Chapter 7

Use Case Model

Objectives

- Describe the benefits of use-case modeling.
- Define actors and use cases and be able to identify them from context diagrams and other sources.
- Describe the relationships that can appear on a use-case model diagram.
- Describe how to construct a use-case model diagram.
- Describe the various sections of a use-case narrative and be able to prepare one.
- Define the purpose of the use-case ranking and priority matrix and the use-case dependency diagram.

- One of the primary challenges is the ability to elicit the correct and necessary system requirements from the stakeholders and specify them in a manner understandable to them so those requirements can be verified and validated. (证实和验证)

The hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is a difficult as establishing the detailed technical requirements, including all the interfaces to people, to machines, and to other software systems. No other work so cripples the resulting system if done wrong. No other part is more difficult to rectify later. Fred Brooks

User-Centered Development and Use-Case Modeling

User-centered development – a process of systems development based on understanding the needs of the stakeholders and the reasons why the system should be developed.

Use-case modeling – the process of modeling a system's functions in terms of business events, who initiated the events, and how the system responds to those events.

- Use-case modeling has roots in object-oriented modeling.
- Gaining popularity in non-object development environments because of its usefulness in communicating with users.
- Compliments traditional modeling tools.

Benefits of Use-Case Modeling

- Provides tool for capturing functional requirements.
- Assists in decomposing system into manageable pieces.
- Provides means of communicating with users/stakeholders concerning system functionality in language they understand.
- Provides means of identifying, assigning, tracking, controlling, and management system development activities.
- Provides aid in estimating project scope, effort, and schedule.

Benefits of Use-Case Modeling (continued)

- Aids in defining test plans and test cases.
- Provides baseline for user documentation.
- Provides tool for requirements traceability.
- Provides starting point for identification of data objects or entities.
- Provides specifications for designing user and system interfaces.
- Provides means of defining database access requirements.
- Provides framework for driving the system development project.

7.2   System Concepts for Use-Case Modeling

Use case – a behaviorally related sequence of steps both automated and manual, for the purpose of completing a single business task.

- Description of system functions from the perspective of external users in terminology they understand.

Use-case diagram – a diagram that depicts the interactions between the system and external systems and users.

- graphically describes who will use the system and in what ways the user expects to interact with the system.

Use-case narrative – a textual description of the business event and how the user will interact with the system to accomplish the task.

Sample Use-Case Model Diagram
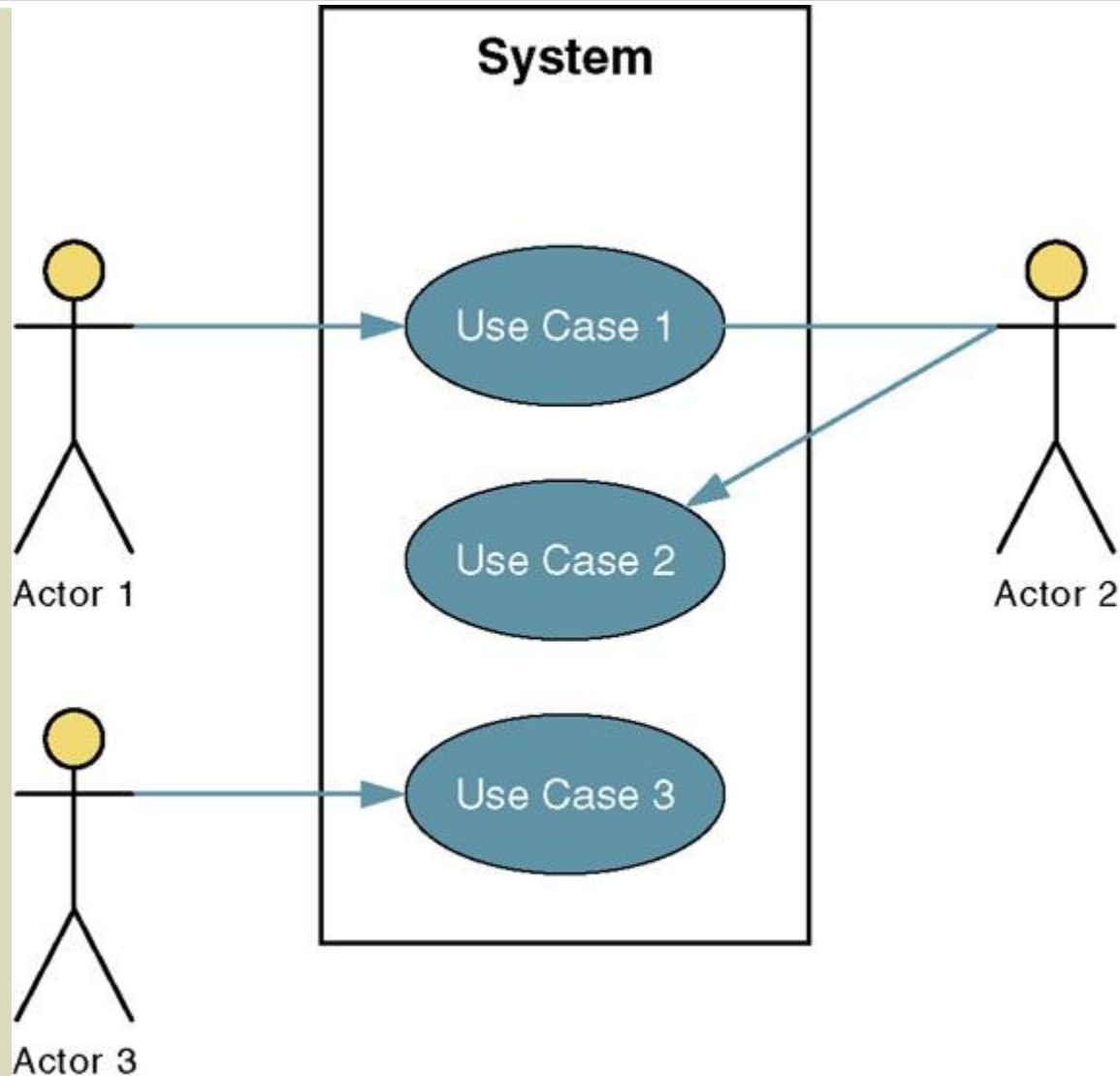
7.2.1 Basic Use-Case Symbols

Use case – subset of the overall system functionality

- Represented by a horizontal ellipse with name of use case above, below, or inside the ellipse.

Use Case Symbol

Actor – anyone or anything that needs to interact with the system to exchange information.

- human, organization, another information system, external device, even time.

Actor Symbol

Temporal event – a system event triggered by time.

- The actor is time.

Four Types of Actors

- **Primary business actor**
  - The stakeholder that primarily benefits from the execution of the use case.
  - e.g. the employee receiving the paycheck
- **Primary system actor**
  - The stakeholder that directly interfaces with the system to initiate or trigger the business or system event.
  - e.g. the bank teller entering deposit information
- **External server actor**
  - The stakeholder that responds to a request from the use case.
  - e.g. the credit bureau authorizing a credit card charge
- **External receiver actor**
  - The stakeholder that is not the primary actor but receives something of value from the use case.
 - e.g. the warehouse receiving a packing slip

Use Case Association Relationship

Association – a relationship between an actor and a use case in which an interaction occurs between them.

