Software specification and architecture

Alexander Serebrenik
• Dr. Alexander Serebrenik
• MDSE/Software Engineering & Technology

• MF 7.143
• 040 247 3595

• a.serebrenik@tue.nl
• @aserebrenik
• http://www.win.tue.nl/~aserebre/
You

- **A. Bachelor** (mandatory):
  - Software Science,
  - Combination Software Science/Math
  - Combination Software Science/WebScience

- **B. Bachelor** (elective): any other major

- **C. Pre-master**: Information Security Technology

- **D. Master**: Embedded Systems (homologation only)

- **E. Any other program – please tell me!**
Week schedule

- **Quartile 3, block E**

<table>
<thead>
<tr>
<th>Tuesday</th>
<th>Thursday</th>
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<tbody>
<tr>
<td>13:45-15:30</td>
<td>8:45-10:30</td>
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<tr>
<td>Lecture</td>
<td>Group meetings</td>
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<tr>
<td>AUD 15</td>
<td>Lecture</td>
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<tr>
<td>MF 13,14,15</td>
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<td>MF 5.199</td>
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Instructors

Kees Huizing
MF 7.094
040 247 4120
c.huizing@
~keesh/
@mackees

Anton Wijs
MF 7.145
040 247 3991
a.j.wijs@
~awijs

Sarmen Keshishzadeh
MF 7.074
040 247 4139
s.keshishzadeh@

Ulyana Tikhonova
MF 7.092
040 247 5075
u.tikhonova@

Group supervision only
On-line


• Peach – 2IW80
  • [https://peach.win.tue.nl/](https://peach.win.tue.nl/)
  • If you are registered in OASE, within 1 hour you should be able to access Peach.
  • If you cannot login please contact me immediately!
Assessment

- **50% exam**: April 15, 9-12
  - Basic ideas, small exercises, reflection.
  - Preparation: during instructions

- **50% homework assignments**:  
  - A1 (50%): Given an informal system description
    - Create a req doc, review a doc of a diff team and revise yours
    - Create system specification, review and revise
    - Revised req (30%) + revised specification (70%)
  - A2 (50%): Create system architecture
    - Review architecture of a different team
    - Revise your own architecture
  - Peer-review based correction
Homework assignments

• Group assignments: 5-6 students per group
• Groups meet their supervisor on Thursday
  • 20 minutes per group
  • Ulyana will be absent during the first two weeks, I’ll replace her

• Book your time slots online:
  • http://goo.gl/ALO3d2

• Deadlines are strict
  • No late submissions will be accepted
Effort

- $5 \times 28 = 140$ hours
  - Weekly meetings:
    - Lectures $4h/week +$ instructions $2h/week +$ groups $0.33h/week$
    - $6.33 \text{ h/week} \times 7 \text{ weeks} = 44.33 \text{ hours}$
  - Final exam: 3 hours
  - Homework: 92.66 hour (including the exam preparation)
2IW80 as part of the Software Engineering

B.Sc.

2IP90 Programming

2IPC0 Programming methods

2IW80 Software specification & architecture

2IPD0 Software engineering

2IPE0 Software engineering project

M.Sc.

2IS15 Generic language technology

2IS55 Software evolution

2IS95 Seminar Software Engineering and Technology

2IF85 Program verification techniques

2IP45 Software project management
What happened to testing?

• This course used to be called **Software specification and testing**…

• Testing will be discussed during the **Software engineering** course

• Software specification & architecture: Software Science
• Software engineering: Software Science and Web Science
• There are **lots of books** on software specification and architecture
• You do not need to buy these books!
• You are welcome to consult them
Learning objectives

The student can describe existing or to be developed software systems by means of basic specification techniques.

Based on these specifications, the student can derive an architectural description for these software systems.
Where do we start?

Can anyone write me a program that reads and writes to a text file ...
au.answers.yahoo.com › ... › Programming & Design ▼
Aug 27, 2013 - What language? Do you simply want the program to copy the entire file to another file?

