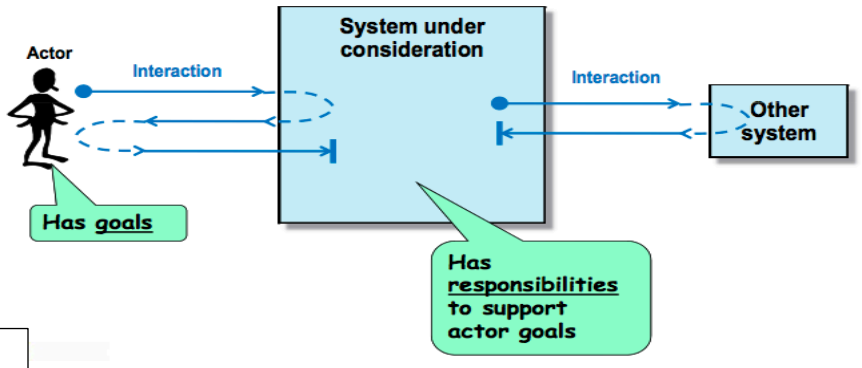
Use Case Modeling

The Use Case Conceptual Framework

- An interaction with a system for the purpose of achieving a clearly defined goal
  - Something which is of value to the actor



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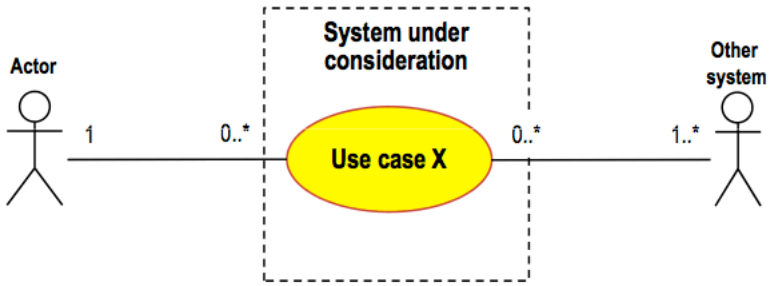
UML Representation of Use Cases

- The UML graphical representation is merely a shorthand rendering of a use case
  - The important (and hard) part is specifying the use case itself



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Key Concepts

- *NB: There is still no visible consensus on the definitions of key use case concepts*
  - A workshop of 14 leading OO consultants had 14 definitions of "use case"
  - Occurs on the boundary between the informal (i.e., what users want) and formal (i.e., what engineers implement)
- Actor: an entity (person or system) which interacts with a system to achieve one or more goals
- Use case: a *collection* of possible interactions between actors and a system relating to one or more goals
  - Being a collection of possible scenarios, a use case is similar to a class
  - ..we talk about "instances" (occurrences) of use cases

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Steps of UC Modeling

- For event-driven systems, UC modeling consists of the following steps:
  - Scope the system (by considering different Actor perspectives)
  - Identify events and *actors*
    - » Actors are abstractions generating events
    - » Think of internal and external events
  - List use-case titles (and prioritize them)
  - Produce a use-case diagram
  - Document use-cases using a scenario textual description (STD) technique

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Identifying External Events

Event	System Resp.	Arrival	Response
offhook -->	dialtone	aperiodic <100/min	<500msec
first digit -->	cancel dialtone	aperiodic <20 sec after dialtone	Digit tone <100msec
last digit -->	translation result	interdigit time = 4sec	a.s.a.p
<--ringing			a.s.a.p after last digit
answer-->	cancel ringing and ringtone	aperiodic	<100msec

