

UNIT 3

What is UML

The UML stands for Unified modeling language, is a standardized general-purpose visual modeling language in the field of Software Engineering. It is used for specifying, visualizing, constructing, and documenting the primary artifacts of the software system. It helps in designing and characterizing, especially those software systems that incorporate the concept of Object orientation. It describes the working of both the software and hardware systems.

Characteristics of UML

The UML has the following features:

- It is a generalized modeling language.
- It is distinct from other programming languages like C++, Python, etc.
- It is interrelated to object-oriented analysis and design.
- It is used to visualize the workflow of the system.
- It is a pictorial language, used to generate powerful modeling artifacts.

Conceptual Modeling

Before moving ahead with the concept of UML, we should first understand the basics of the conceptual model.

A conceptual model is composed of several interrelated concepts. It makes it easy to understand the objects and how they interact with each other. This is the first step before drawing UML diagrams.

Following are some object-oriented concepts that are needed to begin with UML:

- **Object:** An object is a real world entity. There are many objects present within a single system. It is a fundamental building block of UML.
- **Class:** A class is a software blueprint for objects, which means that it defines the variables and methods common to all the objects of a particular type.
- **Abstraction:** Abstraction is the process of portraying the essential characteristics of an object to the users while hiding the irrelevant information. Basically, it is used to envision the functioning of an object.
- **Inheritance:** Inheritance is the process of deriving a new class from the existing ones.
- **Polymorphism:** It is a mechanism of representing objects having multiple forms used for different purposes.
- **Encapsulation:** It binds the data and the object together as a single unit, enabling tight coupling between them.

Design using UML

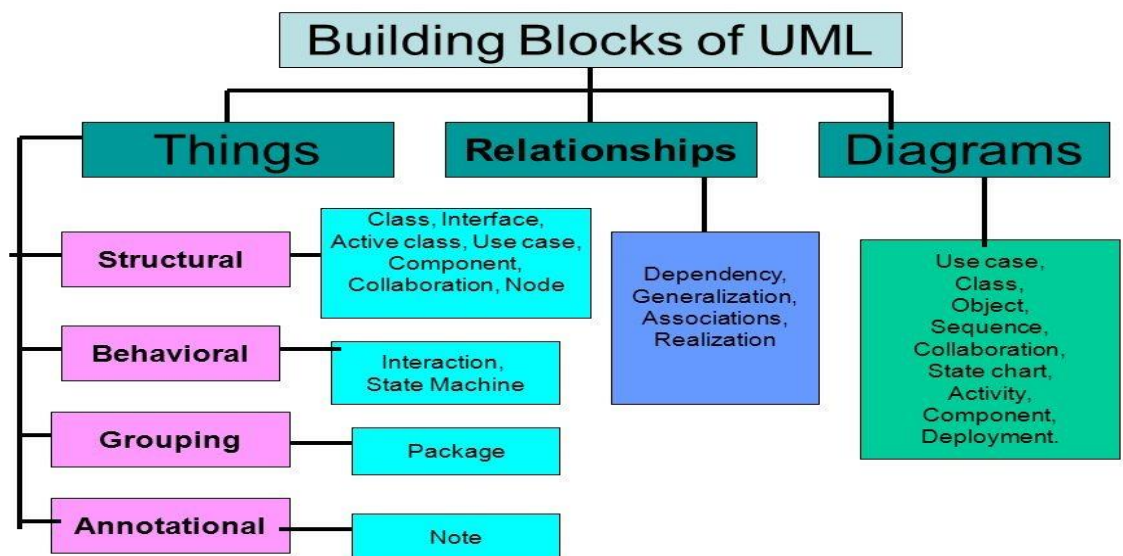
As UML describes the real-time systems, it is very important to make a conceptual model and then proceed gradually. The conceptual model of UML can be mastered by learning the following three major elements –

- UML building blocks
- Rules to connect the building blocks
- Common mechanisms of UML

Building Blocks of UML

This chapter describes all the UML building blocks. The building blocks of UML can be defined as –

- Things
- Relationships
- Diagrams



Things

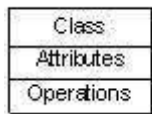
Things are the most important building blocks of UML. Things can be –

- Structural
- Behavioral
- Grouping
- Annotational

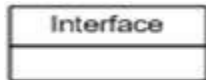
Structural Things

Structural things define the static part of the model. They represent the physical and conceptual elements. Following are the brief descriptions of the structural things.

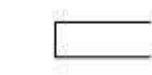
Class – Class represents a set of objects having similar responsibilities.