- Association modeled as a solid line connecting the actor and the use case.
- Association with an arrowhead touching the use case indicates that the use case was initiated by the actor. (1)
- Association lacking arrowhead indicates a receiver actor. (2)
- Associations may be bidirectional or unidirectional.

1 → Place New Member Order ← **2**

Club Member   Distribution Center

例：ATM机系统
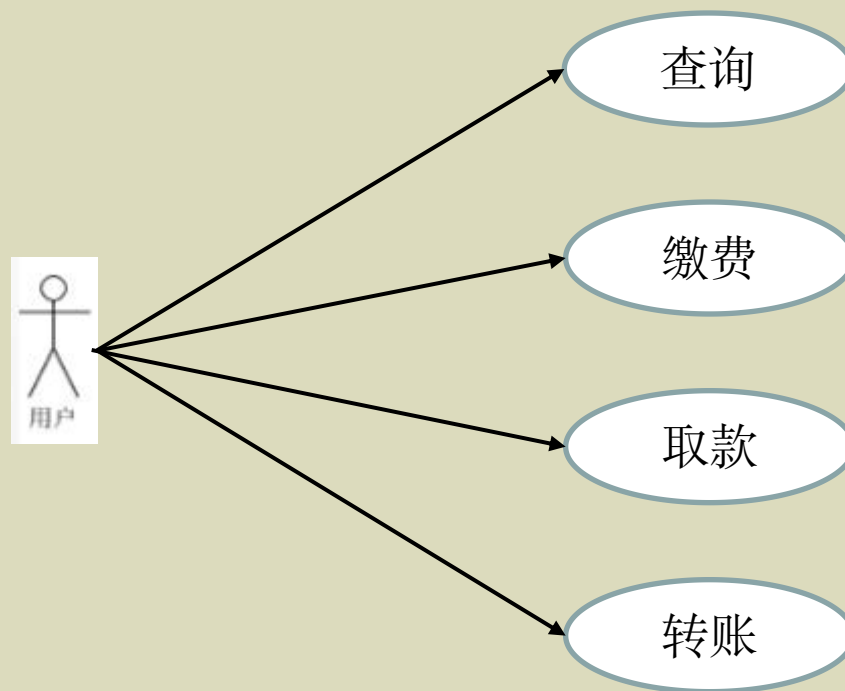
Use Case Extends Relationship

Extension use case –use case consisting of steps extracted from another use case to simplify the original.

- Extends the functionality of the original use case.
- Extends relationship represented as arrow beginning at the extension use case and pointing to use case it is extending.
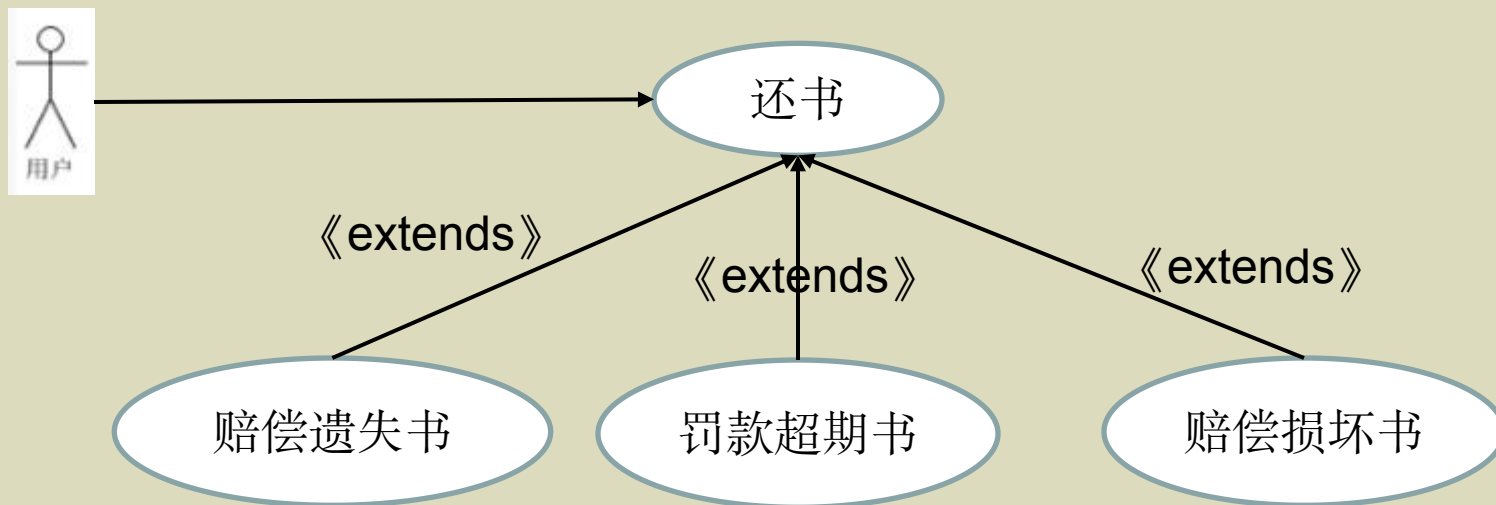- Labeled <<extends>>.
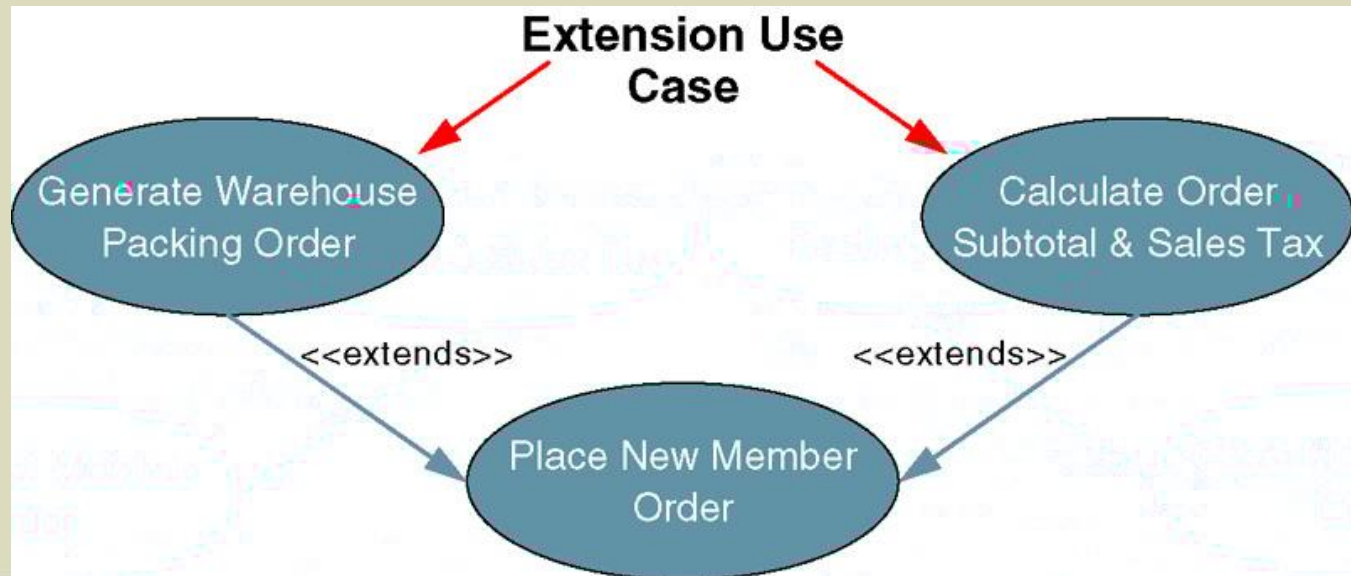
可以出于以下几个目的使用扩展用例：

