UML Sequence Diagrams

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Types of Diagrams

- Structural Diagrams – focus on static aspects of the software system
  - Class, Object, Component, Deployment
- Behavioral Diagrams – focus on dynamic aspects of the software system
  - Use-case, Interaction, State Chart, Activity

Structural Diagrams

- **Class Diagram** – set of classes and their relationships. Describes interface to the class (set of operations describing services)
- **Object Diagram** – set of objects (class instances) and their relationships
- **Component Diagram** – logical groupings of elements and their relationships
- **Deployment Diagram** - set of computational resources (nodes) that host each component.

Behavioral Diagram

- **Use Case Diagram** – high-level behaviors of the system, user goals, external entities: actors
- **Sequence Diagram** – focus on time ordering of messages
- **Collaboration Diagram** – focus on structural organization of objects and messages
- **State Chart Diagram** – event driven state changes of system
- **Activity Diagram** – flow of control between activities

Use Case Diagrams

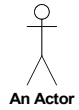
Use Case Diagrams

- Describes a set of sequences.
- Each sequence represents the interactions of things outside the system (*actors*) with the system itself (and key abstractions)
- Use cases represent the functional requirements of the system (non-functional requirements must be given elsewhere)

Use case

- Each use case has a descriptive name
- Describes what a system does but not how it does it.
- Use case names must be unique within a given package
- Examples: withdraw money, process loan

Actor

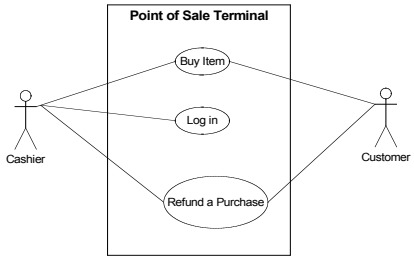


- Actors have a name
- An actor is a set of roles that users of use cases play when interacting with the system
- They are external entities
- They may be external an system or DB
- Examples: Customer, Loan officer

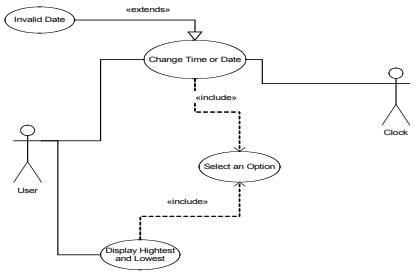
What is a Use Case

- Use case captures some user-visible functionality
- Granularity of functionality depends on the level of detail in your model
- Each use case achieves a discrete goal for the user
- Use Cases are generated through requirements elicitation

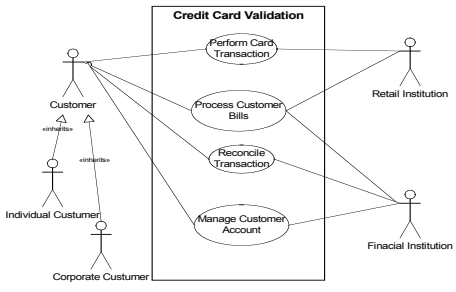
Example



Extend and Include



Example (generalization)



- Modeling Behavior
- Sequence Diagrams

Refining the Object Model

- Typically, only very simplistic object models can be directly derived from use cases.
- A better understanding of the behavior of each use case is necessary (i.e., analysis)
- Use interaction diagrams to specify and detail the behavior of use cases
- This helps to identify and refine key abstractions and relationships
- Operations, attributes, and messages are also identified during this process

Interaction Diagrams

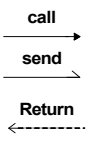
- There is one (or more) Interaction diagram per use case
  - Represent a sequence of interactions
  - Made up of objects, links, and messages
- Sequence diagrams
  - Models flow of control by time ordering
  - Emphasizes passing messages wrt time
  - Shows simple iteration and branching
- Collaboration diagrams
  - Models flow of control by organization
  - Structural relationships among instances in the interaction
  - Shows complex iteration and branching

