From Requirements to Architecture:

Linguistics-based Specifications for the Software Startup

Sjaak Brinkkemper

with assistance from Garm Lucassen, Fabiano Dalpiaz, Jan Martijn van der Werf, Slinger Jansen, and Sean Martens

ICT-Entrepreneurship

Session 5

24 February 2020

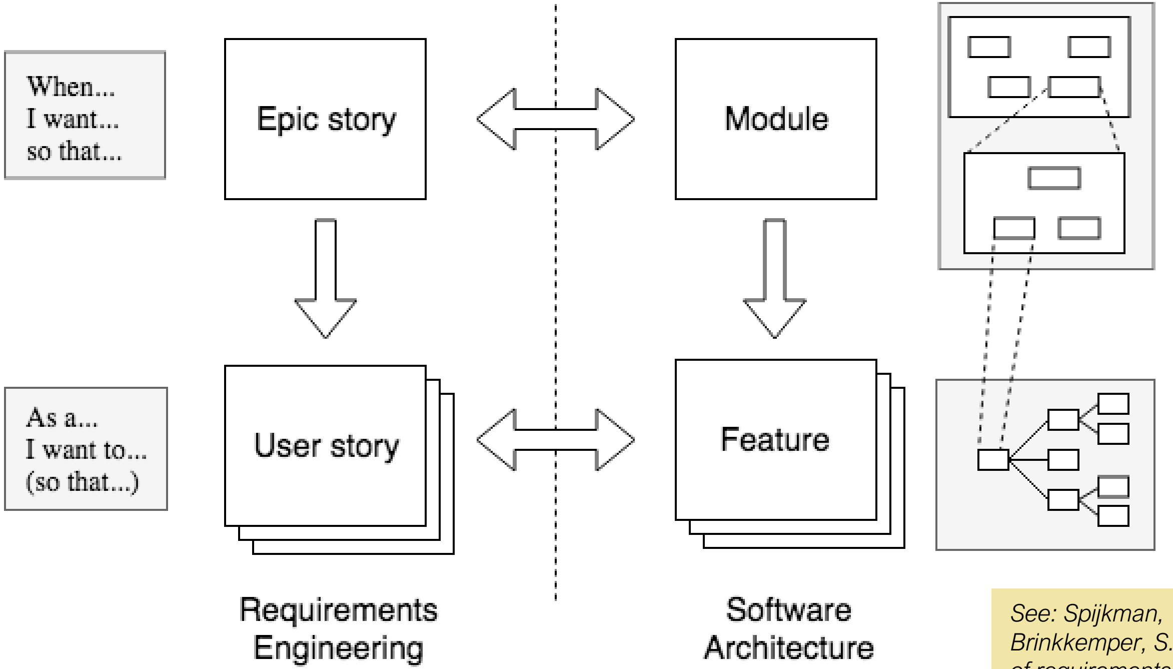
Universiteit Utrecht

[Faculty of Science
Information and Computing Sciences]

Program of this Workshop

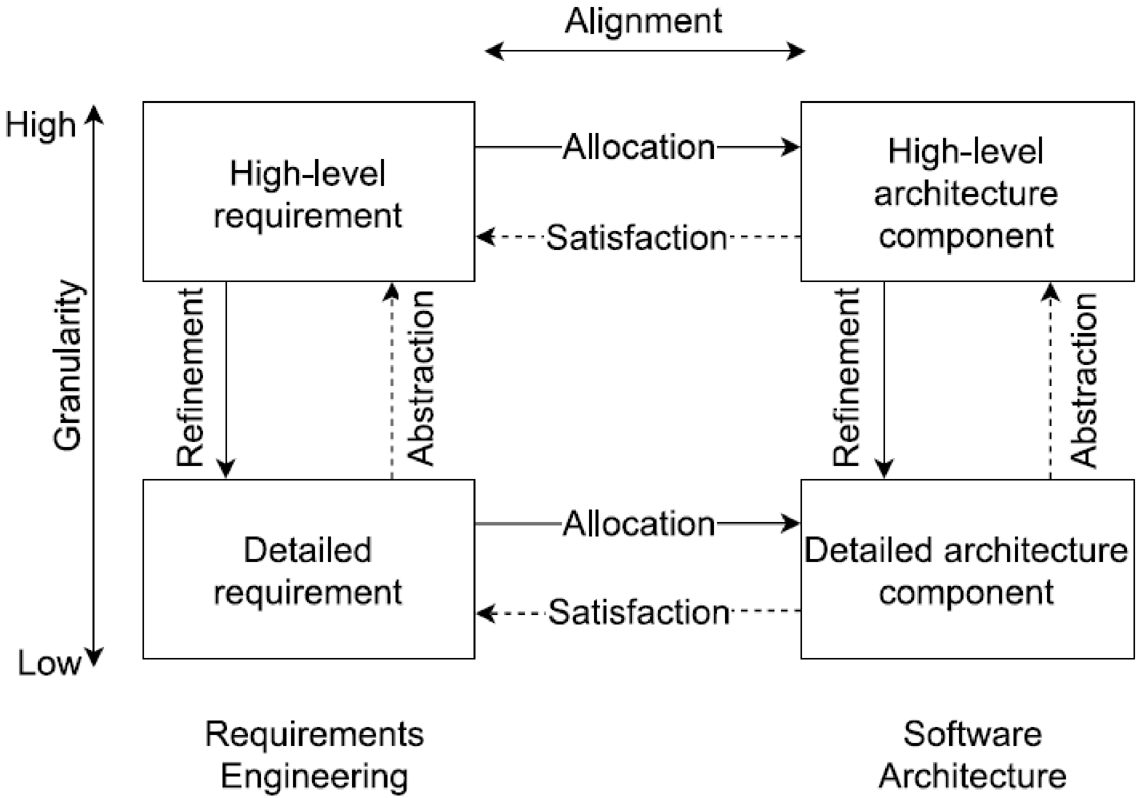
- Rationale
- Overview of the approach
  - W1 - Brainstorm
  - W2 - Jobs
  - W3 - Epic Stories
  - W4 - User Stories
  - W5 - Modules
  - W6 - Features
  - W7 – Reflection
- Discussion

