Review of UML

Introduction

- UML stands for **U**nified **M**odeling **L**anguage.
- UML is different from the other common programming languages like C++, Java, COBOL etc.
- UML is a pictorial language used to make software blue prints.
- UML is a standard language for specifying, visualizing, constructing, and documenting the artifacts of software systems.
- UML was created by Object Management Group and UML 1.0 specification draft was proposed to the OMG in January 1997.

Introduction

- The OMG specification states:
  - *"The Unified Modeling Language (UML) is a graphical language for visualizing, specifying, constructing, and documenting the artifacts of a software-intensive system. The UML offers a standard way to write a system's blueprints, including conceptual things such as business processes and system functions as well as concrete things such as programming language statements, database schemas, and reusable software components."*

Goals of UML

- *A picture is worth a thousand words*
- to define some general purpose modeling language which all modelers can use and also it needs to be made simple to understand and use.

Conceptual Model of UML

- To understand conceptual model of UML first we need to clarify *What is a conceptual model?* and *Why a conceptual model is at all required?*
- A conceptual model can be defined as a model which is made of concepts and their relationships.
- A conceptual model is the first step before drawing a UML diagram. It helps to understand the entities in the real world and how they interact with each other.
- As UML describes the real time systems, it is very important to make a conceptual model and then proceed gradually.
- Conceptual model of UML can be mastered by learning the following three major elements:
  - UML building blocks
  - Rules to connect the building blocks
  - Common mechanisms of UML

Relation of UML with OO

- The relation between OO design and UML is very important to understand.
- The OO design is transformed into UML diagrams according to the requirement.
- Before understanding the UML in details the OO concepts should be learned properly.
- Once the OO analysis and design is done the next step is very easy.
- The input from the OO analysis and design is the input to the UML diagrams.
- class diagram, object diagram, collaboration diagram, interaction diagrams all would basically be designed based on the objects.

Building blocks of UML

- Things
- Relationships
- Diagrams

Building blocks of UML

- Things:
  - are the most important building blocks of UML. Things can be:
    - Structural
    - Behavioral
    - Grouping
    - Annotational
- Structural:
  - define the static part of the model.
  - They represent physical and conceptual elements.

Building blocks of UML

- Structural:
  - Class:
    - represents set of objects having similar responsibilities.
  - Interface:
    - defines a set of operations which specify the responsibility of a class.
  - Collaboration:
    - defines interaction between elements.
  - Use case:
    - represents a set of actions performed by a system for a specific goal.
  - Component:
    - describes physical part of a system.
  - Node:
    - physical element that exists at run time.

Building blocks of UML

- Behavioral:
  - consists of the dynamic parts of UML models.
  - Interaction:
    - defined as a behavior that consists of a group of messages exchanged among elements to accomplish a specific task.
  - State Machine:
    - defines the sequence of states an object goes through in response to events.
    - is useful when the state of an object in its life cycle is important.

Building blocks of UML

- Group:
  - can be defined as a mechanism to group elements of a UML model together.
  - Package:
    - is the only one grouping thing available for gathering structural and behavioral things.
- Annotational:
  - can be defined as a mechanism to capture remarks, descriptions, and comments of UML model elements.
  - Note:
    - is used to render comments, constraints etc of an UML element.

Building blocks of UML

- Relationships:
  - another most important building block of UML.
  - It shows how elements are associated with each other and this association describes the functionality of an application.
  - Different kinds of relationship are:
    - Dependency
      - is a relationship between two things in which change in one element also affects the other one.

Building blocks of UML

- Association:
  - is basically a set of links that connects elements of an UML model.
  - It also describes how many objects are taking part in that relationship.
- Generalization:
  - can be defined as a relationship which connects a specialized element with a generalized element.
  - It basically describes inheritance relationship in the world of objects.
- Realization:
  - can be defined as a relationship in which two elements are connected.
  - One element describes some responsibility which is not implemented and the other one implements them.
  - This relationship exists in case of interfaces.

Building blocks of UML

- UML Diagram:
  - All the elements, relationships are used to make a complete UML diagram and the diagram represents a system.
  - The visual effect of the UML diagram is the most important part of the entire process. All the other elements are used to make it a complete one.
  - Different UML diagrams are
    - Class diagram
    - Object diagram
    - Use case diagram
    - Sequence diagram
    - Collaboration diagram
    - Activity diagram
    - State chart diagram
    - Deployment diagram
    - Component diagram

- UML plays an important role in defining different perspectives of a system.
- These perspectives are:
  - Design
  - Implementation
  - Process
  - Deployment
- And the centre is the **Use Case** view which connects all these four.
- A **Use case** represents the functionality of the system. So the other perspectives are connected with use case.
- **Design** of a system consists of classes, interfaces and collaboration.
  - UML provides class diagram, object diagram to support this.
- **Implementation** defines the components assembled together to make a complete physical system.
  - UML component diagram is used to support implementation perspective.
- **Process** defines the flow of the system.
  - So the same elements as used in *Design* are also used to support this perspective.
- **Deployment** represents the physical nodes of the system that forms the hardware.
  - UML deployment diagram is used to support this perspective.

