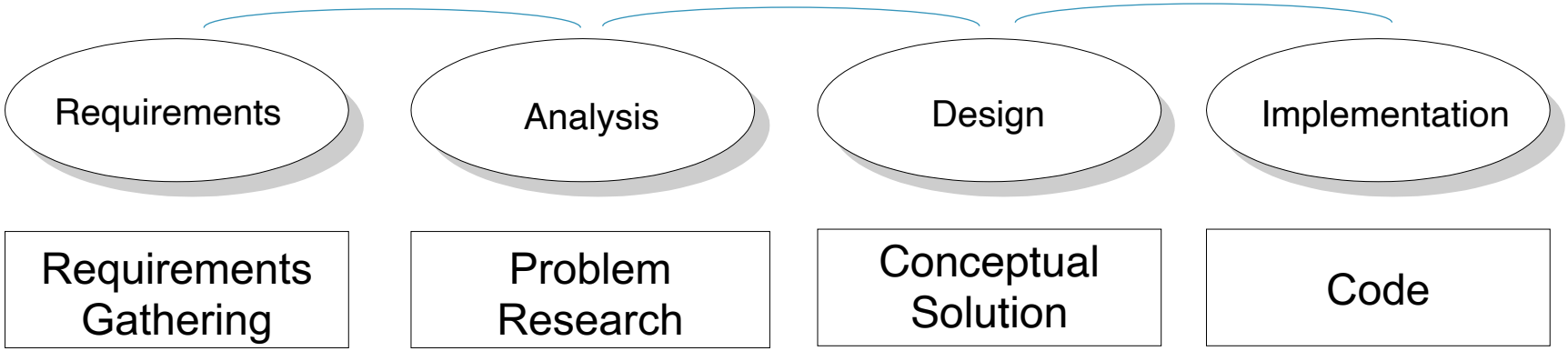
US 006 – Class Diagram



From requirements to code (4/4)



From requirements to code (4/4)



Coding (excerpt from CreateTaskController)

```
public Optional<Task> createTask(String reference, String description, String informalDescription,
                                 String technicalDescription, Integer duration, Double cost,
                                 String taskCategoryDescription) {

    TaskCategory taskCategory = getTaskCategoryByDescription(taskCategoryDescription);

    Employee employee = getEmployeeFromSession();
    Optional<Organization> organization = getOrganizationRepository().getOrganizationByEmployee(employee);

    Optional<Task> newTask = Optional.empty();

    if (organization.isPresent()) {
        newTask = organization.get()
                .createTask(reference, description, informalDescription, technicalDescription, duration, cost,
                        taskCategory, employee);
    }


    return newTask;
}
```

Coding (excerpt from Organization Class)

```
public Optional<Task> createTask(String reference, String description, String informalDescription,
                                 String technicalDescription, Integer duration, Double cost,
                                 TaskCategory taskCategory, Employee employee) {

   // When a Task is added, it should fail if the Task already exists in the list of Tasks.
   // In order to not return null if the operation fails, we use the Optional class.
   Optional<Task> optionalValue = Optional.empty();

   Task task = new Task(reference, description, informalDescription, technicalDescription, duration, cost,
         taskCategory, employee);

   if (addTask(task)) {
      optionalValue = Optional.of(task);
   }
   return optionalValue;
}
```

Testing: Ensure is it not possible to create a Task Class with a null Reference

```
@Test
void ensureTaskReferenceIsNotNull() {
   //Arrange
   Employee employee = new Employee("john.doe@this.company.com");
   TaskCategory taskCategory = new TaskCategory("Task Category Description");

   //Act and Assert
   assertThrows(IllegalArgumentException.class,
         () -> new Task(null, "description", "informal description", "technical description", 1, 1d,
               taskCategory, employee));
}
```

Testing: Ensure that it is not possible to add two Tasks with the same reference

```
@Test
void ensureAddingDuplicateTaskFails() {
   //Arrange
   Organization organization = new Organization("123456789");
   Employee employee = new Employee("john.doe@this.company.com");
   TaskCategory taskCategory = new TaskCategory("Task Category Description");
   //Add the first task
   Optional<Task> originalTask =
         organization.createTask("Task Description", "Task Category Description", "informal description",
               "technical description", 1, 1d, taskCategory, employee);

   //Act
   Optional<Task> duplicateTask =
         organization.createTask("Task Description", "Task Category Description", "informal description",
               "technical description", 1, 1d, taskCategory, employee);

   //Assert
   assertTrue(duplicateTask.isEmpty());
}
```

Summary

Promoted Working Method (1/2)

- Sequence of Engineering Activities
  - Requirements
    - Use Cases / User Stories / Acceptance Criteria / FURPS+ / Other Texts
  - Analysis
    - Inputs&outputs / Domain Concepts / Domain Model
  - Design
    - Method signatures / Classes / Components / Modularization
  - Testing
    - Specify a set of tests covering all/most common and uncommon scenarios
  - Implementation
    - Code the design methods and classes
- Repeat the above sequence as needed for each use case

Promoted Working Method (2/2)

- Activities
  - Each one has a well-defined information/artifacts as input
  - Each one has a well-defined artifacts as output
  - Outputs of one activity are used as inputs on other activities

- Supported by best enginnering practices
- Promotes best enginnering practices too
- Clear, simple and easy to adopt

Bibliography

- [1] Larman, Craig; Applying UML and Patterns; Prentice Hall (3rd ed.); ISBN 978-0131489066

- [2] https://www.scnsoft.com/blog/software-development-models