RE4SA-agile: bridging requirements and architecture



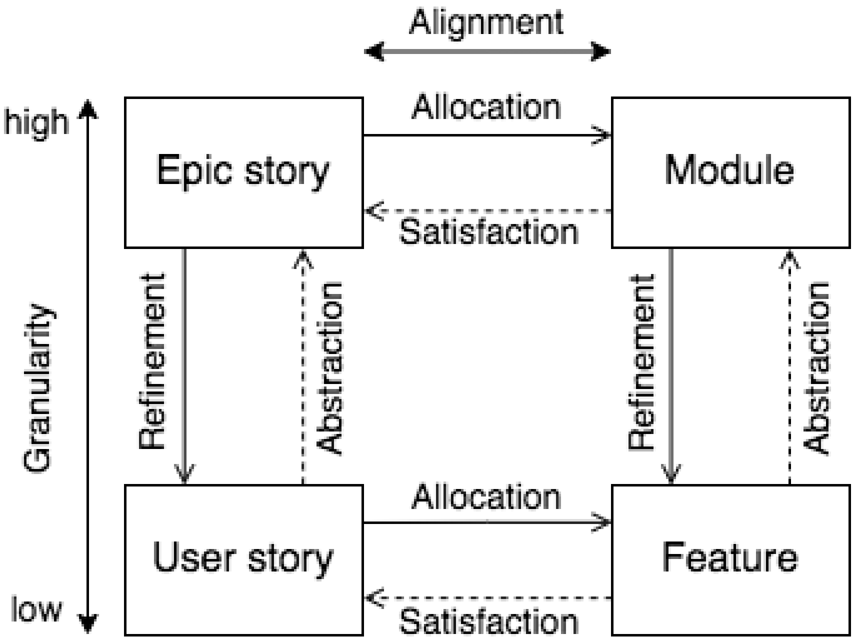
See: Spijkman, T., Molenaar, S., Dalpiaz, F., & Brinkkemper, S. (2021). *Alignment and granularity of requirements and architecture in agile development: A functional perspective.* ***Information and Software Technology***, *106535.*

RE4SA generic model



Apply your own preferred notations

RE4SA: alignment and *granularity*



Granularity: the extent to which a system is composed of distinguishable pieces.

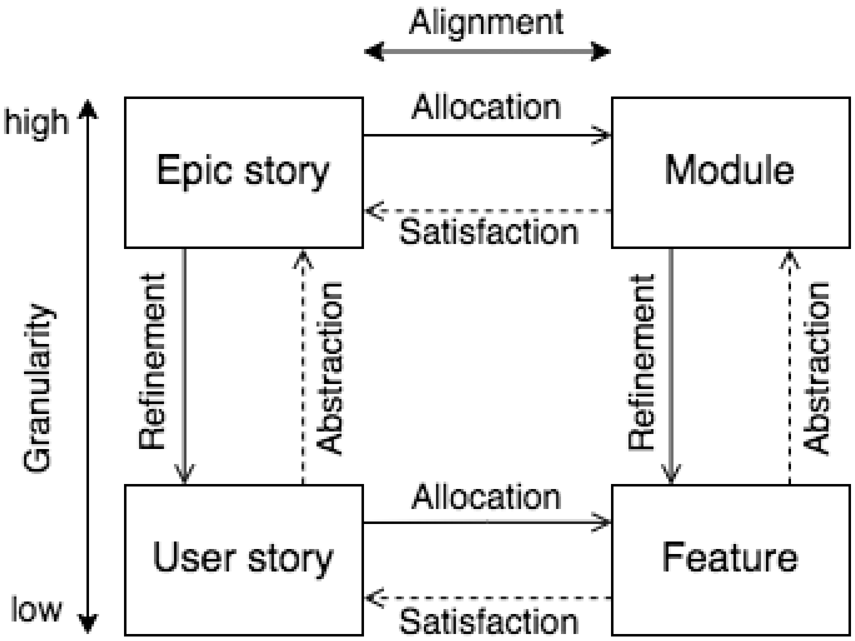
Granularity can be **expressed in levels** of decomposition.

It can either refer to the extent to which a larger entity is ***subdivided***, or the extent to which groups of smaller indistinguishable entities have ***joined together*** to become larger distinguishable entities

Refinement: High-level requirements and architecture components are decomposed into detailed requirements and architecture components, respectively

Abstraction: Detailed requirements are grouped using high-level requirements, while detailed architecture components are bundled together based on similar functionality and placed in high-level architecture

RE4SA: *alignment* and granularity



Allocation: Relating requirements to architectural components is the assignment to architecture components responsible for satisfying the requirements

Satisfaction: Analyzing and elaborating the requirements demands that the architecture/design components that will be responsible for satisfying the requirements be identified

Alignment between requirements and architecture is a state in which the requirements specification is in harmony with the architectural specification and both describe the same application.

Perfect alignment between requirements and functional architecture is a state in which **all** the system requirements are satisfied by a component in the architecture, and **all** components in the architecture can be linked to the requirements.

Customer wish

Job to be done

A Job to be done is the process a consumer goes through whenever aiming to transform the existing life-situation into a preferred one, but cannot because there are constraints. (Klement, 2016)

Template:
Help me <verb> <noun phrase>

Google-maps:
- Help me plan a route to my destination.
- Help me find a location
- Help me find an object in the environment

A Job-to-be-done motivates a customer to invest in the acquisition of a product.

This implies that the precise formulation of a job is essential in the definition of a product.