UML Modeling Types

- Structural Modeling
  - captures the static features of a system
  - represents the framework for the system and this framework is the place where all other components exist.
  - never describes the dynamic behavior of the system.
  - Consists of
    - Classes diagrams
    - Objects diagrams
    - Deployment diagrams
    - Package diagrams
    - Composite structure diagram
    - Component diagram

UML Modeling Types

- Behavioral Modeling
  - describes the interaction in the system.
  - It represents the interaction among the structural diagrams.
  - Behavioral modeling shows the dynamic nature of the system.
  - Consists of
    - Activity diagrams
    - Interaction diagrams
    - Use case diagrams

UML Modeling Types

- Architectural Modeling
  - represents the overall framework of the system.
  - It contains both structural and behavioral elements of the system.
  - Architectural model can be defined as the blue print of the entire system.
  - Package diagram comes under architectural modeling.

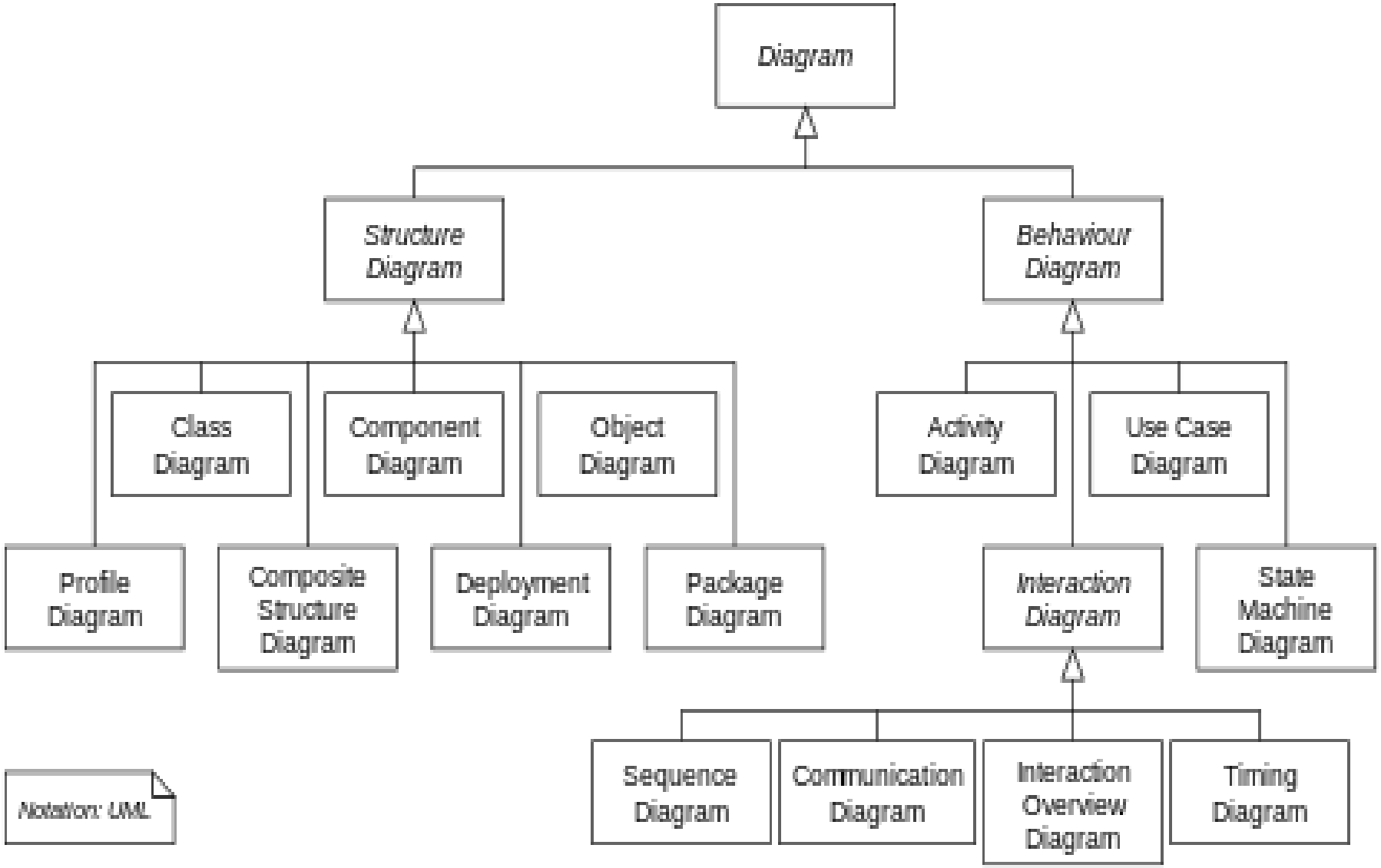


Diagram
Structure Diagram
Behaviour Diagram
Class Diagram
Component Diagram
Object Diagram
Activity Diagram
Use Case Diagram
Profile Diagram
Composite Structure Diagram
Deployment Diagram
Package Diagram
Interaction Diagram
State Machine Diagram
Sequence Diagram
Communication Diagram
Interaction Overview Diagram
Timing Diagram
Notation: UML