- 表明用例的某一部分是可选（或可能可选）的系统行为。这样，可以将模型中的可选行为和必选行为分开。

- 可以在基本用例中的扩展点处插入的行为段（以及插入的顺序）将取决于在执行基本用例时与参与者进行的交互。

- 表明只在特定条件（有时是例外条件）下才执行分支流，如触发警报。

例: 对于电话业务，可以在基本通话(Call)业务上扩展出一些增值业务如：呼叫等待(Call Waiting)和呼叫转移(Call Transfer)。
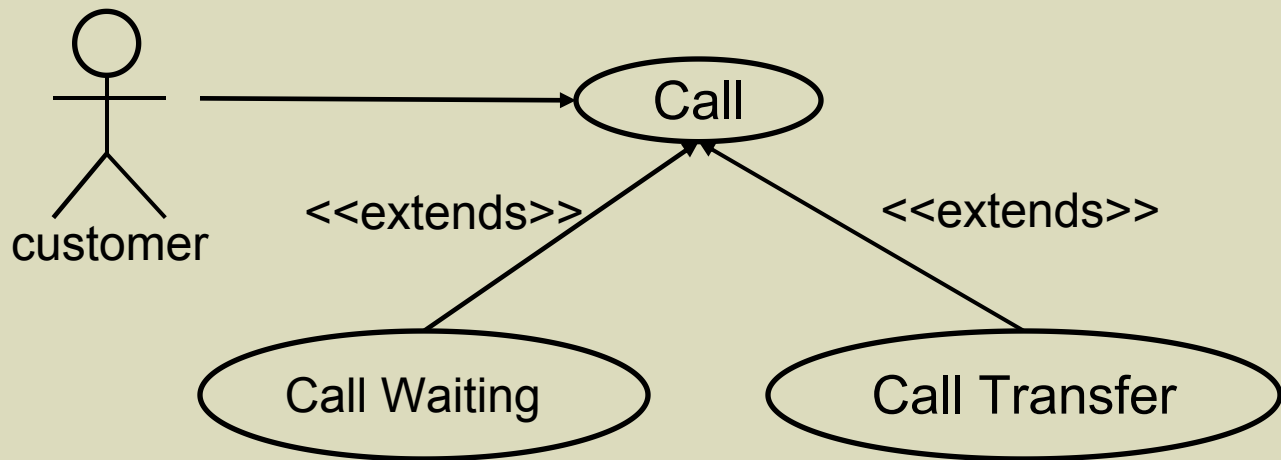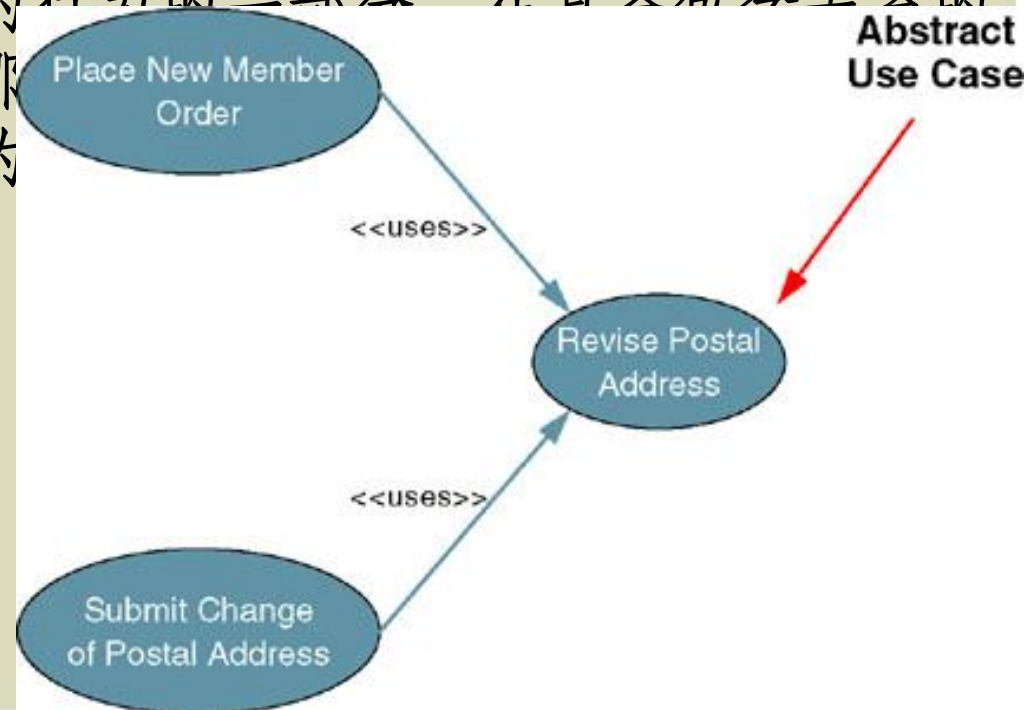
Use Case Uses Relationship

Abstract use case (使用，包含）– use case that reduces redundancy in two or more other use cases by combining common steps found in both.

- 包含关系意味着基用例显式地在其指定位置将另一个用例包含进来，使其成为自己的行为的一部分。在具备包含关系的两个用例中，被包含的那~~~~例的形式存在于包含它的~~~~