Software product

Example: Maps

N230
Overvecht-Noord
OVERVECHT
Groenekan
A27
Zuilen
Blauwkapel
De Bilt
ering
Tuinwijk
RIJN
and
N237
A27
N412
A28
Utrecht Central Station
20 min
7,9 km
Uithof
dsdam
A2
Kanaleneiland
PAPENDORP
A12
Hoograven
LUNETTEN
N411
Vechten
A12
A12
A27
N408
Wayen
N409
Zuilenstein
Oud-Wulven
N42

Requirements engineering

Epic story

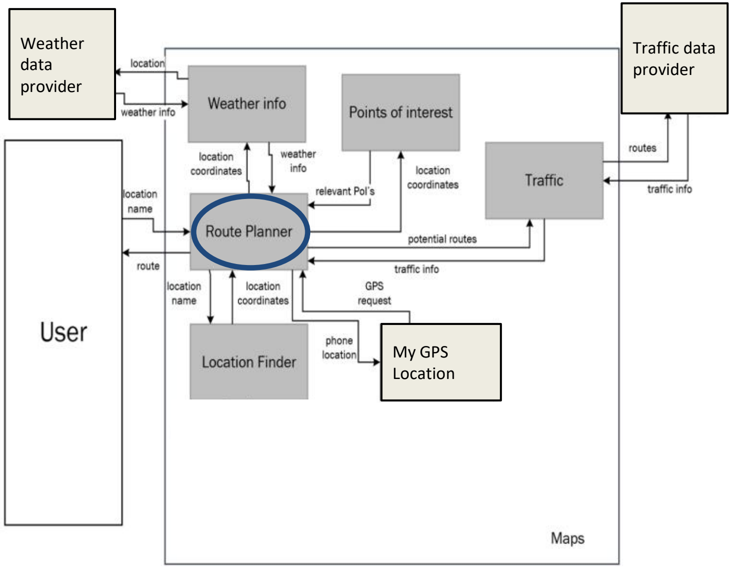
Epic stories emphasize the *motivational and situational* context that drives customer behaviour. (Klement, 2013)

Template:
When <situation>,
I want <motivation>,
so that <expected outcome>

"When I have to go to a place I don't know,
I want to have a route planned for me,
so that I can plan my trip and find the location."

Software architecture

Module



Functional Architecture Diagram

Requirements engineering

User story

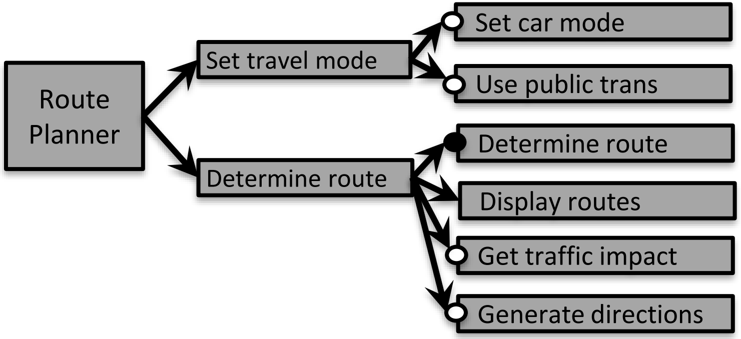
User stories represent customer requirements in a card, leading to conversation and confirmation (Jeffries, 2001)

Template:
As a <role>,
I want <goal>,
so that <benefit>

"As a consultant,
I want to see the fastest route to my destination,
so that I can minimize my travel time when visiting customers"

Software architecture

Feature



Feature Diagram

Requirements engineering

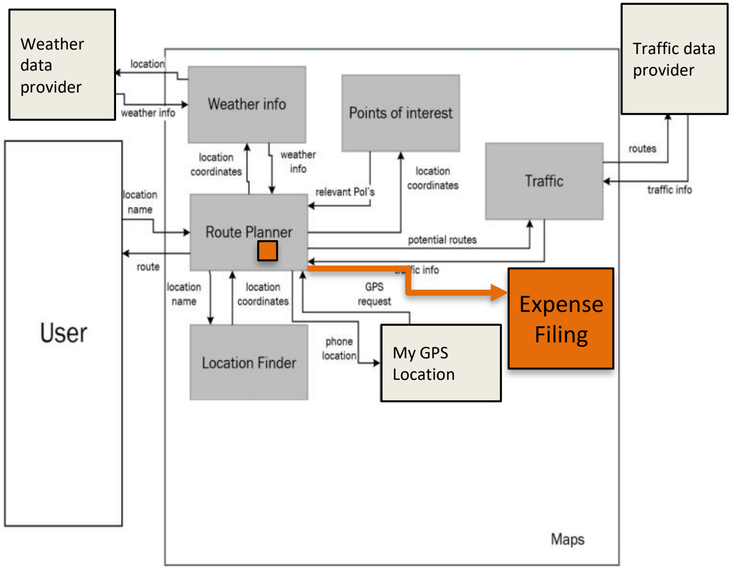
Epic story

Product extension with a new Epic Story:

“When I have to file for expenses to my employer,
I want to have all my routes and local expenses registered,
so that I can collect my expense data and minimize effort for filing.”

Software architecture

Module



Functional Architecture Diagram

Requirements engineering

Software architecture

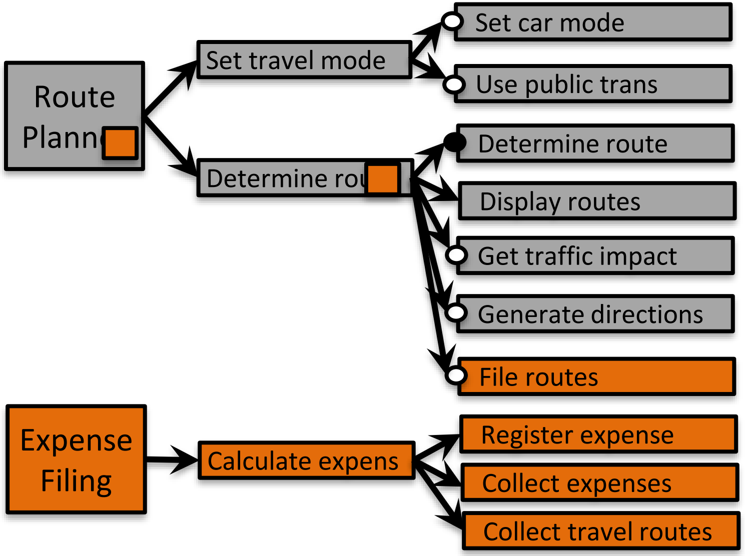
User story ↔ Feature

User stories represent customer requirements in a card, leading to conversation and confirmation (Jeffries, 2001)