Who can write me a program that runs strcmp function without using ...
answers.yahoo.com › ... › Computers & Internet › Programming & Design ▼
Dec 1, 2007 - int _my__strcmp(char *str1, char *str2) { while(*str1 && *str2 && *str1++ == *str2++) return *str1 - *str2; }.
Please help me write c program that calculates GPA ... 1 answer 14 Nov 2010
Could someone write me a program that will make my ... 3 answers 10 Mar 2008
More results from answers.yahoo.com
Where do we start?

Google: "write me a program that"

Rent a coder.
Programming and design services.

Browse projects

Convert VB application to mobile application
I would like to have a mobile version created of a vb application, ideally, the mobile application would function multiple mobile device platforms, the initial target mobile device is iOS. The application can be found at www.hoopsnet.com and a trial version can be downloaded at www.hoopsnet.com/p [...] Categories: Other
Posted by hoopsnet on 10/15/2013

App or Website to mark floor plans
I am interested in a platform (apk or web based) that would allow for two to four users on different devices to interact with the same 2d floor plan, where the users could select one of the assigned numbered floor spaces, see who it is assigned to, and be able to change its color/status/leave a note [...] Categories: Cad, Java, Javascript, Other, Web design
Posted by docy9 on 10/15/2013

Kick Ass Developer Job
Join the revolution! We are looking for extraordinary developers, people who can make the difference, passionate about software development and driven to develop the perfect product for the end customer. Our developers want to be at the revolution. Eindhoven's software development team is on [...].
We always build software for somebody

Customer

Software engineer
Software specification: contract

- **Software specification:** contract between the *specifier* and the *implementor* defining the system to be constructed [Balzer, Goldman 1981].

- What does this imply? What is a good specification?
Software specification: contract

- **Software specification**: contract between the *specifier* and the *implementor* defining the system to be constructed [Balzer, Goldman 1981].

- What does this imply? What is a good specification?

  - Clear to both parties
  - Realistic
  - Conformance should be verifiable
  - Easy to modify
Altitude: 1500 m
Clear to both parties: April 15, 1999

Altitude: 1500 m

1500 feet (~457 meters)
Clear to both parties: April 15, 1999

8 dead, 37 injured, aircraft lost
How can one verify conformance?

- Depends on the specification mechanism…

- In general,
  - Testing – 2IPD0 Software engineering (and testing)
  - Formal analysis – 2IW26 System validation
  - Review
  - …

- However,
  - each approach has its limitations
  - frequently we cannot guarantee conformance even with thorough testing and formal analysis
Why should specifications be easy to modify?

Software usually represents the real world (or operates in it)

Real World → Model → Program

abstraction → change → reification

Study of how software changes, why, by whom and how can we make it easier: software evolution, 2IS55 (Master)
In this course...

- **We discuss** a number of specification techniques

- **Apply** them on small examples (*instructions*) and a larger case study (*homework assignments*)

- **Evaluate** the advantages/disadvantages of these specification techniques wrt
  - Ease of unambiguous specification
  - Realism
  - Ease of verification
  - Suitability for evolution
The next step

- We know *what* the customer wants
- but we still do not *know* how to achieve this…
The next step

- We know **what** the customer wants
- but we still do not **know** how to achieve this…

- *[ISO/IEC/IEEE 42010:2011]* **Software architecture** is the fundamental organization of a system embodied in
  - its **elements**,
  - **relationships**,
  - and in the principles of its **design** and **evolution**.
In this course...

• **We discuss**
  - different concerns pertaining to architecture, and
  - a number of architecture description techniques

• **Apply** them on small examples (*instructions*) and a larger case study (*homework assignments*)

• **Evaluate** the advantages/disadvantages of these techniques wrt the concerns identified
2IW80 Software specification and architecture

Requirements

Alexander Serebrenik
Requirements specification

• **Textual** description of system behavior
• **Basic** specification technique
• Most used in **practice**
What is requirement?