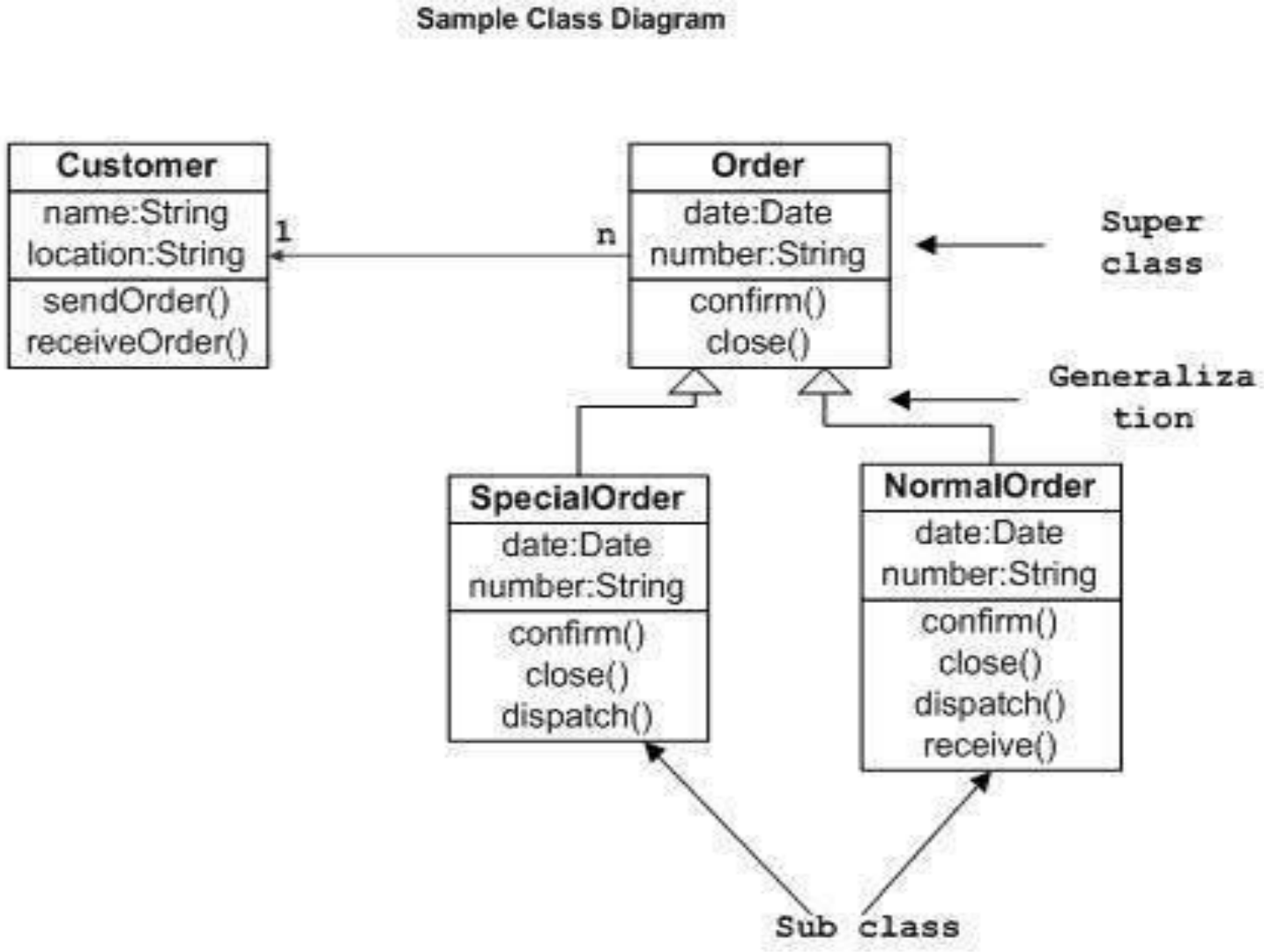
Class Diagram

- is a static diagram.
- represents the static view of an application.
- Class diagram is not only used for visualizing, describing and documenting different aspects of a system but also for constructing executable code of the software application.
- The class diagram describes the attributes and operations of a class and also the constraints imposed on the system.
- The class diagrams are widely used in the modeling of object oriented systems because they are the only UML diagrams which can be mapped directly with object oriented languages.
- The class diagram shows a collection of classes, interfaces, associations, collaborations and constraints. It is also known as a *structural diagram*.
- Purpose:
  - Analysis and design of the static view of an application.
  - Describe responsibilities of a system.
  - Base for component and deployment diagrams.
  - Forward and reverse engineering.

Class Diagram

- How to draw?
  - The name of the class diagram should be meaningful to describe the aspect of the system.
  - Each element and their relationships should be identified in advance.
  - Responsibility (attributes and methods) of each class should be clearly identified.
  - For each class minimum number of properties should be specified. Because unnecessary properties will make the diagram complicated.
  - Use notes when ever required to describe some aspect of the diagram. Because at the end of the drawing it should be understandable to the developer/coder.
  - Finally, before making the final version, the diagram should be drawn on plain paper and rework as many times as possible to make it correct.