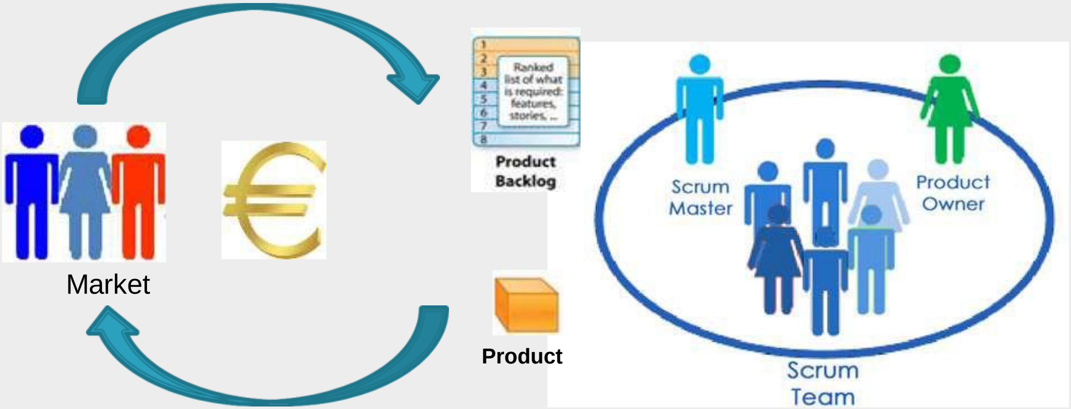
New User story

"As a consultant,
I want to file my travel expenses,
so that I have complete expense and travel data with minimal effort."

Feature Diagram



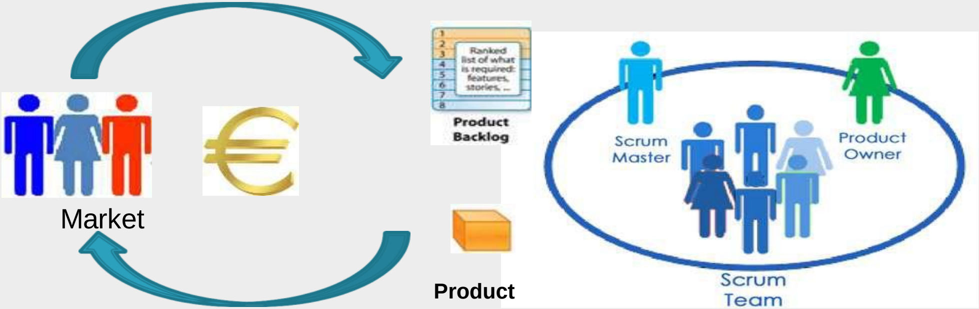
Agile perspective of software production