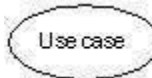
Interface – Interface defines a set of operations, which specify the responsibility of a class.



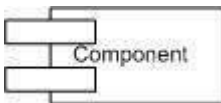
Collaboration –Collaboration defines an interaction between elements.



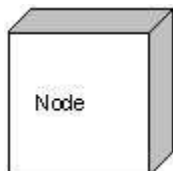
Use case –Use case represents a set of actions performed by a system for a specific goal.



Component –Component describes the physical part of a system.



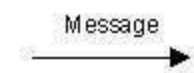
Node – A node can be defined as a physical element that exists at run time.



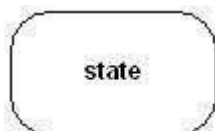
Behavioral Things

A **behavioral thing** consists of the dynamic parts of UML models. Following are the behavioral things –

Interaction – Interaction is defined as a behavior that consists of a group of messages exchanged among elements to accomplish a specific task.



State machine – State machine is useful when the state of an object in its life cycle is important. It defines the sequence of states an object goes through in response to events. Events are external factors responsible for state change



Grouping Things

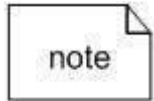
Grouping things can be defined as a mechanism to group elements of a UML model together. There is only one grouping thing available –

Package – Package is the only one grouping thing available for gathering structural and behavioral things.



Annotational Things

Annotational things can be defined as a mechanism to capture remarks, descriptions, and comments of UML model elements. **Note** - It is the only one Annotational thing available. A note is used to render comments, constraints, etc. of an UML element.



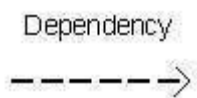
Relationship

Relationship is another most important building block of UML. It shows how the elements are associated with each other and this association describes the functionality of an application.

There are four kinds of relationships available.

Dependency

Dependency is a relationship between two things in which change in one element also affects the other.



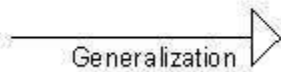
Association

Association is basically a set of links that connects the elements of a UML model. It also describes how many objects are taking part in that relationship.



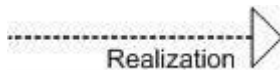
Generalization

Generalization can be defined as a relationship which connects a specialized element with a generalized element. It basically describes the inheritance relationship in the world of objects.



Realization

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.



UML Diagrams

UML diagrams are the ultimate output of the entire discussion. 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 complete.

UML includes the following nine diagrams, the details of which are described in the subsequent chapters.

- Class diagram
- Object diagram
- Use case diagram
- Sequence diagram
- Collaboration diagram
- Activity diagram
- State chart diagram
- Deployment diagram
- Component diagram

UML DIAGRAMS

We prepare UML diagrams to understand the system in a better and simple way. A single diagram is not enough to cover all the aspects of the system. UML defines various kinds of diagrams to cover most of the aspects of a system.

You can also create your own set of diagrams to meet your requirements. Diagrams are generally made in an incremental and iterative way.

There are two broad categories of diagrams and they are again divided into subcategories –

- Structural Diagrams
- Behavioral Diagrams

Structural Diagrams

The structural diagrams represent the static aspect of the system. These static aspects represent those parts of a diagram, which forms the main structure and are therefore stable.

These static parts are represented by classes, interfaces, objects, components, and nodes. The four structural diagrams are –

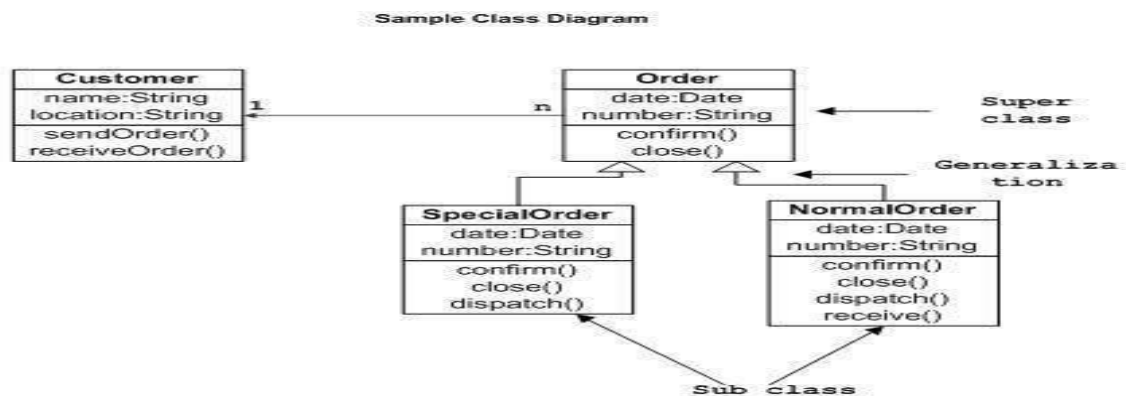
- Class diagram
- Object diagram
- Component diagram
- Deployment diagram

Class Diagram

Class diagrams are the most common diagrams used in UML. Class diagram consists of classes, interfaces, associations, and collaboration. Class diagrams basically represent the object-oriented view of a system, which is static in nature.

