Weaving
Multiple Viewpoint Specifications
in Goal Oriented
Requirements Analysis

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Outline

• Background and Purpose of this Research
• Techniques for weaving viewpoints.
  – Graph composition, and
  – Cross-Cutting Tables for weaving goal graphs.
  – Aspect Patterns for weaving elements in a use case model.
• Case Study
• Conclusions and Future Works.
What is Viewpoint?

• One viewpoint shows fragments of req. of a stakeholder.
• There are multiple viewpoints because of multiple stakeholders.
• Viewpoints should be integrated in a req. specification.
• Viewpoints are hard to be managed when they are written together.
• Examples of different viewpoints:
  – Functional view and Non-functional view.
  – Users’ view, developers’ view, maintainers’ view ....
Background

• Goal Oriented Requirements Analysis (GORA) and Use Case Modeling (UCM) are useful for requirements elicitation.

• Two Problems:
  1. No guideline to describe different viewpoints respectively.
  2. No support for collaboration among stakeholders.
Purpose of this Research

• An Integration of viewpoints approach into GORA and UCM
  – for overcoming last two problems.

• Techniques for weaving viewpoints:
  1. Weaving several Goal Graphs by the graph composition and Cross-Cutting Table.
  2. Weaving Non-Functional Req. (NFR) into a Use Case Model or a Use Case Description by Aspect patterns.
Req. Elicitation Process

**Goal-oriented Analysis**

Goal Graph for a viewpoint
- e.g. Functional Requirements

Customer, User
- Analyst

Use Case Models with NFR.

**Another Goal Graph** for another viewpoint
- e.g. Non-functional Requirements (NFR)

Weaving Goal graphs

Weaving Use Case Models

1st step  2nd step  3rd step  4th step
Weaving Goal Graphs

- Goal hierarchy is represented in simple AND-OR (directed acyclic) graphs.
- Relationship among goals can be written in logical formula.
- We can weave goals graphs in the same way as logical formulas.
Weaving Two Goal Graphs

Weave A2 and B
Distribute B1, 2 to A21, 22
Leaves => use cases
By use case level weaving, U_A21, U_B1 are integrated.
Goal Graph of FR: A viewpoint

PC Chairs’ Task

Having Many Participants

Reviewing Papers

Reducing PC Chairs’ Task

Having Many High Quality Papers

OR

Reviewing Papers By PC Committee

Reviewing Papers By PC Chairs

OR

Appointing PC members

Receiving Paper Submission

Distributing Papers to Reviewers

Receiving Review Reports

Deciding Acceptance Or Rejection

Notifying Acceptance or Rejection

Composing & Distributing a Program

Use case “Deciding Acceptance or rejection”
Non-Functional Goals: Another

Quality Characteristics

- Functionality
- Efficiency
- Reliability
  - Fault tolerance
  - Recoverability

- Accuracy
- Security
- Compliance
- Maturity

From ISO9126 standards or other taxonomies.
Mixture of FR and NFR in a Graph

This graph is too complex without multiple viewpoint. Multiple viewpoint prevent such complexity. However ... too many possibilities.
Cross-Cutting Table (Matrix)

• Represent explicit relationship between two different viewpoints, e.g. FR and NFR.

• Advantages
  – Do not have to examine all possibilities in weaving goal graphs.
  – Easy to find trade-offs between two viewpoints.

• Hierarchical representation is OK.
Example of Cross-Cutting Table

<table>
<thead>
<tr>
<th>FR</th>
<th>NFR</th>
<th>Security</th>
<th>Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appoint PC members</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiving Paper Submissions</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Distributing Papers to Reviewers</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Receiving Review Reports</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Deciding Acceptance or rejection</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Notifying Acceptance or Rejection</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Composing &amp; Distributing a Program</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1st level

<table>
<thead>
<tr>
<th>FR</th>
<th>NFR</th>
<th>Maturity</th>
<th>Fault-tolerantness</th>
<th>Recoverability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appoint PC members</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2nd level

13
Elements of Use Case Modeling

• Use Case Diagram with data and control dependencies.