Place New Member Order

<<uses>>

Revise Postal Address

Abstract Use Case

<<uses>>

Submit Change of Postal Address

Use Case Uses Relationship

- 包含关系典型的应用就是复用。将程序的某一段算法封装成一个子过程，然后再从主程序中调用这一子过程。

网络申购定期定额基金 —— <<uses>> —→ 电子邮件交易通知

网络申购单笔基金 —— <<uses>> —→

例：银行ATM机

客户 → 身份验证

《includes》 查询

缴费

《extends》

取款

转账

打印回执
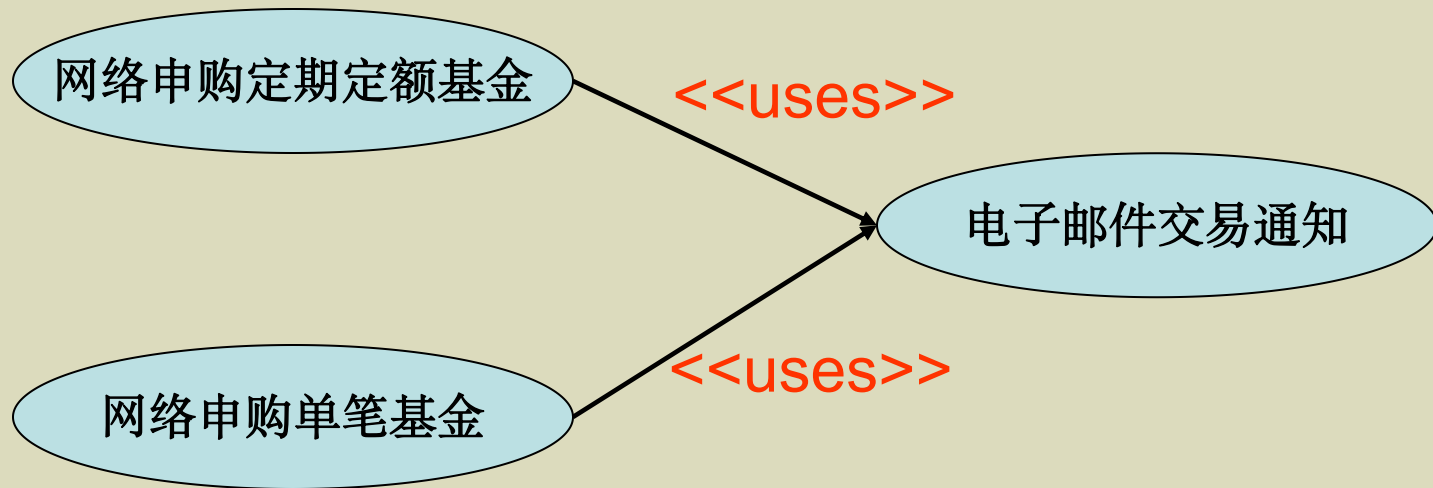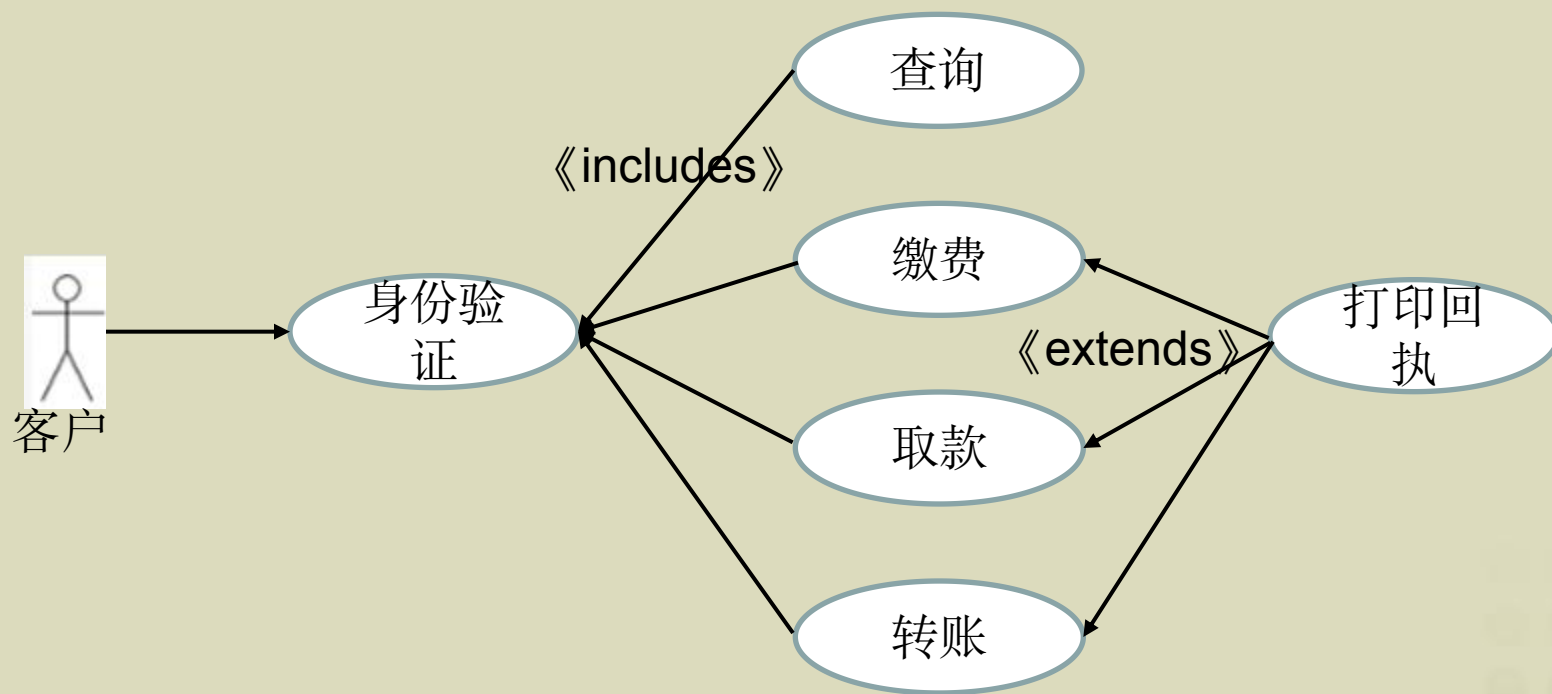
当多个用例共同拥有一种类似的结构和行为时，可以将他们的共性抽象成为父用例，其他的用例作为泛化关系的子用例。