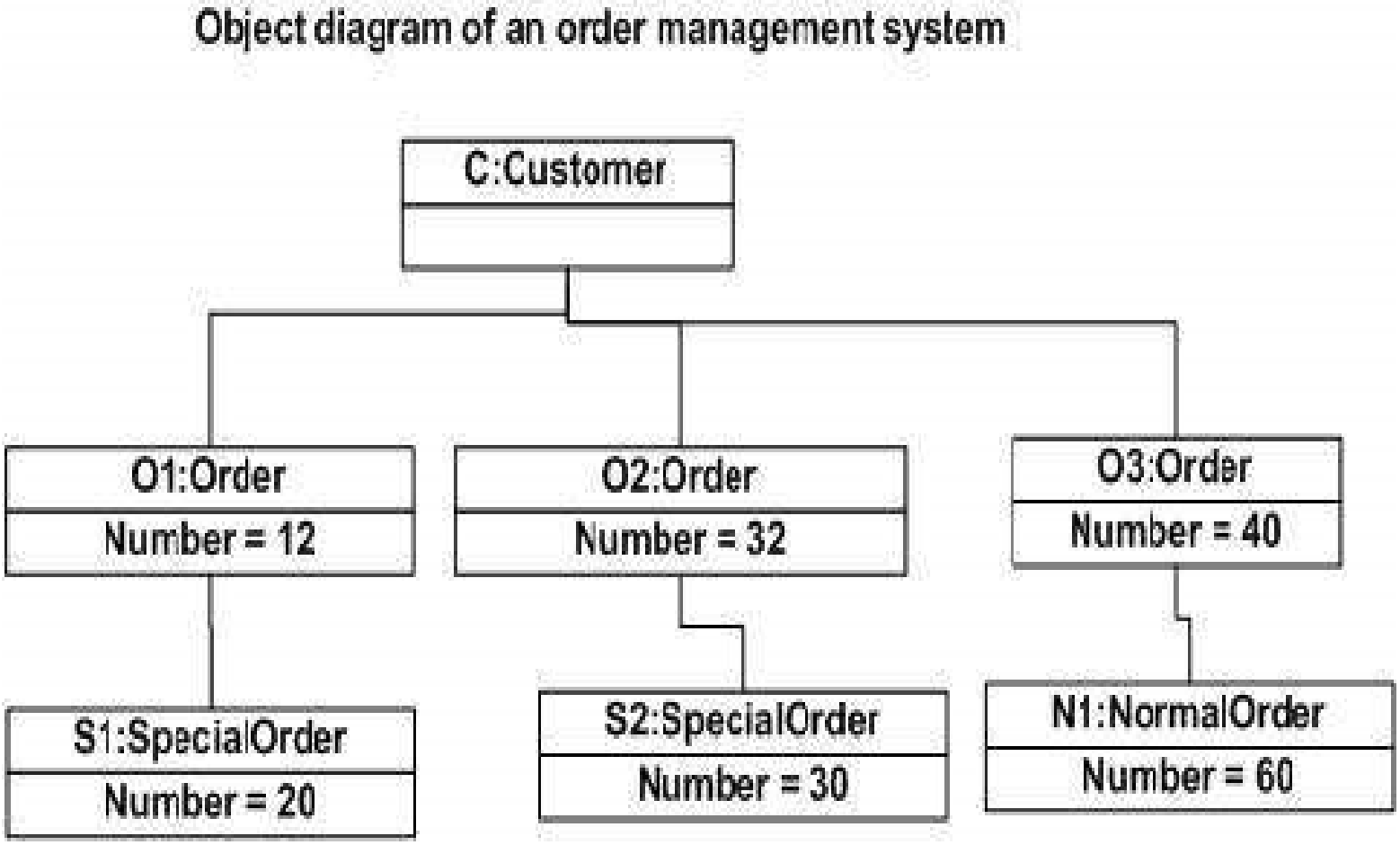
Class Diagram



Object Diagram

- represent an instance of a class diagram.
- are used to render a set of objects and their relationships as an instance.
- The difference between class and object diagram is that a class diagram represents an abstract model consisting of classes and their relationships. But an object diagram represents an instance at a particular moment which is concrete in nature.
- Purpose:
  - Forward and reverse engineering.
  - Object relationships of a system
  - Static view of an interaction.
  - Understand object behavior and their relationship from practical perspective

Object Diagram



Use case Diagram

- is dynamic in nature there should be some internal or external factors for making the interaction.
- internal and external agents are known as actors.
- So use case diagrams are consists of actors, use cases and their relationships.
- The diagram is used to model the System/subsystem of an application.
- A single use case diagram captures a particular functionality of a system.
- Purpose:
  - Used to gather requirements of a system.
  - Used to get an outside view of a system.
  - Identify external and internal factors influencing the system.
  - Show the interacting among the requirements are actors.

Use case Diagram

- How to draw???
  - Functionalities to be represented as an use case
  - Actors
  - Relationships among the use cases and actors.
  - Then:
    - The name of a use case is very important. So the name should be chosen in such a way so that it can identify the functionalities performed.
    - Give a suitable name for actors.
    - Show relationships and dependencies clearly in the diagram.
    - Do not try to include all types of relationships. Because the main purpose of the diagram is to identify requirements.
    - Use note when ever required to clarify some important points.