Active class is used in a class diagram to represent the concurrency of the system.

Class diagram represents the object orientation of a system. Hence, it is generally used for development purpose. This is the most widely used diagram at the time of system construction.



Object Diagram

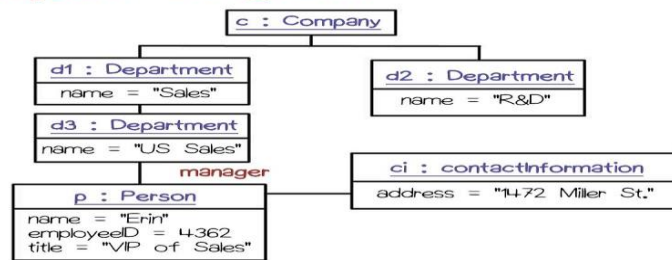
Object diagrams can be described as an instance of class diagram. Thus, these diagrams are more close to real-life scenarios where we implement a system.

Object diagrams are a set of objects and their relationship is just like class diagrams. They also represent the static view of the system.

The usage of object diagrams is similar to class diagrams but they are used to build prototype of a system from a practical perspective.

Object Diagram

Conveys **objects** and **links** instead of **classes** and **relationships**

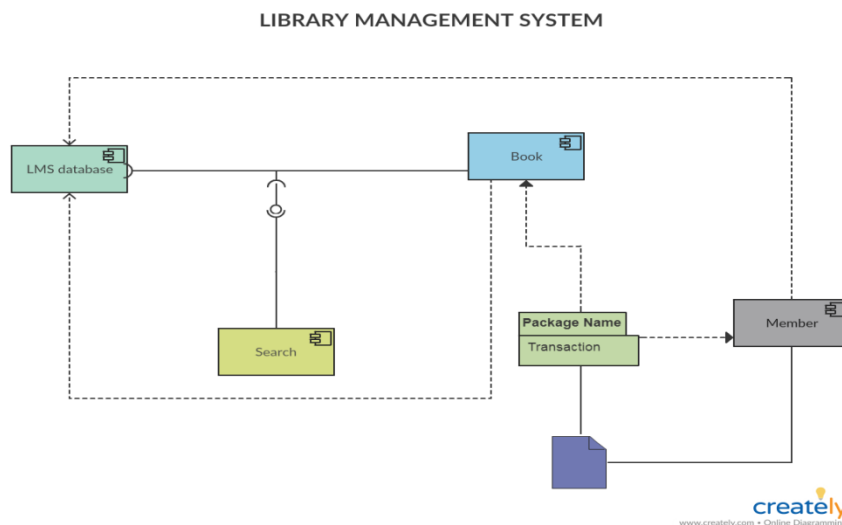


Component Diagram

Component diagrams represent a set of components and their relationships. These components consist of classes, interfaces, or collaborations. Component diagrams represent the implementation view of a system.

During the design phase, software artifacts (classes, interfaces, etc.) of a system are arranged in different groups depending upon their relationship. Now, these groups are known as components.

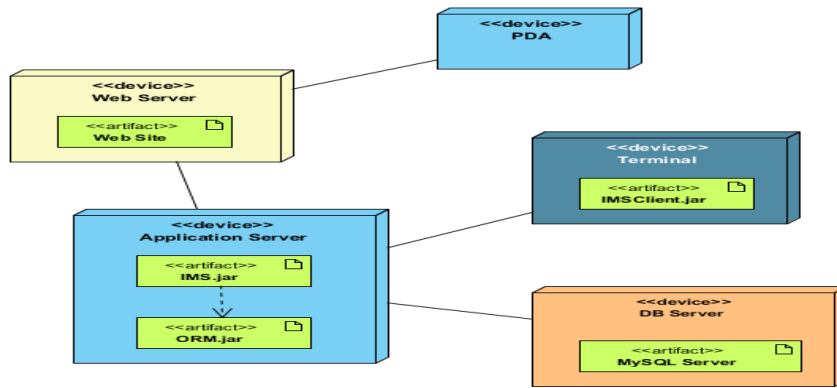
Finally, it can be said component diagrams are used to visualize the implementation.