子用例从父用例处继承行为和属性，还可以添加行为或覆盖、改变已继承的行为。

在用例的泛化关系中，子用例是父用例的一种特殊形式，它继承了父用例的所有结构、行为、关系。其中三角箭头指向父用例。在任何使用基用例的地方都可以用子用例来代替。

本地注册

用户注册

网上注册
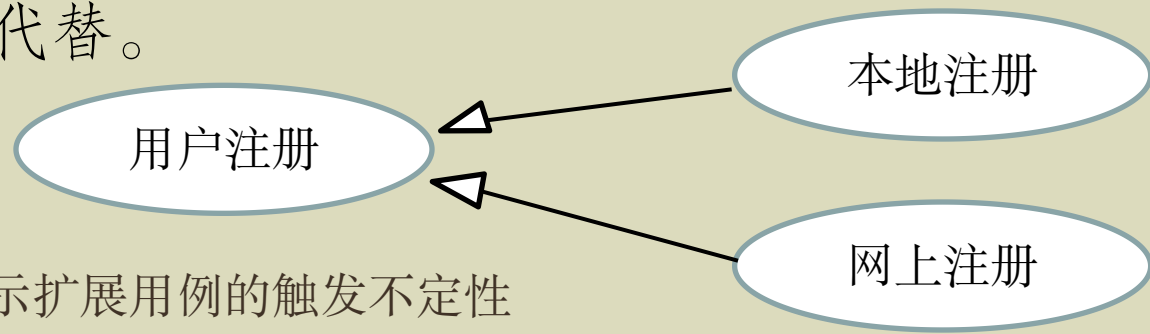
扩展侧重表示扩展用例的触发不定性

泛化侧重表示子用例间的互斥性，父用例通常是抽象的。
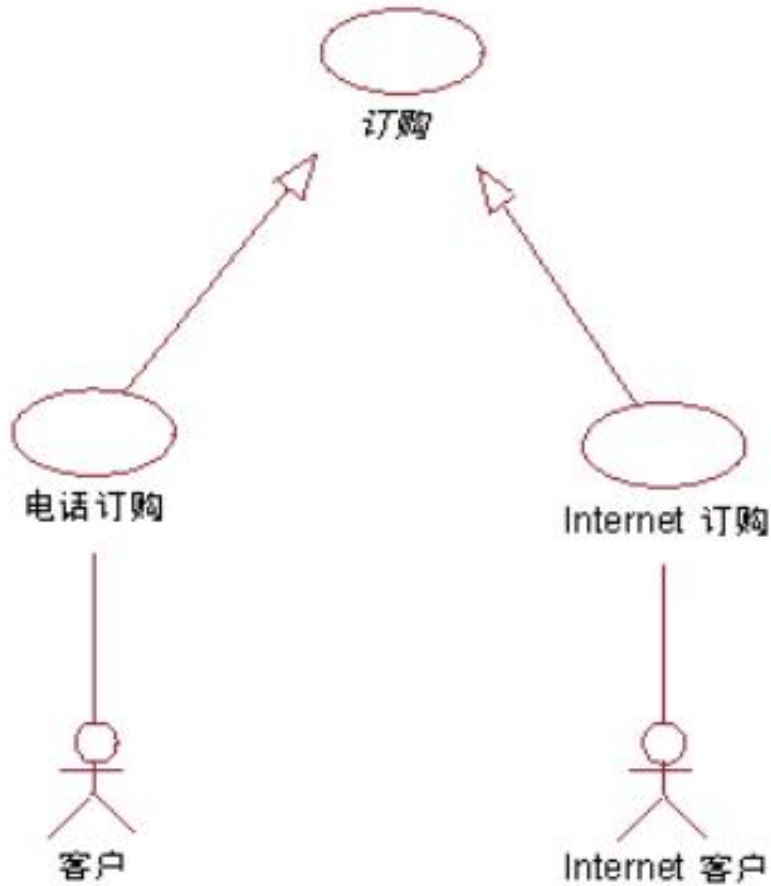
在订单管理系统中，"电话订购"和"Internet 订购"两个用例在结构和行为上存在很多的共同点。

而一般用例"订购"是根据结构和公有行为的定义来定义的。虽然抽象用例"订购"本身无须完整，但是它提供了一个大体的、通过子用例进行完善的行为框架。

- 泛化表示类似于术语"继承"或"多态"。
- UML中的Use Case泛化过程是将不同Use Case之间的可合并部分抽象成独立的父Use Case，并将不可合并部分单独成各自的子Use Case；
- 包含以及扩展过程与泛化过程类似，但三者对用例关系的优化侧重点是不同的：
  -- 泛化侧重表示子用例间的互斥性；
  -- 包含侧重表示被包含用例对Actor提供服务的间接性
  -- 扩展侧重表示扩展用例的触发不定性；

1. 现有两个用例UC1和UC2.其中UC2是一个完整的用例,可被实例化,而UC1需要UC2中的事件流才可被实例化,且UC1指定了UC2的精确位置,则UC1和UC2间的关系是____。

2. UML用例图展示了各类actor与系统所提供的用例之间的连接。在银行储蓄管理信息系统中,不属于外部actor的是____。

A. 存折   B. 银行工作人员

C. 储蓄客户   D. 数据库

Use Case Depends On Relationship

Depends On – use case relationship that specifies which other use cases must be performed before the current use case.

- Can help determine sequence in which use cases need to be developed.
- Depicted as arrow beginning at one use case and pointing to use case it depends on.
- Labeled <<depends on>>.
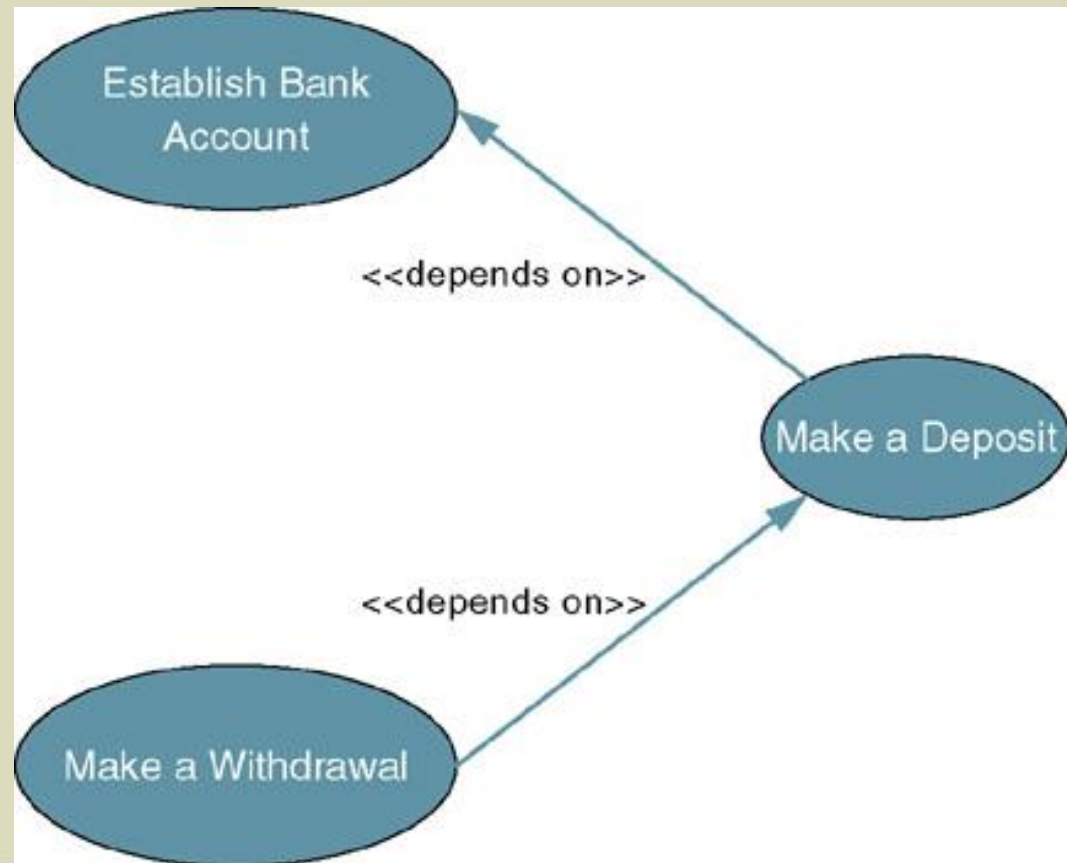
Use Case Inheritance Relationship

Inheritance – a use case relationship in which the common behavior of two actors initiating the same use case is extrapolated and assigned to a new *abstract* actor to reduce redundancy.

- Other actors can inherit the interactions of the abstract actor.