Use case Diagram

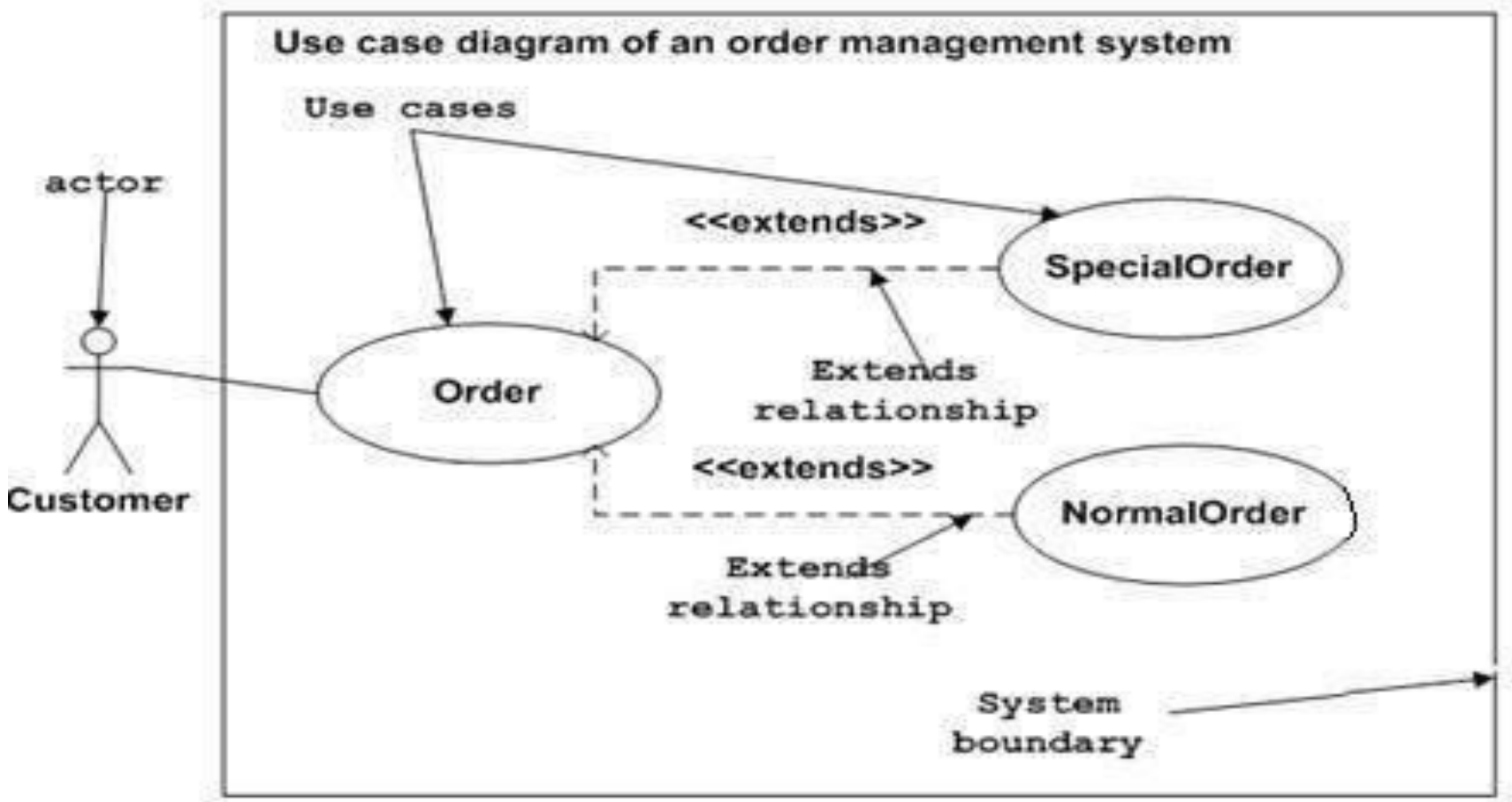


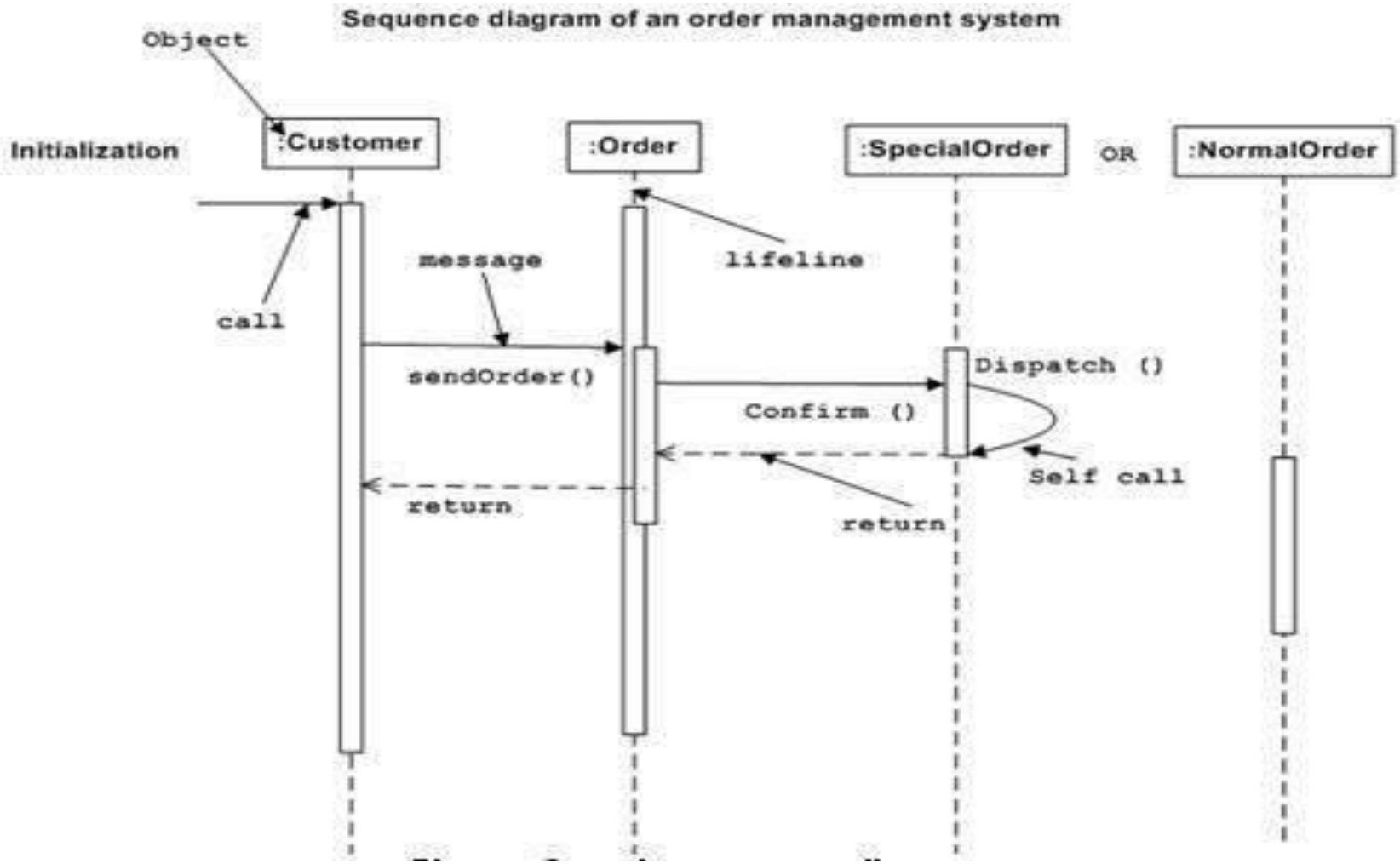
Figure: Sample Use Case diagram

Interaction Diagram

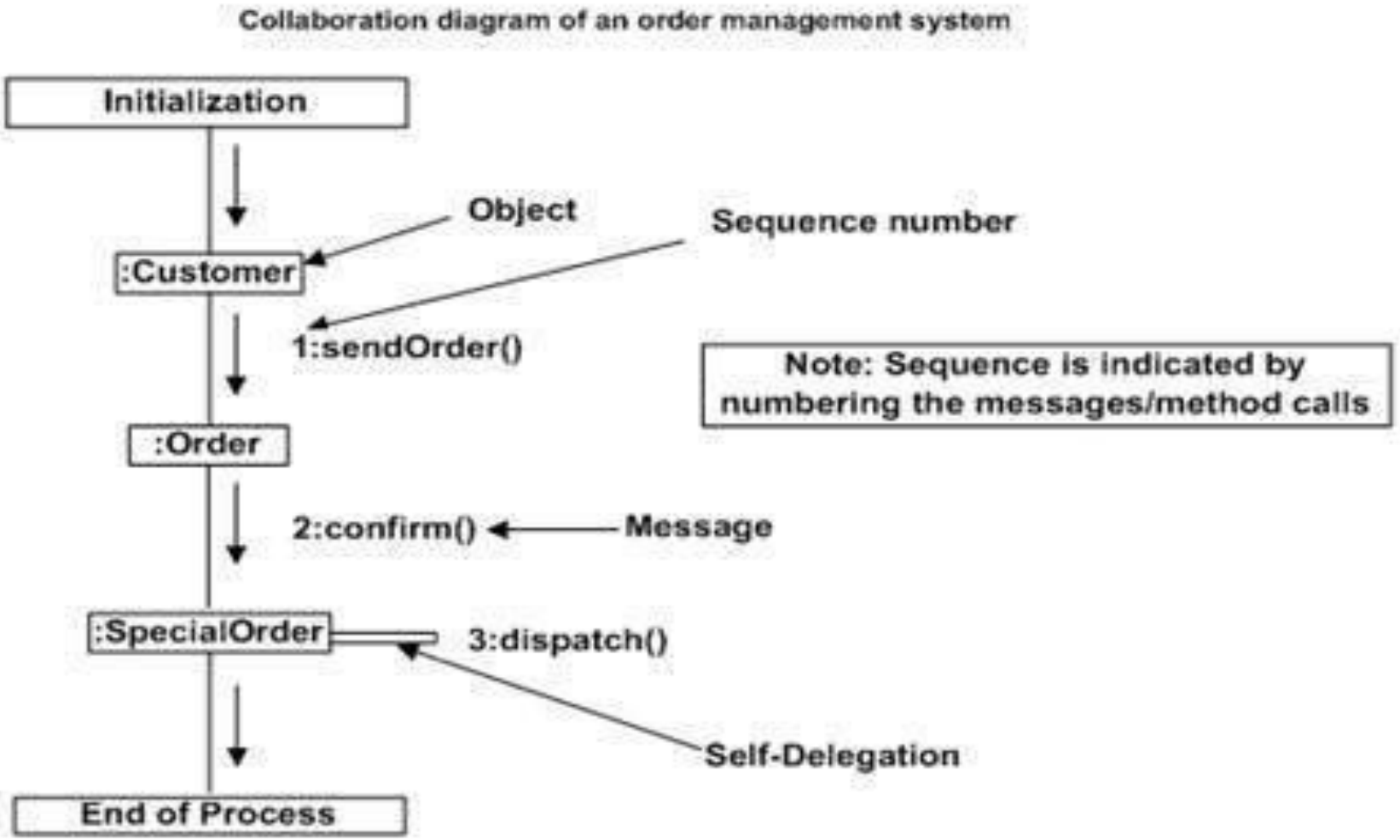
- is used to describe some type of interactions among the different elements in the model.
- Represents dynamic behavior.
- interactive behavior is represented in UML by two diagrams known as *Sequence diagram* and *Collaboration diagram*.
- The basic purposes of both the diagrams are similar.
- Sequence diagram emphasizes on time sequence of messages and collaboration diagram emphasizes on the structural organization of the objects that send and receive messages.
- Purpose:
  - To capture dynamic behavior of a system.
  - To describe the message flow in the system.
  - To describe structural organization of the objects.
  - To describe interaction among objects.