Deployment Diagram

Deployment diagrams are a set of nodes and their relationships. These nodes are physical entities where the components are deployed.

Deployment diagrams are used for visualizing the deployment view of a system. This is generally used by the deployment team.



Note – If the above descriptions and usages are observed carefully then it is very clear that all the diagrams have some relationship with one another. Component diagrams are dependent upon the classes, interfaces, etc. which are part of class/object diagram. Again, the deployment diagram is dependent upon the components, which are used to make component diagrams.

Behavioral Diagrams

Any system can have two aspects, static and dynamic. So, a model is considered as complete when both the aspects are fully covered.

Behavioral diagrams basically capture the dynamic aspect of a system. Dynamic aspect can be further described as the changing/moving parts of a system.

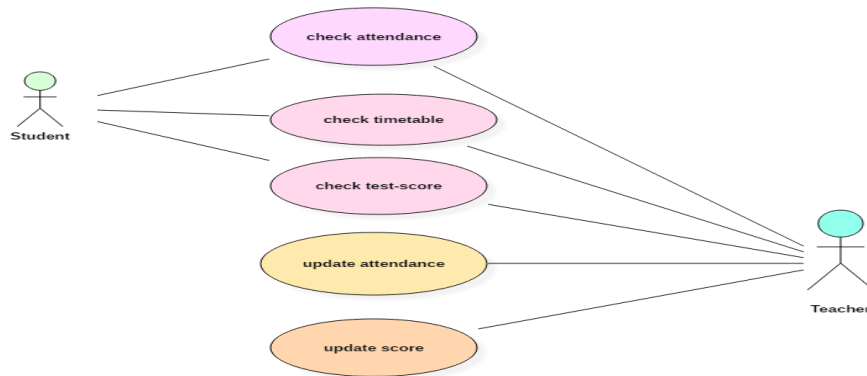
UML has the following five types of behavioral diagrams –

- Use case diagram
- Sequence diagram
- Collaboration diagram
- State chart diagram
- Activity diagram

Use Case Diagram

Use case diagrams are a set of use cases, actors, and their relationships. They represent the use case view of a system.

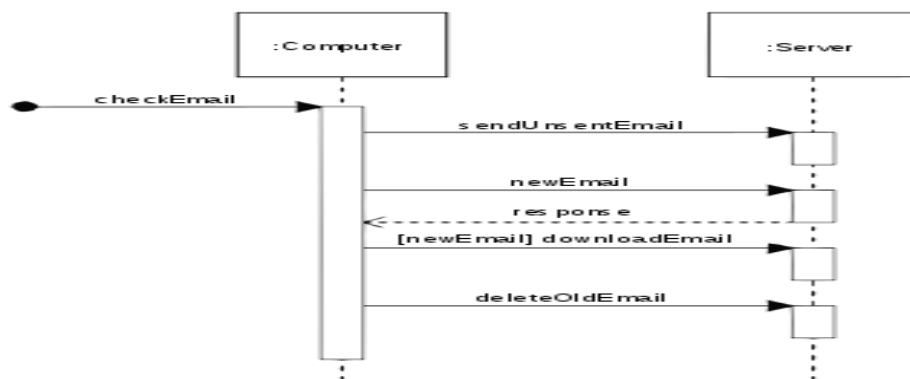
A use case represents a particular functionality of a system. Hence, use case diagram is used to describe the relationships among the functionalities and their internal/external controllers. These controllers are known as **actors**.



Sequence Diagram

A sequence diagram is an interaction diagram. From the name, it is clear that the diagram deals with some sequences, which are the sequence of messages flowing from one object to another.

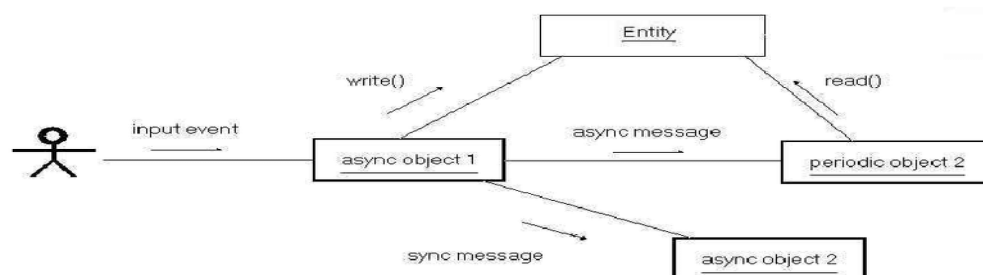
Interaction among the components of a system is very important from implementation and execution perspective. Sequence diagram is used to visualize the sequence of calls in a system to perform a specific functionality.