- Depicted as an arrow beginning at one actor and pointing to the abstract actor whose interactions the first actor inherits.

```
class customer{
  ……
void searchlibraryinventory (){
…….
  }
 }
class patron extends customer{ …….
 checkoutbooks()  {
   }  }

class visitor extends customer{…….
 applyformembership()  {
   }
```

例：棋牌馆管理系统

1. 客户通过Internet预订座位，在"预订座位" 的执行过程中，将"检查座位信息"，如果没有空闲的座位或满意的座位，可以选择进入等候队列（"处理等候队列"）。

2. 总台服务员在客户到棋牌馆时，启动"安排座位"，在执行过程中，将 "检查座位信息"。

3. 当客户要离开棋牌馆时，总台服务员将 "处理结账"，并且定义了两种"收款"方式 ，一个是"处理现金结账"，另一个是"处理银行卡结账"，而后一个用例将通过与外部系统"银联POS系统"交互来完成。
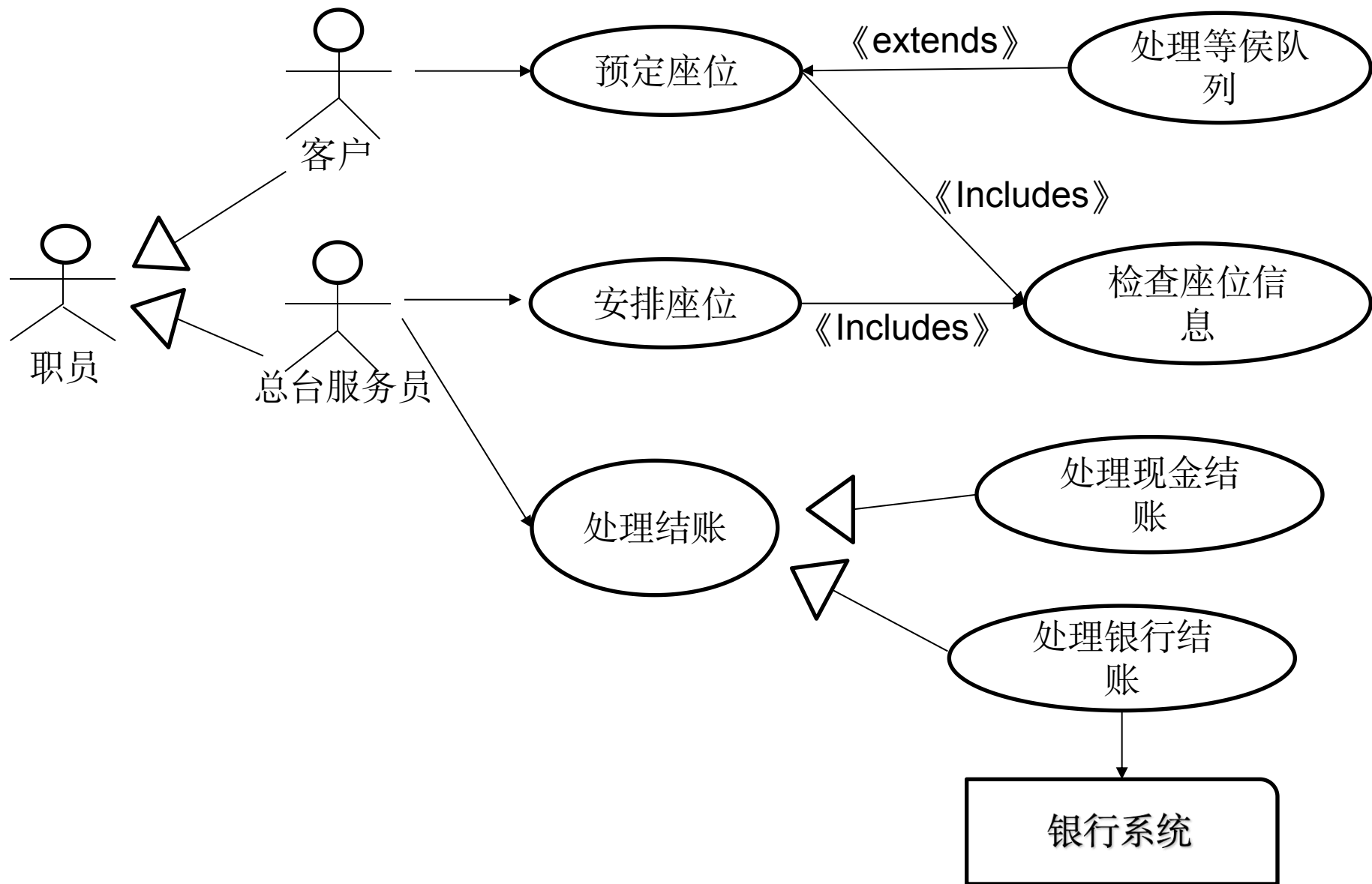
获取用例的步骤

(1)找出系统外部的参与者和外部系统，确定系统的边界和范围。

(2)确定每一个参与者所期望的系统行为

(3)把这些系统行为命名为用例

(4)使用关联、包含、扩展等关系处理系统行为的公共或变更部分

(5)编制每一个用例的脚本

(6)绘制用例图

(7)区分基本事件流和异常情况的事件流，如有需要可以把表示异常情况的事件流作为单独的用例来处理

(8)细化用例图，解决用例间的重复与冲突。

7.3 The Process of Requirements Use-Case Modeling

- **Objective** is to elicit and analyze enough requirements information to prepare a model that:
  - Communicates what is required from a user perspective.
  - Is free of specific details about how system will be implemented.
- **Steps**
  1. Identify business actors.
  2. Identify business use cases.
  3. Construct use-case model diagram.
  4. Documents business requirements use-case narratives.

Step 1: identify Business Actors

- **When looking for actors, ask the following questions:**
  - **Who or what provides inputs to the system?**
  - **Who or what receives outputs from the system?**
  - **Are interfaces required to other systems?**
  - **Are there events that are automatically triggered at a predetermined time?**
  - **Who will maintain information in the system?**
- **Actors should be named with a noun or noun phrase**

Sample List of Actors

Term	Synonym	Description
1. Potential member		An individual or corporation that submits a subscription order in order to join the club.
2. Club member	Member	An individual or corporation that has joined the club via an agreement.
3. Past member	Inactive member	A type of member that has fulfilled the agreement obligation but has not placed an order within the last six months but is still in good standing.
4. Marketing		Organization responsible for creating promotion and subscription programs and generating sales for the company.
5. Member services		Organization responsible for providing point of contact for SoundStage Entertainment customers in terms of agreements and orders.
6. Distribution center	Warehouse	Entity that houses and maintains SoundStage Entertainment product inventory and processes customer shipments and returns.
7. Accounts receivable		Organization responsible for processing customer payments and billing as well as maintaining customer account information.
8. Time		Actor concept responsible for triggering temporal events.

Business Requirements Use Case - a use case created during requirements analysis to capture the interactions between a user and the system free of technology and implementation details.

- During requirements analysis, strive to identify and document only the most critical, complex, and important use cases, often called *essential* use cases.(基本用例)

Step 2: Identify Business Requirements Use Cases (cont.)