Market

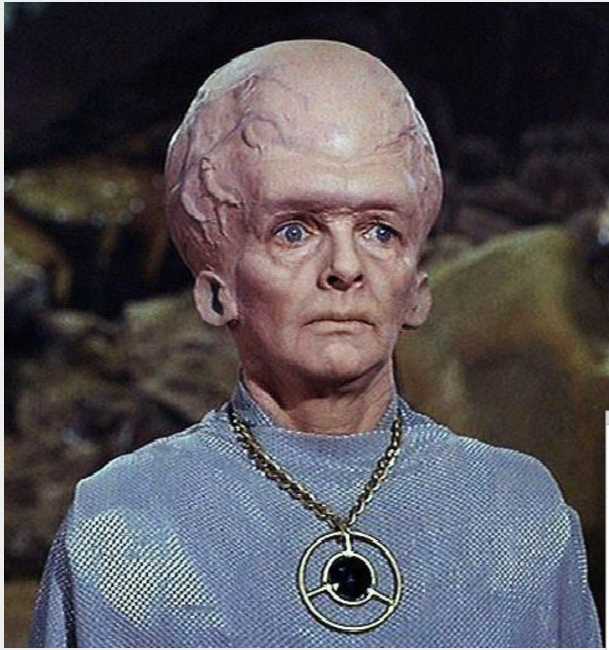
Product

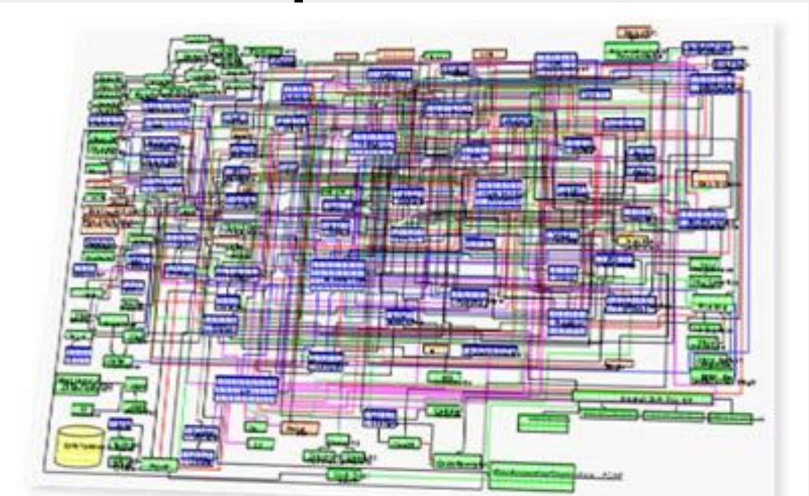
Continuous Delivery overview

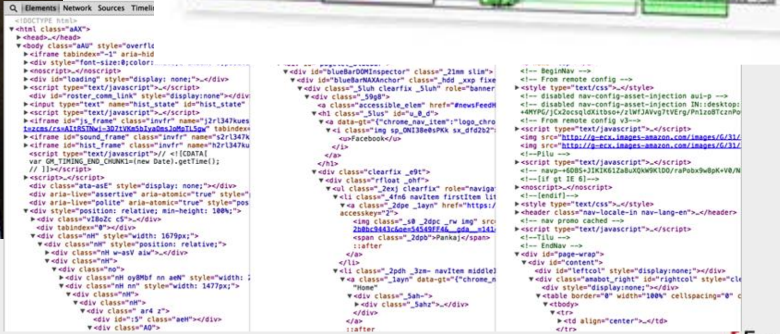


Continuous Tracking → Continuous Planning → Continuous Integration → Continuous Testing → Continuous Deployment

Key role: Software developers







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    ▶<noscript>…</noscript>
    ▶<div id="loading" style="display: none;">…</div>
    ▶<script type="text/javascript">…</script>
     <div id="roster_comm_link" style="display:none"></div
    ▶<input type="text" name="hist_state" id="hist_state"
    ▶<script type="text/javascript">…</script>
    ▶<iframe id="js_frame" class="invfr" name="j2rl347kues
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    ▶<iframe id="hist_frame" class="invfr" name="h2rl347ku
     <script type="text/javascript">// <![CDATA[
     var GM_TIMING_END_CHUNK1=(new Date).getTime();
     // ]]></script>
    ▶<script>…</script>
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     <div aria-live="assertive" aria-atomic="true" style="
     <div aria-live="polite" aria-atomic="true" style="pos
    ▼<div style="position: relative; min-height: 100%;">
      ▶<div class="vI8oZc cS">…</div>
       <div tabindex="0"></div>
      ▼<div class="nH" style="width: 1679px;">
        ▼<div class="nH" style="position: relative;">
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              ▼<div class="nH nn" style="width: 1477px;">
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               <u>Facebook</u>
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           </a>
         </h1>
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            ▼<ul class="_2exj clearfix" role="naviga
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                   "Home"