Sequence Diagrams

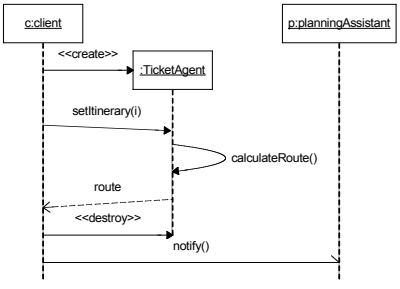
- X-axis is objects
  - Object that initiates interaction is left most
  - Object to the right are increasingly more subordinate
- Y-axis is time
  - Messages sent and received are ordered by time
- Object life lines represent the existence over a period of time
- Activation (double line) is the execution of the procedure.

Message Passing

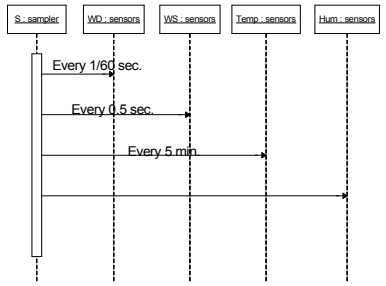
- Send – sends a signal (message) to an object
- Return – returns a value to a caller
- Call – invoke an operation
- Stereotypes
  - <<create>>
  - <<destroy>>

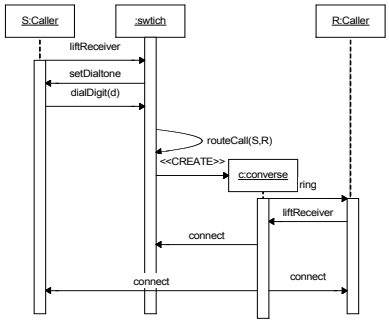


Example UML Sequence Diagram

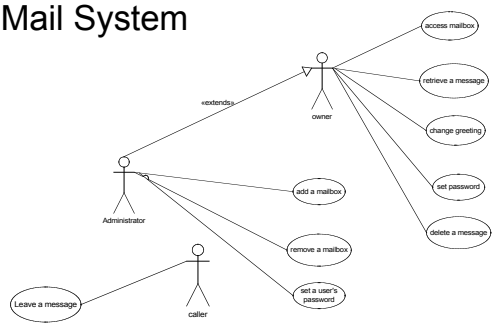


Example

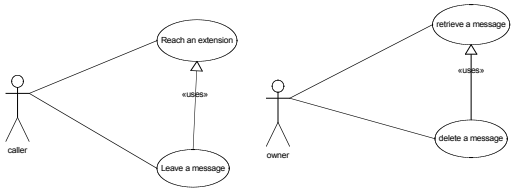




Mail System

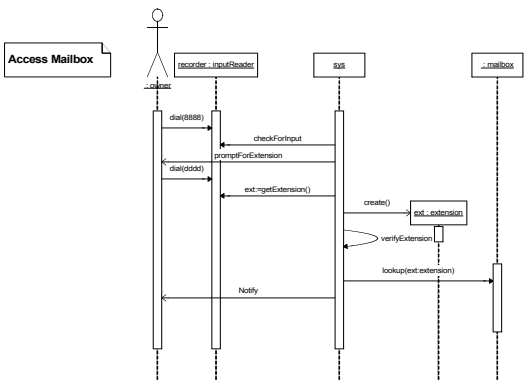


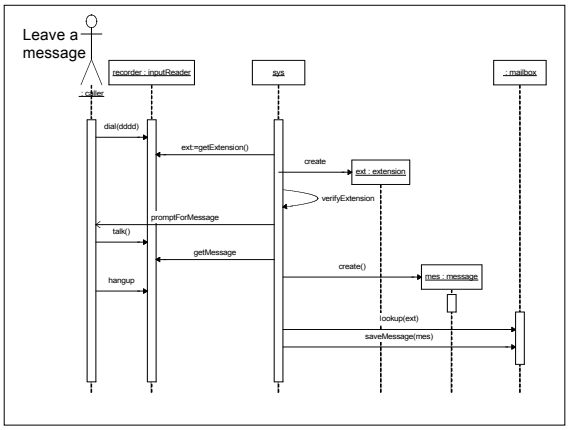
Mail System (2)