- **When looking for use cases, ask the following questions:**
  - **What are the main tasks of the actor?**
  - **What information does the actor need form the system?**
  - **What information does the actor provide to the system?**
  - **Does the system need to inform the actor of any changes or events that have occurred?**
  - **Does the actor need to inform the system of any changes or events that have occurred?**

Sample Context Diagram

Member Services Context Diagram

Club Member
- Submit Member Order
- Inquire Account (order & payment history)
- Generate Inquiry Responses
- Send Promotion Offer

Potential Club Member
- Submit Subscription Order (apply for membership)
- Send Subscription Offer

Past Member
- Submit Subscription Renewal
- Send Resubscription Offer

Accounts Receivable
- Submit Member Credit Status Response

Member Services System

Marketing
- Sales
- Submit Promotion Information
- Submit Subscription Program
- Generate Various Subscription Reports
- Generate Various Promotion Reports
- Generate Various Sales Reports

- Send Packing Order

Distribution Center (Warehouse)

- Generate Various Member Reports

Member Services

Sample Use-Case Glossary

| Use-Case Name	Use-Case Description	Participating Actors and Roles
Submit Subscription Order	This use case describes the event of a potential member requesting to join the club by subscribing. ("Take any 12 CDs for one penny and agree to buy 4 more at regular prices within two years.")	• Potential member (primary business) • Distribution Center (external receiver)
Submit Subscription Renewal Order	This use case describes the event of a past member requesting to rejoin the club by subscribing. ("Take any 12 CDs for one penny and agree to buy 4 more at regular prices within two years.")	• Past member (primary business) • Distribution Center (external receiver)
Submit Member Profile Changes	This use case describes the event of a club member submitting changes to his or her profile for such things as postal address, e-mail address, privacy codes, and order preferences.	• Club member (primary business)
Place New Order	This use case describes the event of a club member submitting an order for SoundStage products.	• Club member (primary business) • Distribution Center (external receiver) • Accounts Payable/Receivable (external server)

Sample Use-Case Glossary (cont.)

Revise Order	This use case describes the event of a club member revising an order previously placed. (Order must not have shipped.)	• Club member (primary business) • Distribution Center (external receiver) • Accounts Payable/Receivable (external server)
Cancel Order	This use case describes the event of a club member canceling an order previously placed. (Order must not have shipped.)	• Club member (primary business) • Distribution Center (external receiver) • Accounts Payable/Receivable (external server)
Make Product Inquiry	This use case describes the event of a club member viewing products for possible purchase. (Driven by web access requirement.)	• Club member (primary business)
Make Purchase History Inquiry	This use case describes the event of a club member viewing her or his purchasing history. (Three-year time limit.)	• Club member (primary business)

Sample Use-Case Glossary (cont.)

Establish New Member Subscription Program	This use case describes the event of the marketing department establishing a new membership subscription plan to entice new members	• Marketing (primary business)
Submit Subscription Program Changes	This use case describes the event of the marketing department changing a subscription plan for club members (e.g., extending the fulfillment period).	• Marketing (primary business)
Establish Past Member Resubscription Program	This use case describes the event of the marketing department establishing a resubscription plan to lure back former members.	• Marketing (primary business)
Submit Member Profile Changes	This use case describes the event of the marketing department establishing a new promotion plan to entice active and inactive members to order the product. (Note: A promotion features specific titles, usually new, that the company is trying to sell at a special price. These promotions are integrated into a catalog sent (or communicated) to all members.)	• Marketing (primary business)
Revise Promotion	This use case describes the event of the marketing department revising a promotion.	• Marketing (primary business)
Generate Daily 10-30-60-Day Default Agreement Report	This use case describes the event of a report that is generated on a daily basis to list the members who have not fulfilled their agreement by purchasing the required number of products outlined when they subscribed. This report is sorted by members who are 10 days past due, 30 days past due, and 60 days past due.	• Time (initiating actor) • Member Services (primary* — external receiver)

Step 3: Construct Use-Case Model Diagram
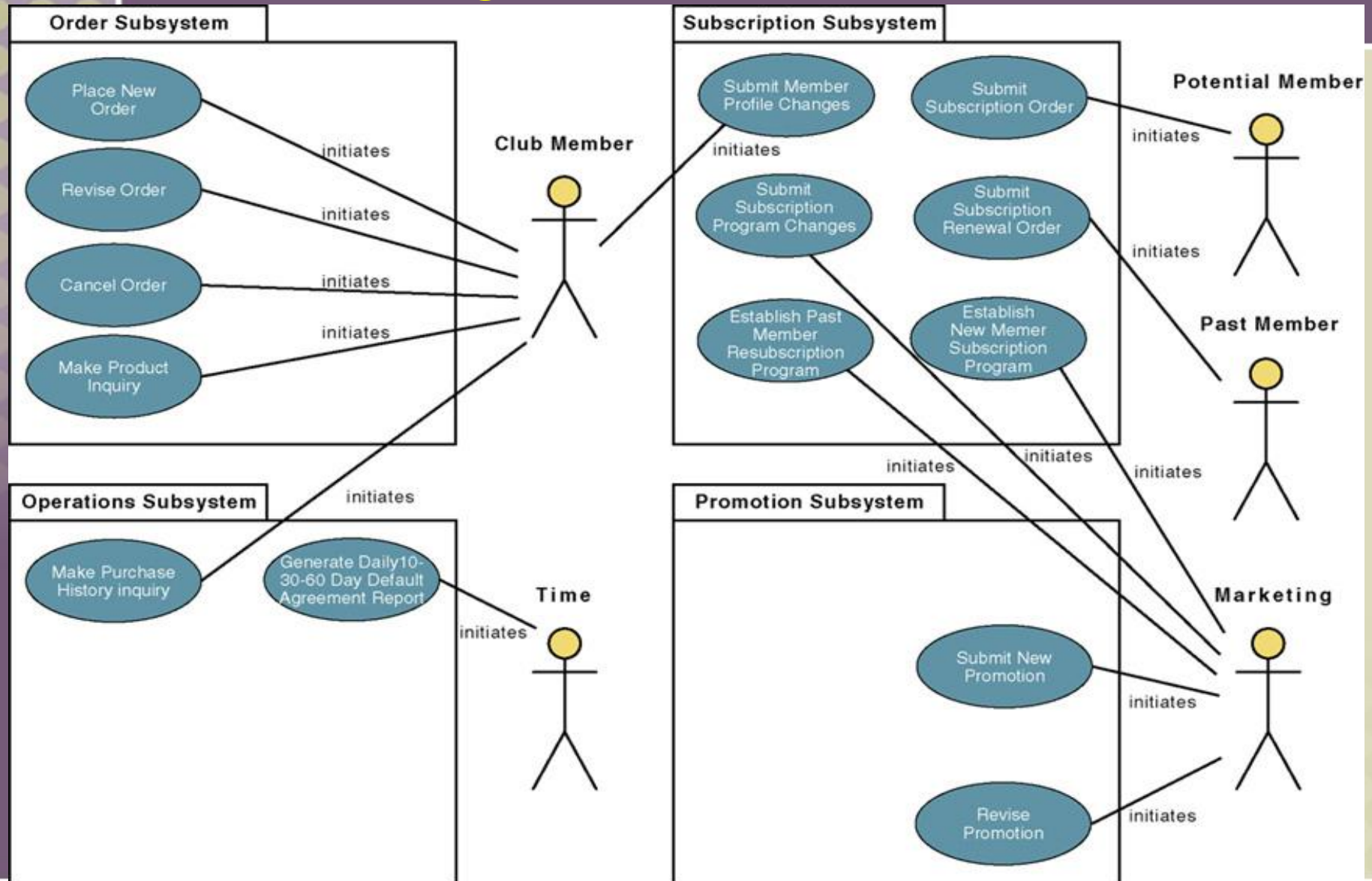
Step 4: Document Business Requirements Use-Case Narratives

- Document first at high level to quickly obtain an understanding of the events and magnitude of the system.