                  ▼<div class="_5ah-">
                    ▶<div class="_5ahz">…</div>
                   </div>
                 </a>
                 ::after
```

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 <!-- BeginNav -->
 <!-- From remote config -->
▶<style type="text/css">…</style>
 <!-- disabled nav-config-asset-injection aui-p -->
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 +4MYPG/jCx2ocsqldXitbso+/zlWfJAVvg7tVErg/Pn1zoBTcznPo
 <!-- From remote config v3-->
▶<script type="text/javascript">…</script>
 <img src="http://g-ecx.images-amazon.com/images/G/31/
 <img src="http://g-ecx.images-amazon.com/images/G/31/
 <!--Pilu -->
▶<script type="text/javascript">…</script>
 <!-- navp-+6DBS+JIKIK61Za8uXQkW9KlDO/raPobx9w8pK+V0/N
 <!--[if gt IE 6]-->
▶<noscript>…</noscript>
 <!--[endif]-->
▶<style type="text/css">…</style>
▶<header class="nav-locale-in nav-lang-en">…</header>
 <!-- nav promo cached -->
▶<script type="text/javascript">…</script>
 <!--Tilu -->
 <!-- EndNav -->
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  ▼<div id="content">
     <div id="leftcol" style="display:none;"></div>
    ▼<div class="amabot_right" id="rightcol" style="cle
       <div style="display:none;"></div>
      ▼<table border="0" width="100%" cellspacing="0" c
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          ▼<tr>
            ▶<td align="center">…</td>
           </tr>
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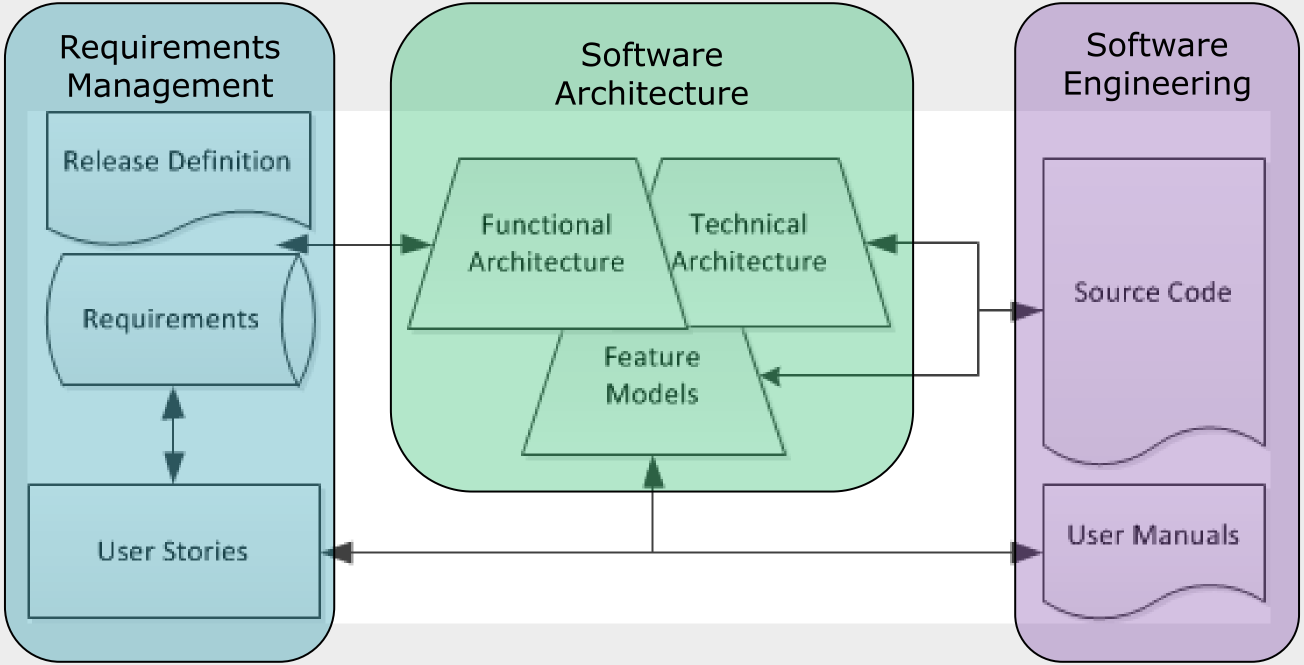
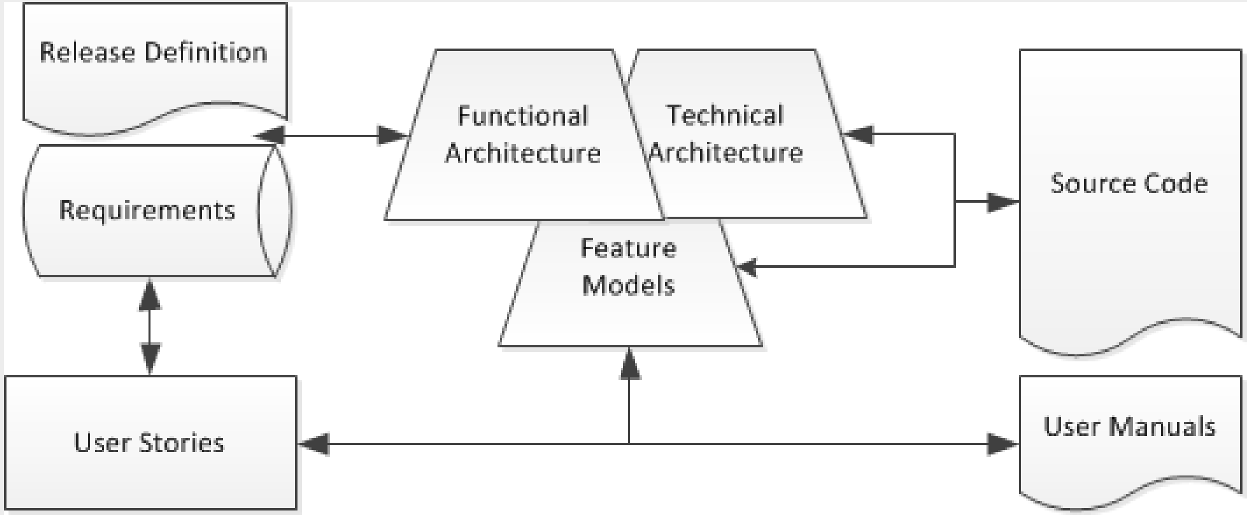
Information and Computing Sciences]

Will software developers need Talosian brains?

Development Domains



Artefact Integration using NLP



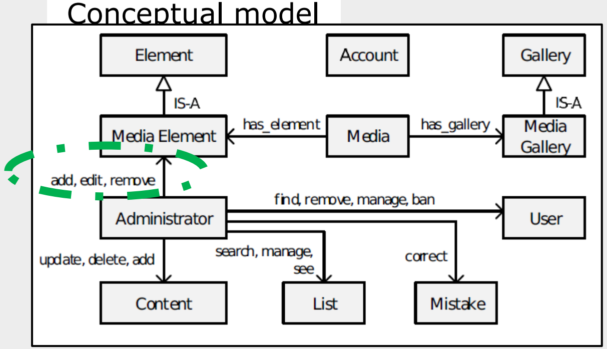
Artefacts and Domain Knowledge

User story:

```
As a Media User
I want to edit earlier uploaded video's
So that my video contents stay up-to-date
```

Backlog item:
Sp-2-32: Cutting video segments
Sp-3-21: Inserting video segments
Sp-3-22: Publish new video after edit

Conceptual model



```
@feature(VideoEditing)
Public class VideoEditor {
    // Sp-3-21 & 22 ...
   void CutSegment(String _videoTitle, ....)
   void Publish(String _videoTitle)
. . . .
}
```

BDD: Gherkin template

Given I have finished editing
When I publish the updated video
Then the updated video appears in my video list

Feature Description

```
The system supports
editing of video
contents uploaded
earlier with …
```

User manual

…..

6. **Publishing** When you have finished editing the video segment, click on the Publish button and the video will appear in your listing of video's
7. ….

Conceptual models

Feature tracing

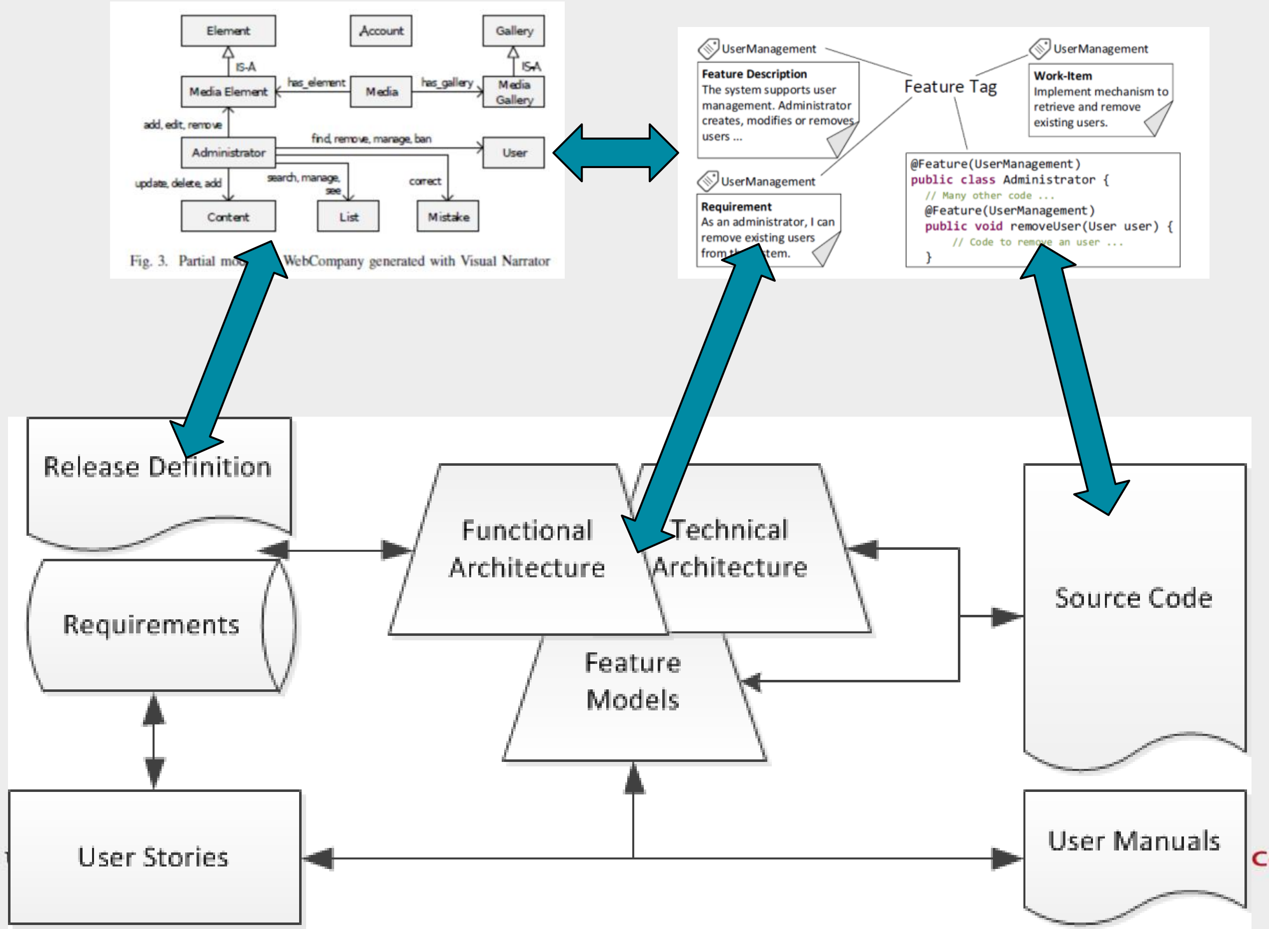


Fig. 3. Partial mo WebCompany generated with Visual Narrator

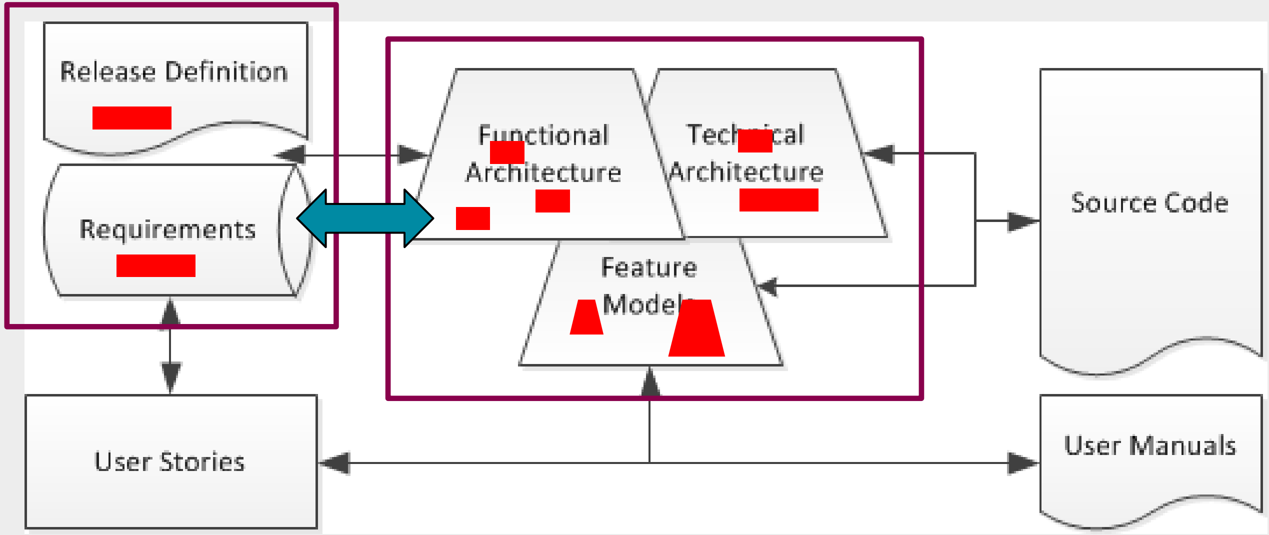
Feature Description
The system supports user management. Administrator creates, modifies or removes users ...

Work-Item
Implement mechanism to retrieve and remove existing users.

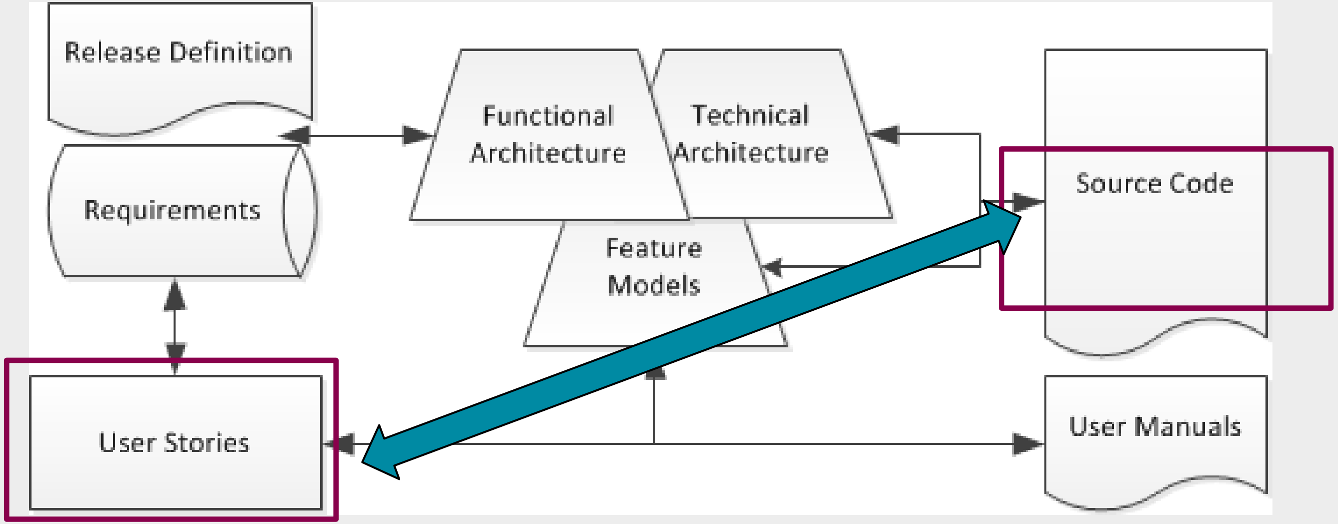
Requirement
As an administrator, I can remove existing users from th tem.