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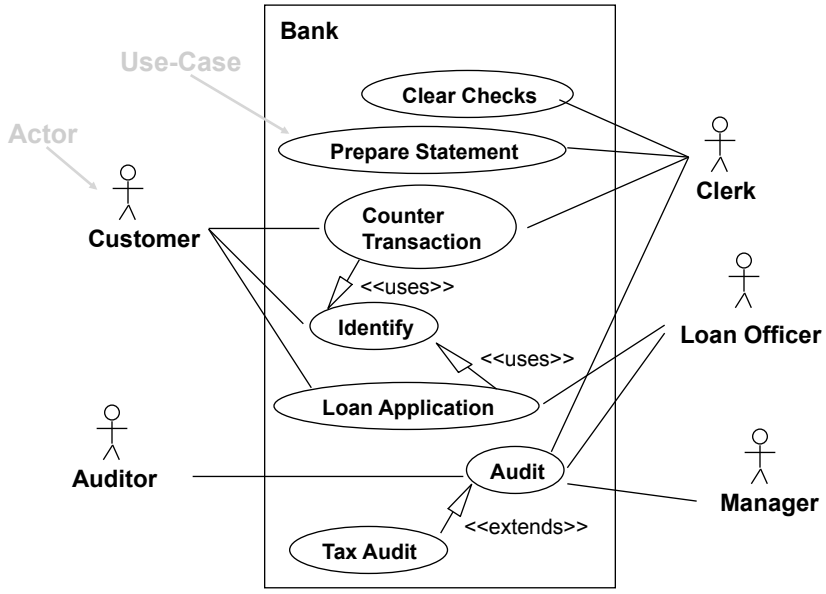
A Use-Case Diagram



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An Example Use Case

Use Case: Making a successful POTS connection

- Actors: calling party, called party
- **Scenario:**
- Caller lifts telephone receiver
- Caller hears dial tone
- Caller dials digits
- Caller receives audible ring tone
  Called party's phone rings
- Called party lifts receiver
- Caller and Called party are now connected and can talk
- Called party hangs up
- Caller receives dial tone
- Caller hangs up

Key points: System as Black Box, event/response

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How to Start?

- You must start by writing down a list of *verifiable* requirements and going from them to UCs.
- Each use case captures a cluster of scenarios:
  - the scenarios of a UC must be logically clustered together
  - a scenario is formed by a (more or less abstract) sequence of input/output events processed by the system (as a black box)
  - through the use of words such as 'OR', 'AND', 'eventually', 'optionally', 'repeatedly', each step of a UC, each scenario, and ultimately each UC can be viewed as a grammar of events
  - In OO, we use a set of UCs to describe system behavior:
    - » unless otherwise documented, UCs are taken to be independent of and concurrent with each other
    - » inter-UC relationships (annotated with stereotypes) are important to identify: the more the UCs are tied to each other, the less partial the overall specification is!
    - » there is generally no overall grammar to build for the whole system but we do aim for req. coverage (via traceability)

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Organizing Use Cases

- We propose that each use case be documented using an STD that ideally contains the following information:
  - » a unique identifier
  - » a brief textual description of the overall objective of the UC
  - » the set of external actors that participate in the UC
  - » a set of possible triggering events
  - » a pre-condition that must be satisfied in order to enable the execution of the UC
  - » a sequence of system *responsibilities (or steps)* for the main scenario (JP: if not for ALL scenarios!!!)
  - » a set of possible resulting events for the UC
  - » a post-condition that must evaluate to true after the execution of the UC
  - » a set of alternative scenarios (optional but important!)
  - » a set of nonfunctional requirements that apply to the UC (optional)
  - » a comment section that may be used by designers as a free format text window to specify different issues related to the UC (e.g., which scenarios were grouped into this UC)

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Example STD (1)

Use Case Identifier: UC-9 ATM withdraw transaction
Description: Describes the steps of a normal withdraw transaction
External Actors: User, Central Bank System (CBS)
Related Use Cases: UC-15 Transaction
Precondition: ATM is idle **Triggering event:** A user inserts a valid bank card
1. User enters a valid bank card. **2.** ATM swallows the bank card and reads the card information. **3.** ATM initiates the transaction. **4.** ATM asks the user to enter PIN. User enters PIN. **5.** CBS validates PIN. **6.** ATM asks user to choose a transaction option. User chooses the withdraw option. **7.** ATM asks for amount to withdraw. User enters amount. **8.** ATM sends a withdraw transaction request to CBS. **9.** CBS verifies that the user account balance is sufficient to cover the requested amount. **10.** CBS registers the withdraw transaction. **11.** ATM dispenses cash. User picks up cash. **12.** ATM prints a transaction receipt. User picks up the receipt. **13.** ATM returns the bank card. User picks up the card.