Collaboration Diagram

Collaboration diagram is another form of interaction diagram. It represents the structural organization of a system and the messages sent/received. Structural organization consists of objects and links.

The purpose of collaboration diagram is similar to sequence diagram. However, the specific purpose of collaboration diagram is to visualize the organization of objects and their interaction.

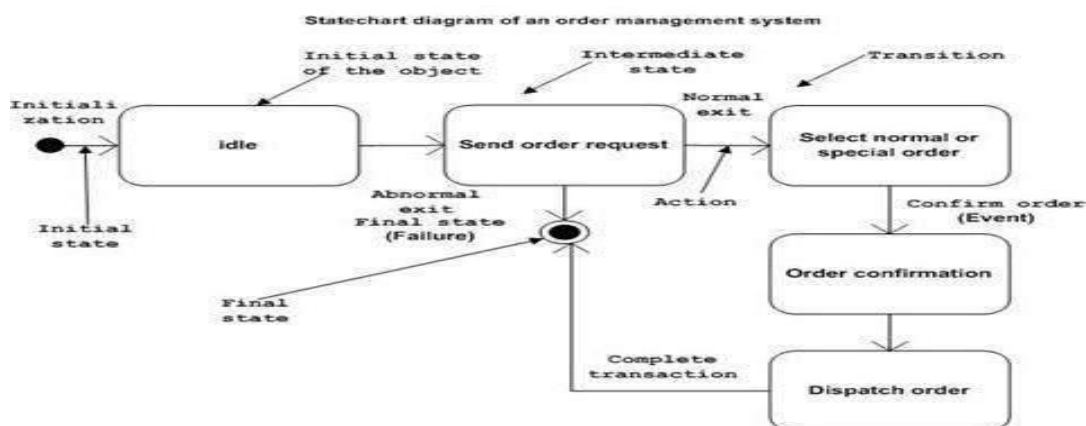


State chart Diagram

Any real-time system is expected to be reacted by some kind of internal/external events. These events are responsible for state change of the system.

State chart diagram is used to represent the event driven state change of a system. It basically describes the state change of a class, interface, etc.

State chart diagram is used to visualize the reaction of a system by internal/external factors.

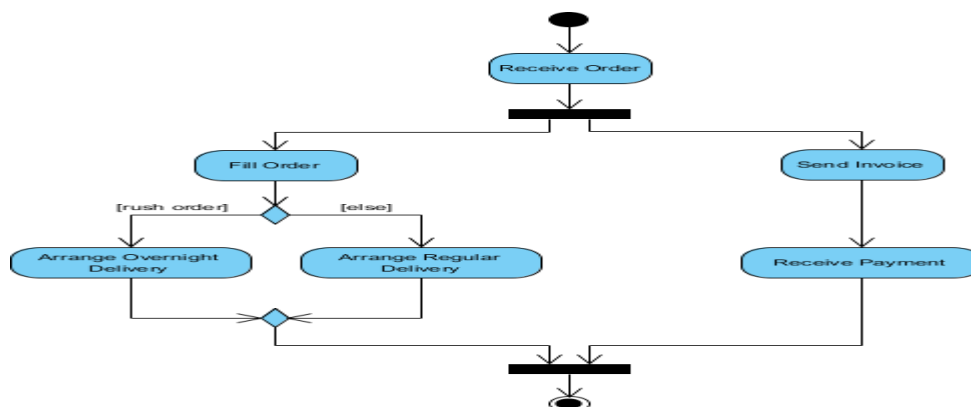


Activity Diagram

Activity diagram describes the flow of control in a system. It consists of activities and links. The flow can be sequential, concurrent, or branched.

Activities are nothing but the functions of a system. Numbers of activity diagrams are prepared to capture the entire flow in a system.

Activity diagrams are used to visualize the flow of controls in a system. This is prepared to have an idea of how the system will work when executed.



Note – Dynamic nature of a system is very difficult to capture. UML has provided features to capture the dynamics of a system from different angles. Sequence diagrams and collaboration diagrams are isomorphic, hence they can be converted from one another without losing any information. This is also true for State chart and activity diagram.