  Use Case Map technique.

• Use Case Description represented by notations for behavior. e.g. scenario.
Aspect Patterns

• Templates for weaving several viewpoints in the level of use case modeling.

• Two types of patterns:
  – Transforming topology of a part of use case map so as to weave a specific viewpoint.
  – Transforming use case description so as to weave a specific viewpoint.
    • e.g. inserting specific activity in an original scenario
Example of use case map transformation

Aspect Pattern (Reliability)

Instantiation

PC chair
Deciding Acceptance or Rejection

Making a Proposal#2

PC Chair
Making a Proposal#1

PC Vice-Chair
Discussing Acceptance or Rejection

transform (weave with the aspect)

transform (weave with the aspect)
Example of UCD transformation

Aspect Pattern (Reliability)

Receiving [Something]
Objective, Actors, Activation Condition
Activity Flow
1. Receiving [Something] from [Sender].
2. Checking [Something].
Alternative or Exceptional Flow
2.5 Inform [Sender] if incomplete.

Receiving [Something]
Objective, Actors, Activation Condition
Activity Flow
1. Receiving [Something] from [Sender].
2. Checking [Something].
3. Sending a Confirmation to [Sender].
Alternative or Exceptional Flow
2.5 Inform [Sender] if incomplete.
A Case Study

• Purpose: to examine the advantages/disadvantages of our method.

• Problem: A simple system to support business persons.

• Four viewpoints and six cross-cutting tables.
  V1: Functional viewpoint
  V2: Comm. channel feature
  V3: Encryption
  V4: Peer Feature

• No aspect patterns were used.
Goal Graphs in each viewpoint

V1: Functional viewpoint
- Support Business Persons to make contracts
  - Exchange contract data
  - Collect public information
  - Report finished contract
  - Get next customers info.

V2: Channel Feature
- Communication Channel
  - Public data channel
  - Private data channel

V3: Encryption
- Encrypting Method
  - Using public key
  - Using private key

V4: Peer Feature
- Peer Feature
  - Specific Peer
  - Public Peer
# Cross-Cutting Tables

<table>
<thead>
<tr>
<th>V2</th>
<th>V1</th>
<th>Report</th>
<th>Get next</th>
<th>Collect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pub chan.</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pri. chan.</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V3</th>
<th>V2</th>
<th>Pub. key</th>
<th>Pri. key</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pub chan.</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pri. chan.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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<tr>
<th>V3</th>
<th>V1</th>
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<th>Get next</th>
<th>Collect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pub key</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pri. key</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V4</th>
<th>V2</th>
<th>Specific peer</th>
<th>Public peer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pub chan.</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Pri. chan.</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>V4</th>
<th>V1</th>
<th>Report</th>
<th>Get next</th>
<th>Collect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Weaved Graphs (two possibilities)

Support Business Persons to make contracts

AND

Collect public information

Public Peer

Public data channel

Exchange contract data

AND

Specific Peer

Private data channel

Get next customers info.

Report finished contract

Support Business Persons to make contracts

AND

Public data channel

Collect public information

Exchange contract data

AND

Specific Peer

Using private key

Public Peer

Get next customers info.

Report finished contract
Lesson Learned

• We could concentrate on each viewpoint respectively because we could weave them later.
• Viewpoints of NFR seem to be reusable because they do not depend on a problem.
  – Also, cross-cutting tables about NFR viewpoints seem to be reusable.
• We can systematically find alternatives of weaved goal graphs.
• CASE tool support must be required because it was hard to write and weave goals graphs manually.
Conclusion

• Propose a method to weave different viewpoints in goal oriented req. analysis and use case modeling.

• Basic techniques:
  – Goal composition
  – Cross-Cutting Tables
  – Aspect patterns

• We achieved a small case study to examine this method.
Future Works

• CASE tool support must be required especially in weaving goal graphs.
• Aspect patterns and its mining methods are required.
• Combination between our method (and its supporting tools) and collaboration tools such as groupware should be investigated.
  – Stakeholders can intrinsically collaborate with each other with our method,
  – but there is no explicit guideline now.