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Example STD (2)

Use Case Identifier: ATM withdraw transaction
Resulting event: ATM returns the bank card **Postcondition:** ATM is idle again
Alternatives: - If the user enters three successive invalid PINs, then the transaction is refused and the card is kept. - If the user's account balance is insufficient, then the transaction is refused. - If the ATM does not have enough cash, then the transaction is refused.
Nonfunctional requirements: - A transaction must be completed in less than two minutes - ATM can only handle one transaction at the time.
Comments: - A transaction can be cancelled at any time before the transaction is sent to the CBS.

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UML 's Stereotypes

- A *stereotype* is a user-defined label that allows extensions to the semantics of UML
  - this is a key mechanism to introduce your own semantics into the modeling process

Stereotypes for Use-Cases

- A *Basic* Use-Case:
  - must describe a typical usage of the system from end-to-end
  - must keep an external, event-driven perspective
- An *Extension*
  - captures functionality that is optional or additional to one or more basic use cases
    - » We prefer to list alternatives inside an STD.
  - is related to basic a use-case using an *extends* arrow
- A *Reference*
  - gives a name to a group of steps repeated in several use-cases
  - is related to basic a use-case using a *uses* arrow

Some Conclusions

Why OO people like Use-Cases

Use-cases:

- **constitute a simple, intuitive form of scenario modeling**
  - **temporal logic for event specification is much more complicated**
- **are not object-oriented**
  - **only solutions to the requirements are OO!**
- **make clear what external functionality is expected**
  - **the system is treated as a black-box**
  - **the interface and the DB functionality are typically separated**
- **may be helpful infinding objects**
  - **how to do this is discussed later in COMP 3004**
  - **only *domain* (i.e., problem as opposed to solution) objects should be mentioned in use-cases**
- **are traceable to detailed interaction diagrams used later in the design process**
- **may be used as a basis for black-box testing of the system**

Working with Use-Cases

- **Use-cases proliferate quickly:**
  - It is naive to think you can simply write down all of the use-cases and *exhaustively* describe the behavior of the system
  - We repeat, it is easy to confuse scenarios, their steps, and use-cases
- **Several authors suggest finding "key" scenarios and use-cases**
  - but no one gives good guidelines for selecting such "key" use-cases... See Wirfs-Brock tutorial
- **Don't forget about scenario interactions (next slide)**

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About Scenario Relationships

- **It is important to group together related scenarios into a single scenario *cluster*:**
  - A use-case should be thought of as a cluster of related scenarios
  - Exception handling scenarios can be viewed as extensions or alternatives of basic use-cases
- **Individual scenarios are typically straightforward. It is essential to capture the *relationships* between scenarios! The same holds for use-cases!!**
  - Such relationships typically define at least a temporal, if not a *causal* order between scenarios, and/or between use-cases.
  - A use-case diagram may be used to document inter-UC relationships. But we need lots of stereotypes!

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The Bottom Line

- **Don't do procedural decomposition through the use-cases**
  - **don't describe algorithms or specific paths of execution inside the system**
  - **Each scenario of a UC is an end-to-end sequence of events corresponding to a typical use of the system, which is viewed as a black box.**
- **Review use-cases with respect to completeness and consistency**
  - **trace individual scenarios to requirements**
  - **inter-scenario and inter-UC relationships are crucial in verifying consistency**