- Then expand to a fully-documented business requirement narrative.

  - Include the use case's typical course of events and its alternate courses.

Member Services System

Author (s): _____ ①   Date: _____ ②

Version: ③

Use-Case Name:	Place New Order ④	Use-Case Type
Use-Case ID:	MSS-BUC002.00 ⑥	**Business Requirements:** ☑
Priority:	High ⑦	⑤
Source:	Requirement — MSS-R1.00 ⑧	
Primary Business Actor:	Club member ⑨	
Other Participating Actors:	• Warehouse (external receiver) • Accounts Receivable (external server) ⑩	
Other Interested Stakeholders:	⑪ • Marketing — Interested in sales activity in order to plan new promotions. • Procurement — Interested in sales activity in order to replenish inventory. • Management — Interested in order activity in order to evaluate company performance and customer (member) satisfaction.	
Description: ⑫	This use case describes the event of a club member submitting a new order for SoundStage products. The member's demographic information as well as his or her account standing is validated. Once the products are verified as being in stock, a packing order is sent to the warehouse for it to prepare the shipment. For any product not in stock, a back order is created. On completion, the member will be sent an order confirmation.	

Sample Expanded Version of a Use-Case Narrative

Member Services System

Author (s): _____   **Date:** _____

Version:

Use-Case Name:	Place New Order		**Use-Case Type**
Use-Case ID:	MSS-BUC002.00		**Business Requirements:** ☑
Priority:	High		
Source:	Requirement — MSS-R1.00		
Primary Business Actor:	Club member		
Other Participating Actors:	• Warehouse (external receiver) • Accounts Receivable (external server)		
Other Interested Stakeholders:	• Marketing — Interested in sales activity in order to plan new promotions. • Procurement — Interested in sales activity in order to replenish inventory. • Management — Interested in order activity in order to evaluate company performance and customer (member) satisfaction.		
Description:	This use case describes the event of a club member submitting a new order for SoundStage products. The member's demographic information as well as his or her account standing is validated. Once the products are verified as being in stock, a packing order is sent to the warehouse for it to prepare the shipment. For any product not in stock, a back order is created. On completion, the member will be sent an order confirmation.		
Precondition: ➊	The party (individual or company) submitting the order must be a member.		
Trigger: ➋	This use case is initiated when a new order is submitted.		

Sample Expanded Version of a Use-Case Narrative (cont)

Typical Course of Events: ③	Actor Action	System Response
	Step 1: The club member provides his or her demographic information as well as order and payment information.	**Step 2:** The system responds by verifying that all required information has been provided. **Step 3:** The system verifies the club member's demographic information against what has been previously recorded. **Step 4:** For each product ordered, the system validates the product identity. **Step 5:** For each product ordered, the system verifies the product availability. **Step 6:** For each available product, the system determines the price to be charged to the club member. **Step 7:** Once all ordered products are processed, the system determines the total cost of the order. **Step 8:** The system checks the status of the club member's account. **Step 9:** The system validates the club member's payment if provided. **Step 10:** The system records the order information and then releases the order to the appropriate distribution center (warehouse) to be filled. **Step 10:** Once the order is processed, the system generates an order confirmation and sends it to the club member.

Alternate Courses: ④	**Alt-Step 2:** The club member has not provided all the information necessary to process the order. The club member is notified of the discrepancy and prompted to resubmit.
	Alt-Step 3: If the club member information provided is different from what was previously recorded, verify what was recorded is current, then update the club member information accordingly.
	Alt-Step 4: If the product information the club member provided does not match any of SoundStage's products, notify the club member of the discrepancy and request clarification.
	Alt-Step 5: If the quantity ordered of the product is not available, a back order is created.
	Alt-Step 8: If the status of the club member's account is not in good standing, record the order information and place it in hold status. Notify the club member of the account status and the reason the order is being held. Terminate use case.
	Alt-Step 9: If the payment the club member provided (credit card) cannot be validated, notify the club member and request an alternative means of payment. If the club member cannot provide an alternate means, cancel the order and terminate the use case.
Conclusion: ⑤	This use case concludes when the club member receives a confirmation of the order.
Postcondition: ⑥	The order has been recorded and if the ordered products were available, they were released. For any product not available a back order has been created.
Business Rules: ⑦	• The club member responding to a promotion or a member using credits may affect the price of each ordered item. • Cash or checks will not be accepted with the orders. If provided, they will be returned to the club member. • The club member is billed for products only when they are shipped.
Implementation Constraints and Specifications: ⑧	• GUI to be provided for Member Services associate, and web screen to be provided for club member.
Assumptions: ⑨	Procurement will be notified of back orders by a daily report (separate use case).
Open Issues: ⑩	1. Need to determine how distribution centers are assigned.

concluded

Use-Case Ranking and Priority Matrix

- In most projects, the most important use cases are developed first.

  Use-case ranking and priority matrix – a tool used to evaluate use cases and determine their priority.

  - Evaluates use cases on 1-5 scale against six criteria.
    1. Significant impact on the architectural design.
    2. Easy to implement but contains significant functionality.
    3. Includes risky, time-critical, or complex functions.
    4. Involves significant research or new or risky technology.
    5. Includes primary business functions.
    6. Will increase revenue or decrease costs.

Sample Use-Case Ranking and Priority Matrix

Use-Case Name	Ranking Criteria, 1 to 5						Total Score	Priority	Build Cycle
	1	2	3	4	5	6			
Submit Subscription Order	5	5	5	4	5	5	29	High	1
Place New Order	4	4	5	4	5	5	27	High	2
Make Product Inquiry	1	1	1	1	1	1	6	Low	3
Establish New Member Subscription Program	4	5	5	3	5	5	27	High	1
Generate Daily 10-30-60-Day Default Agreement Report	1	1	1	1	1	1	6	Low	3
Revise Order	2	2	3	3	4	4	18	Medium	2

Use-Case Dependency Diagram

Use-case dependency diagram – graphical depiction of the dependencies among use cases.

- Provides the following benefits:
  - Graphical depiction of the system's events and their states enhances understanding of system functionality.
  - Helps identify missing use cases.
  - Helps facilitate project management by depicting which use cases are more critical.

Sample Use-Case Dependency Diagram