• requirement, functional

A statement of some function or feature that should be implemented in a system [Sommerville 2011].
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  **Functional (A) of non-functional (B) ?**
  The system sends an email to the customer when she places a new order.

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*Functional (A) of non-functional (B)?*

The mail should be send not later than 12 hours after the order has been placed.
What is requirement?

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non-functional
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Functional requirements frequently describe

- Inputs & outputs
- Computations
- Data for/from other systems
Non-functional requirements

• Non-functional requirement relates to quality attributes: e.g., performance, learnability, availability

• functional requirement: "when the user presses the green button the Options dialog appears”:
  - performance: how quickly the dialog appears;
  - availability: how often this function may fail, and how quickly it should be repaired;
  - learnability: how easy it is to learn this function.
Popular Quality Attributes (1)

- reliability
  - availability, fault tolerance, recoverability, ...

- performance
  - time, resource utilization

- operability
  - appropriateness recognizability, ease of use, use of interface aesthetics, technical accessibility, …
Popular Quality Attributes (2)

- security
  - confidentiality, integrity, authenticity, …

- compatibility
  - co-existence, interoperability

- maintainability
  - modularity, reusability, modifiability, testability, analyzability

- portability
  - adaptability, replaceability, installability
Non-functional requirements…

The system can connect to the scheduling system of the Human Resource department.

<table>
<thead>
<tr>
<th></th>
<th>reliability</th>
<th></th>
<th>compatibility</th>
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<tbody>
<tr>
<td>A</td>
<td></td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>performance</td>
<td>E</td>
<td>maintainability</td>
</tr>
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Non-functional requirements...

The system can connect to the scheduling system of the Human Resource department.

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**Answer: D (compatibility)**
The big question

How good are requirements as a specification technique?
How good are requirements as a specification technique?

Do you recall what we expect from a good specification mechanism?
How good are requirements as a specification technique?

Do you recall what we expect from a good specification mechanism?

- Ease of unambiguous specification
- Ease of verification
- Suitability for evolution
Ease of unambiguous specification


http://www.microdot.net/nlp/hypnotic-language/ambiguous-language.shtml
Ease of unambiguous specification

Solution: be **specific**, i.e., clear and unambiguous; without vagaries and platitudes
Tips and tricks for being specific

• Avoid
  • obviously, clearly, certainly, …
  • some, several, many, …
  • etc, and so on, such as, …

• Clarify anaphora
  • When module A calls B its message history file is updated
• Speed of the simulation flight should exceed 300,000 km/s

• What do you think?
  a) good
  b) bad
Realistic

• Speed of the simulation flight should exceed 300,000 km/s

• What do you think?
  a) good
  b) bad

• Check:
  • Specific?
  • Good for evolution?
Realistic

- Speed of the simulation flight should exceed 300,000 km/s
- What do you think?
  a) good
  b) bad
- Check:
  • Specific?
  • Good for evolution?
    - No, requires reconsideration every time
• Speed of the simulation flight should exceed 300,000 km/s

• What do you think?
  a) good
  b) bad

• Check:
  • Specific?
  • Good for evolution?
    – No, requires reconsideration every time
    – Solution: be **attainable**
Tips & tricks for attainability

• Is there a **theoretical solution** to the problem?

• Has it been **done before**?
  • If not, why not?
  • Has a feasibility study been done?

• Are there **physical constraints** on the size of the memory, processor or peripherals?

• Are there **environmental constraints** such as temperature, compressed air?
Not everything attainable can be built...

- **Limited** resources, time, budget, …

- Solution: check whether requirements are **realizable**

- Tips & tricks: prioritize requirements
  - **Must** satisfy
  - **Should** satisfy
  - **Could** satisfy
  - **Would** not satisfy [in this release]
  - **MoSCoW**
Ease of verification

OASE should be as clear as possible.

