2IW80 Software specification and architecture

Use cases

Alexander Serebrenik
Before we start…

Requirement for the art-gallery website:

Every painting always belongs to only one "Theme" for example such as modern art or nature, etc.

This is an example of
a. Functional requirement
b. Non-functional requirement
c. What was this all about?

http://www.ics.uci.edu/~taylor/ICS_52_FQ02/ics52_Fall02_Req_Ver3.doc
Before we start...

Requirement for the art-gallery website:

*Every painting always belongs to only one "Theme" for example such as modern art or nature, etc.*

This is an example of

a. Functional requirement
b. Non-functional requirement

c. What was this all about?
Every painting always belongs to only one "Theme" for example such as modern art or nature, etc.

Is this requirement SMART?

a. Yes

b. No
SMART requirements

Requirements used as a specification technique

- To be useful as a specification technique, requirements should be
  - Specific
  - Measurable
  - Attainable
  - Realisable
  - Traceable

Every painting always belongs to only one "Theme" for example such as modern art or nature, etc.

Is this requirement SMART?

a. Yes
b. No ✔
# Requirements documents in practice

## SEVENTH FRAMEWORK PROGRAMME

**INFORMATION AND COMMUNICATION TECHNOLOGIES**

**Project:**
Accessibility Assessment Simulation Environment for New Applications Design and Development (ACCESSIBLE, Grant Agreement No. 224145)

## Deliverable number and title:

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<th>D 2.2b – User needs and System Requirements Specification</th>
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<td><strong>File name and size</strong></td>
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Format:
- Page 1 of 174
What should a user be able to do?

Requirements documents

SEVENTH FRAMEWORK
PROGRAMME
INFORMATION AND COMMUNICATION
TECHNOLOGIES

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Accessibility Assessment Simulation Environment for New
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[Final Draft] Page 1 of 174 SUN
What should a user be able to do?
What should a user be able to do?

Is this all?
What should a user be able to do?

Is this all?
What should a user be able to do?

Is this all?
What should a user be able to do?

Is this all?
We need a better way

- **Goal**: specify how different parties (users, administrators, external systems, ...) can interact with our system
  - *Recall: unambiguous, realistic, verifiable and evolvable*

- Plain-text does not work

- A more **structured** way is needed
Simple example

• What can you do with

http://globestaronline.com/panasonic-kx-ts500mx-corded-telephone/#.UrF1wPTuLy0
Simple example

- What can you do with

My answers:

- Place a call
- Control the volume
- Receive a call
- Repeat the last call

http://globestaronline.com/panasonic-kx-ts500mx-corded-telephone/#.UrF1wPTuLy0
Simple example

• What can you do with a telephone?

Basic use case diagram
Simple example

• What can you do with a telephone?

Basic use case diagram

Use case
- Place a call
- Receive a call

Actor
- Caller

Association
- Control the volume
- Repeat the last call
What is an actor?

- A class of entities (human or computer), falling beyond the system boundaries, interacting with the system

NB:
- Actor can be an external software system
- One might have multiple actors in a use case: caller/callee
- One user might be represented by multiple actors
  - doctor can be a patient
What is a use case?

• **Use case**: a contract between the stakeholders of a system about its behavior *[Cockburn 2001]*

  • **Stakeholder**: a person, group or organization with an interest in a project

• Usually, a large **end-to-end** process comprising **several** (inter)actions
  
  • Internal operations are NOT use cases
  
  • Individual methods are NOT use cases
  
  • BUT it is one process: specification usually involves multiple use cases
Is placing a call large?

• How do you make a phone call?
  
a) Pick up the phone
b) Dial
c) Talk

• Correct?
Is placing a call large?

• How do you make a phone call?
  
  a) Pick up the phone
  b) Dial
  c) Talk

• Correct?
How do you make a phone call?

a) The user picks up the telephone hook connected to the telephone line “A”.

b) If the line is free, the user receives a dial tone sent by the line.

c) The user dials number “B”.

d) The call request is forwarded to the switch center.

e) If line “B” is not busy, the call request is forwarded to “B” and a tone is sent to “A”.

f) “B”’s telephone rings.

g) If somebody at “B” picks up the hook, the ringing tone at “A” is stopped and a telephone connection will commence.
Is placing a call large?

- How do you make a phone call?
  a) The user picks up the telephone hook connected to the telephone line “A”.
  b) If the line is free, the user receives a dial tone sent by the line.
  c) The user dials number “B”.
  d) The call request is forwarded to the switch center.
  e) If line “B” is not busy, the call request is forwarded to “B” and a tone is sent to “A”.
  f) “B”’s telephone rings.
  g) If somebody at “B” picks up the hook, the ringing tone at “A” is stopped and a telephone connection will commence.
What if the “if” conditions do not hold?

b) If the line is free, the user receives a dial tone sent by the line.

b-1) If the telephone line is engaged in a conversation, the user will be connected to the same conversation.

b-2) If the user does not dial a number for a certain amount of time, a permanent tone is emitted by the switch center, no further call will be accepted and the user has to replace the hook.
What if the “if” conditions do not hold?

b) If the line is free, the user receives a dial tone sent by the line.

  b-1) If the telephone line is engaged in a conversation, the user will be connected to the same conversation.

  b-2) If the user does not dial a number for a certain amount of time, a permanent tone is emitted by the switch center, no further call will be accepted and the user has to replace the hook.
What if the “if” conditions do not hold?

e) If line “B” is not busy, the call request is forwarded to “B” and a tone is sent to “A”.