- How to draw??
  - Identify
    - Objects taking part in the interaction.
    - Message flows among the objects.
    - The sequence in which the messages are flowing.
    - Object organization.

Sequence Diagram



Collaboration Diagram

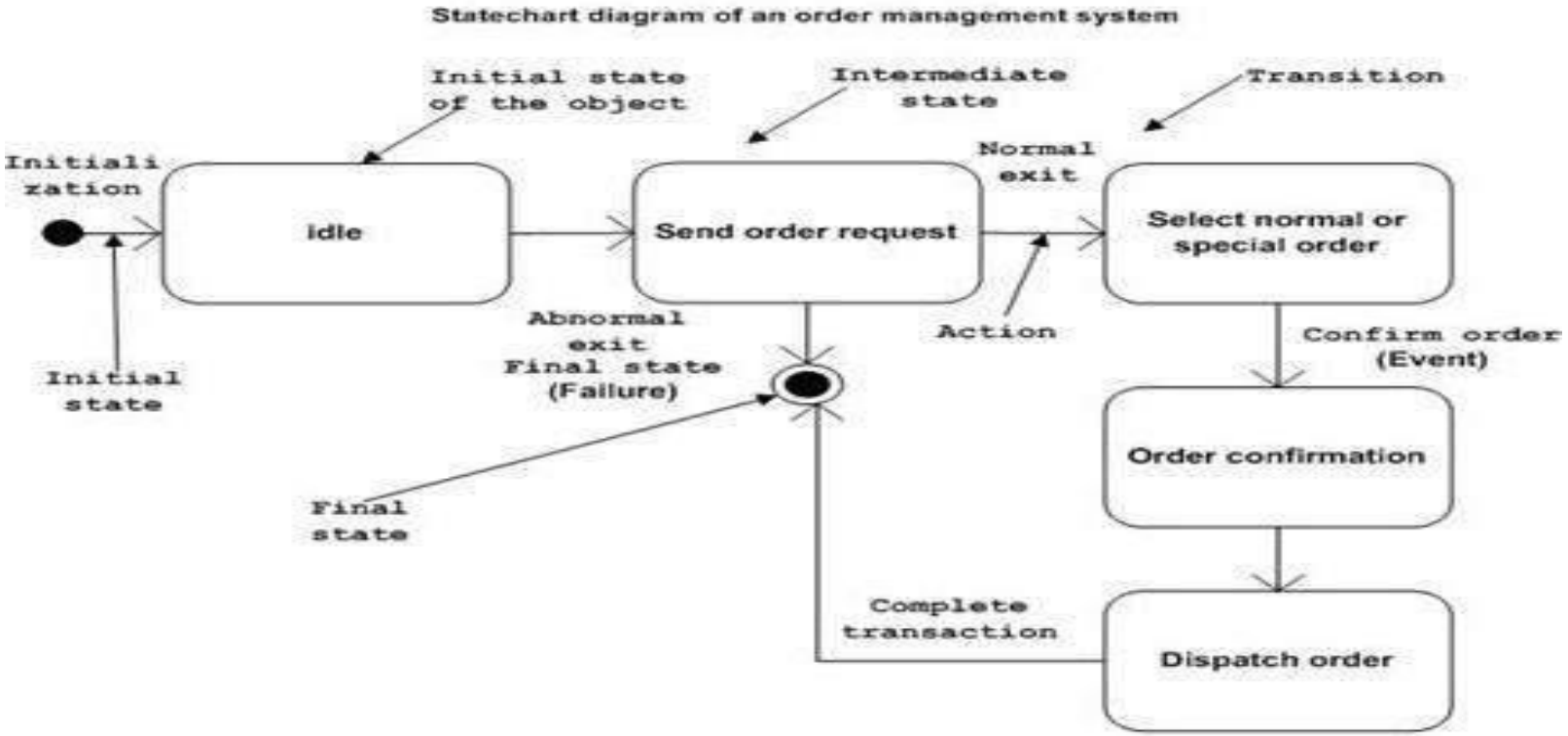


State Chart Diagram

- describes different states of a component in a system.
- The states are specific to a component/object of a system.
- A State-chart diagram describes a state machine.
- Purpose:
  - To model dynamic aspect of a system.
  - To model life time of a reactive system.
  - To describe different states of an object during its life time.
  - Define a state machine to model states of an object.

State Chart Diagram

- How to draw??
  - Identify important objects to be analyzed.
  - Identify the states.
  - Identify the events.



Activity Diagram

- is basically a flow chart to represent the flow form one activity to another activity.
- Purpose:
  - Draw the activity flow of a system.
  - Describe the sequence from one activity to another.
  - Describe the parallel, branched and concurrent flow of the system.
- How to draw??
  - Identify
    - Activities
    - Association
    - Conditions
    - Constraints

Activity Diagram