(Student elections campaign Dec. 2013)

a) good
b) bad
Ease of verification

OASE should be as clear as possible.

(Student elections campaign Dec. 2013)

• How do we know whether OASE is clear enough?
Ease of verification

**OASE should be as clear as possible.**

(Student elections campaign Dec. 2013)

- How do we know whether OASE is clear enough?

- Solution: be **measurable**.
What happens if business needs change?
• What happens if business needs **change**?

• We need to know how individual business need **impacts** requirements, architecture, implementation and tests
Suitability for evolution

- What happens if requirements change?
- We need to know how individual business need impacts requirements, architecture, implementation and tests
- Solution: traceability links
Traceability matrix

- Means of expressing traceability information

<table>
<thead>
<tr>
<th>User req.</th>
<th>SW req.</th>
<th>Design Elem.</th>
<th>Func</th>
<th>Test Case</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC-28</td>
<td>SR-28, SR-15</td>
<td>Class catalog</td>
<td>sort</td>
<td>7, 8</td>
</tr>
<tr>
<td>UC-29</td>
<td>SR-44</td>
<td>Class catalog</td>
<td>import check</td>
<td>12, 13</td>
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Two popular techniques

What are their advantages and disadvantages?

<table>
<thead>
<tr>
<th>User req.</th>
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<tr>
<td></td>
<td>UC-1</td>
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<tr>
<td>UR-1</td>
<td>*</td>
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<tr>
<td>UR-2</td>
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To be useful as a specification technique, requirements should be

- **Specific**
- **Measurable**
- **Attainable**
- **Realisable**
- **Traceable**

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  A statement of some function or feature that should be implemented in a system [Sommerville 2011].

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Functional of non-functional? (1)
The system sends an email to the customer when she places a new order.

Requirements used as a specification technique

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

Week schedule

- Quartile 3, block E

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We always build software for somebody

Customer

Software engineer

Clear to both parties
Verifiable conformance
Realistic
Easy to modify

Verifiable conformance
Easy to modify
Assignment

• Read the “Foxes and Dolphins” description

• Think about omissions and vagueness

• Distill requirements based on the omissions

http://www.minibottlelibrary.com/mbl/alpha/jim-beam/fox-on-dolphin.jpg
Exercise 1: Functional or Non-functional

a) The system shall be able to process at least 40 executing jobs at a time.

b) The system shall provide the means for the resource provider to see on which project his resource is working.

c) The system shall provide the means for the system admin to perform his actions on a computer with Windows XP, Mac OS X or Linux.

d) If one of the resource disappears while it was performing a job, the system should requeue the job.

e) The (de-)installation of the software needed by resource providers should not require a computer expert.
Exercise 1: Functional or Non-functional

a) The system shall be able to process at least 40 executing jobs at a time. **non-functional, performance**
b) The system shall provide the means for the resource provider to see on which project his resource is working. **functional**
c) The system shall provide the means for the system admin to perform his actions on a computer with Windows XP, Mac OS X or Linux. **non-functional, portability**
d) If one of the resource disappears while it was performing a job, the system should requeue the job. **function**
e) The (de-)installation of the software needed by resource providers should be **non-functional, installability**
Exercise 2: SMART or not? Why?

a) The information which is stored on the database can be accessed by any standard computer on the CERN network.

b) In order to obtain a CERN car sticker the person must have a valid CERN ID.

c) The opening of the software shall take less than 3-4 seconds under normal working conditions.

d) The user shall have access to French – English dictionary (this is outside the scope of the application). The user shall ask questions or propose suggestions for words translations by mailing to the administrators.

e) The software will be available 24hrs 365d/year.
Exercise 2: SMART or not? Why?

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Reminder

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• Instructions in MF…
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  • MF14 – Kees Huizing
  • MF15 – Sarmen Keshishzadeh