Propose an alternative for this step and discuss it with your neighbor.
What if the “if” conditions do not hold?

e) If line “B” is not busy, the call request is forwarded to “B” and a tone is sent to “A”.

My solutions

(e-1).1 If line “B” is busy, and “B” does not have call waiting the user at “A” will receive a busy tone.

(e-2).1 If line “B” is busy, and “B” has call waiting the user at “A” will receive a call-waiting tone from the switch center. When line “B” becomes free, sub-scenario (e-g) follows.
Use case description

- **Pre-condition:** when a use case is available to its user
Use case description

• **Pre-condition:** when a use case is available to its user
  • The telephone set is connected to the telephone line “A”, it is on-hook and there is no incoming call (it is not ringing).

• **Trigger:** action that initiates the use case
Use case description

• **Pre-condition:** when a use case is available to its user
  • The telephone set is connected to the telephone line “A”, it is on-hook and there is no incoming call (it is not ringing).

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  • The user picks up the telephone hook connected of the telephone set (connected to line “A”) and dials number “B”.

• **Guarantee (post-condition):** what does the user achieve through the use case
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• **Guarantee (post-condition):** what does the user achieve through the use case
  • A communication between “A” and “B” will commence

• **Main scenario**

• **Alternatives**
• **User presses a “Day Return” button is a**
  a) Trigger
  b) Pre-condition
  c) Guarantee (post-condition)
• **User presses a “Day Return” button is a**
  a) Trigger
  b) Pre-condition
  c) Guarantee (post-condition)
**Summary so far**

**Use case**
- Place a call
- Receive a call

**Actor**
- Control the volume
- Repeat the last call

**Association**

---

**What is an actor?**
- A **class of entities** (human or computer), falling **beyond the system boundaries**, interacting with the system.

- **NB:**
  - Actor can be an **external software system**
  - One might have **multiple actors in a use case**: caller/callee
  - **One user** might be represented by **multiple actors**
    - doctor can be a patient

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**Use case description**
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- **Main scenario**

- **Alternatives**
Practice

Make a description of the “Receive a call” use case

Discuss it with your neighbors
A more complex example

In the file system, users can create new files, execute, display (on different output devices) and delete existing files. There is a special type of delete, which removes the file permanently from the file system. The file system makes use of an access right system which specifies who the owner of each file is and what operations are allowed by which users. The owner of each file may change the access rights to the file and give or take other people’s permissions to access the file. In addition to the person who creates the file, the administrator is considered the owner of all files.

*Identify actors and use cases*
Actors

• Recall:
  • A class of entities (human or computer), falling beyond the system boundaries, interacting with the system

• Hence,
  1. Identify system boundaries
  2. Identify interactions
  3. Classify the interacting entities
In the file system, users can create new files, execute, display (on different output devices) and delete existing files. … The owner of each file may change the access rights to the file and give or take other people’s permissions to access the file. In addition to the person who creates the file, the administrator is considered the owner of all files.

User

File owner

Administrator
Use cases

• Recall:
  • A contract between the stakeholders of a system about its behavior [Cockburn 2001]
  • Usually, a large end-to-end processes comprising several (inter)actions

• Hence,
  1. Identify goals of the actors
  2. Check whether they are “end-to-end”
Use cases

In the file system, users can create new files, execute, display (on different output devices) and delete existing files. There is a special type of delete, which removes the file permanently from the file system. The owner of each file may change the access rights to the file and give or take other people’s permissions to access the file.
Who does what? Associations

User
- Create
- Execute
- Display
- Delete
- Delete permanently

File owner
- Change access rights

Administrator

Correct?
Not all actors have been created equal

• Some users are file owners, but all file owners are users
  • File owner is a special kind of a user.

• Some file owners are administrators, but all administrators are file owners
  • Recall: the administrator is considered the owner of all files
  • Administrator is a special kind of a file owner.
What about use cases?

- There is a special type of delete, which removes the file permanently from the file system.
- Some deletions are permanent deletions, but all permanent deletions are deletions.
- Permanent deletion is a special case of deletion.
**Generalization**

- **Generalization**: A use case / actor is a special case of another one.

- **Substitutability principle**: A specialized class (use case, actor) can always replace the general one.
  - Administrator can do everything the user can (and may be more)

- Does this remind you of the Database course?
Putting it all together: so far

- Execute
- Display
- Delete
- Delete permanently
- Change access rights
- Create

User

File owner

Administrator
Have we specified everything we wanted?