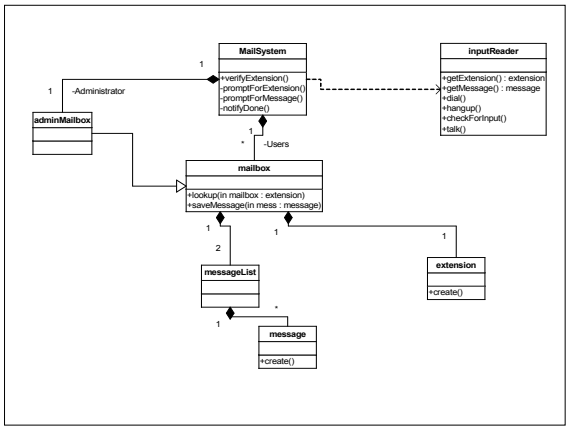


Mail System Objects

- Caller, owner, administrator
- Mailbox, extension, password, greeting
- Message, message list
- Mail system
- Input reader/device







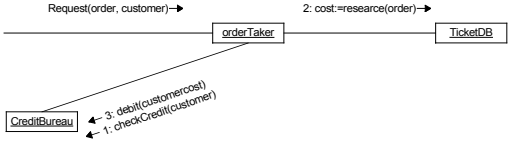
Properties of Sequence Diagrams

- Initiator is leftmost object (boundary object)
- Next is typically a control object
- Then comes entity objects

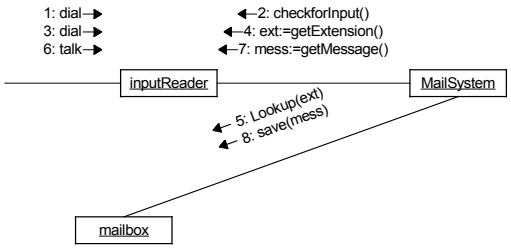
Collaboration Diagrams

- Emphasizes the organization of the objects that participate in an interaction
- Classifier roles
- Association
- Messages, flow, and sequencing

Example Collaboration Diagram



Leave a Message



Collaboration vs Sequence

- The two diagrams really show the same information
- Collaboration diagrams show more static structure (however, class diagrams are better at this)
- Sequence diagrams clearly highlight the orderings and very useful for multi-tasking

Summary (Interaction Diagrams)

- Well structured interaction diagrams:
  - Is focused on communicating one aspect of a system's dynamics
  - Contains only those elements that are essential to understanding
  - Is not so minimalistic that it misinforms the reader about the semantics that are important
- Diagrams should have meaningful names
- Layout diagram to minimize line crossings
- Use branching sparingly (leave for activity dia)

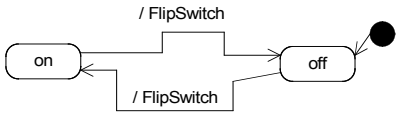
State Diagrams

- Finite state machines (i.e., automata, Mealy/Moore, state transition)
- Used to describe the behavior of one object (or sometimes an operator) for a number of scenarios that affect the object
- They are not good for showing interaction between objects (use interaction diagrams)
- Only use when the behavior of a object is complex and more detail is needed

State Diagram Features

- Event – something that happens at a specific point
  - Alarm goes off
- Condition – something that has a duration
  - Alarm is on
  - Fuel level is low
- State – an abstraction of the attributes and relationships of an object (or system)
  - The fuel tank is in a too low level when the fuel level is below level x for n seconds

Example: on/off Switch



Using guards and actions