A more complex example

In the file system, users can create new files, execute, display (on different output devices) and delete existing files. There is a special type of delete, which removes the file permanently from the file system. The file system makes use of an access right system which specifies who the owner of each file is and what operations are allowed by which users. The owner of each file may change the access rights to the file and give or take other people’s permissions to access the file. In addition to the person who creates the file, the administrator is considered the owner of all files.

*Identify actors and use cases*
What have we missed so far

• “The file system makes use of an access right system which specifies who the owner of each file is and what operations are allowed by which users.”

• What does this mean for the Execute, Create, Display and Delete use cases?
What have we missed so far

• “The file system makes use of an access right system which specifies who the owner of each file is and what operations are allowed by which users.”

• What does this mean for the Execute, Create, Display and Delete use cases?

• “Sub-use case” included in these use cases
Including a use case in another use case

- User
  - Display
  - Execute
  - Delete
    - Delete permanently

- File owner
  - Create
  - Change access rights

- Administrator
  - Check access rights

<<include>>
Formally

- **Dependency**: A use case depends on another use case for realizing its goal.
- The target use case is *always* used by the source.

```
Execute          <<include>>           Check access rights
```
Formally

- **Dependency**: A use case depends on another use case for realizing its goal.
  - The target use case is *always* used by the source.

- What if the use case is used only sometimes?
  - Alternatives in the use case
  - **Extension**

```
Execute <<include>> Check access rights

Get Help on Registration <<extend>> Register
```
http://www.uml-diagrams.org/examples/hospital-management-use-case-diagram-example.html
## Nota Bene:

<table>
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<tr>
<th></th>
<th>&lt;&lt;include&gt;&gt;</th>
<th>&lt;&lt;extend&gt;&gt;</th>
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</thead>
<tbody>
<tr>
<td>Read</td>
<td>A includes B</td>
<td>B extends A</td>
</tr>
</tbody>
</table>

- **stereotypes**

![Diagram showing stereotypes: <<include>> and <<extend>>]

- **Example**
  - **Read**: A includes B
  - **A** includes **B**
  - **<<include>>**
  - **B** extends **A**
  - **<<extend>>**
### Nota Bene:

<table>
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<td><img src="Diagram.png" alt="Diagram" /></td>
</tr>
<tr>
<td>Read</td>
<td>A includes B</td>
<td>B extends A</td>
<td></td>
</tr>
<tr>
<td>A can operate without B</td>
<td>no</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>B is aware of A</td>
<td>no</td>
<td>yes</td>
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What is wrong with the following diagram?

a) A-B
b) B-C
c) C-D
d) A-D
e) nothing

Example due to Ivanov and Novikov
What is wrong with the following diagram?

a) A-B
b) B-C

c) C-D

d) A-D

e) nothing

The only correct one

Example due to Ivanov and Novikov
Actor A is associated with...

a) C

b) D

c) E

d) F

e) none

Example due to Ivanov and Novikov
Actor A is associated with...

a) C
b) D
c) E
d) F
e) none

Example due to Ivanov and Novikov
Which model is correct?

Digital learning environment supports students’ learning through quizzes. Given your knowledge of this kind of systems which of the following models would be correct?

A

Provide Hint

Make a quiz

Report results

B

Provide Hint

Make a quiz

Report results

C

Provide Hint

Make a quiz

<<include>>

Report results

D

Provide Hint

Make a quiz

<<include>>

Report results

Which model is correct?

Digital learning environment supports students’ learning through quizzes. Given your knowledge of this kind of systems which of the following models would be correct?

A

B

C

D

Brief recapitulation

Including a use case in another use case

- User
- File owner
- Administrator
- Execute
- Create
- Change access rights
- Check access rights
Brief recapitulation

Including a use case in another use case

Use case description

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- **Main scenario**
- **Alternatives**
Use case diagrams as a specification technique?

Unambiguous?

Realistic?

Verifiable?

Evolvable?
Use case diagrams as a specification technique?

Unambiguous?
• formal rules how to compose use case diagrams, but ambiguity may be hidden in textual descriptions

Realistic?
• allows to model interaction with the external world but may be too simplistic to capture complex interactions

Verifiable?
• yes, through testing

Evolvable?
• if too many use cases are present the diagram becomes cluttered and less suited for evolution.
• Use case diagram – one of the UML diagram types

• Unified Modeling Language (UML) is a standardized (ISO/IEC 19501:2005), general-purpose modeling language in the field of software engineering.
  • includes graphic notation techniques to create visual models of object-oriented software-intensive systems.
  • started in 1990s
  • UML 1.1 – 1997
  • UML 2.0 – 2005
  • UML 2.4 – 2011
  • We are using UML 2.5 (in progress), September 2013
I do not expect you to learn UML specification by heart, but please consult it in case of doubt.
Reminder…

• Assignment “Requirements”
  • **Deadline**: February 12, 23:59
  • **Groups**:
    – software developers usually work in groups
    – learning to work together
  • **15%** of the grade of 2IW82

http://www.minibottlelibrary.com/mbl/alpha/jim-beam/fox-on-dolphin.jpg