```
@Feature(UserManagement)
public class Administrator {
  // Many other code ...
  @Feature(UserManagement)
  public void removeUser(User user) {
    // Code to remove an user ...
  }
```

Impact forecasting



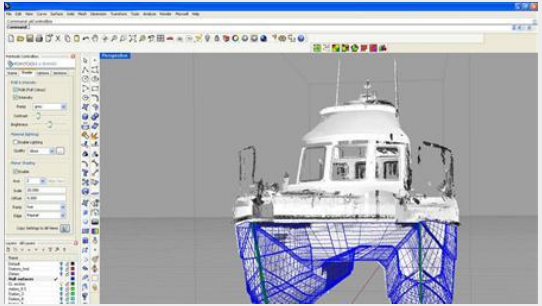
User Story to Acceptance Tests



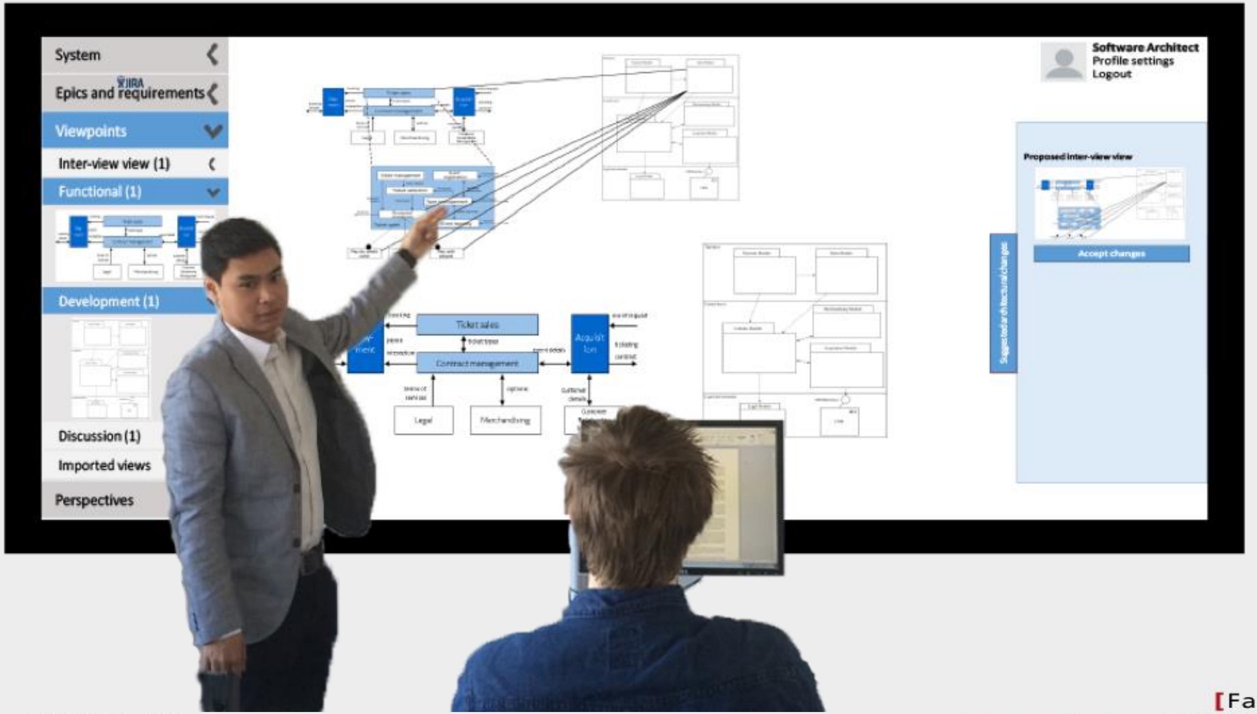
Architecting: find the 7 differences

Observations in architecting

- Traditional architecting disciplines have extensive documentation routines and practices
- Architecture documentation is created during design and modified during redesign
- When contemplating (re)design issues the architecture documentation is the central means for communication

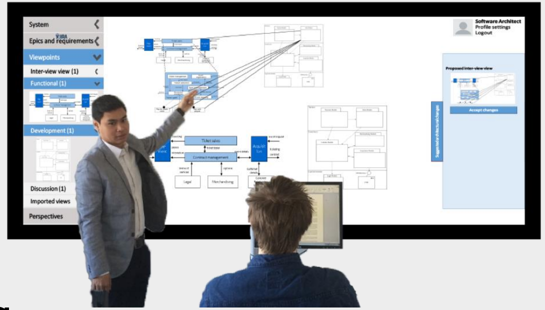


Software Architecture Video Wall



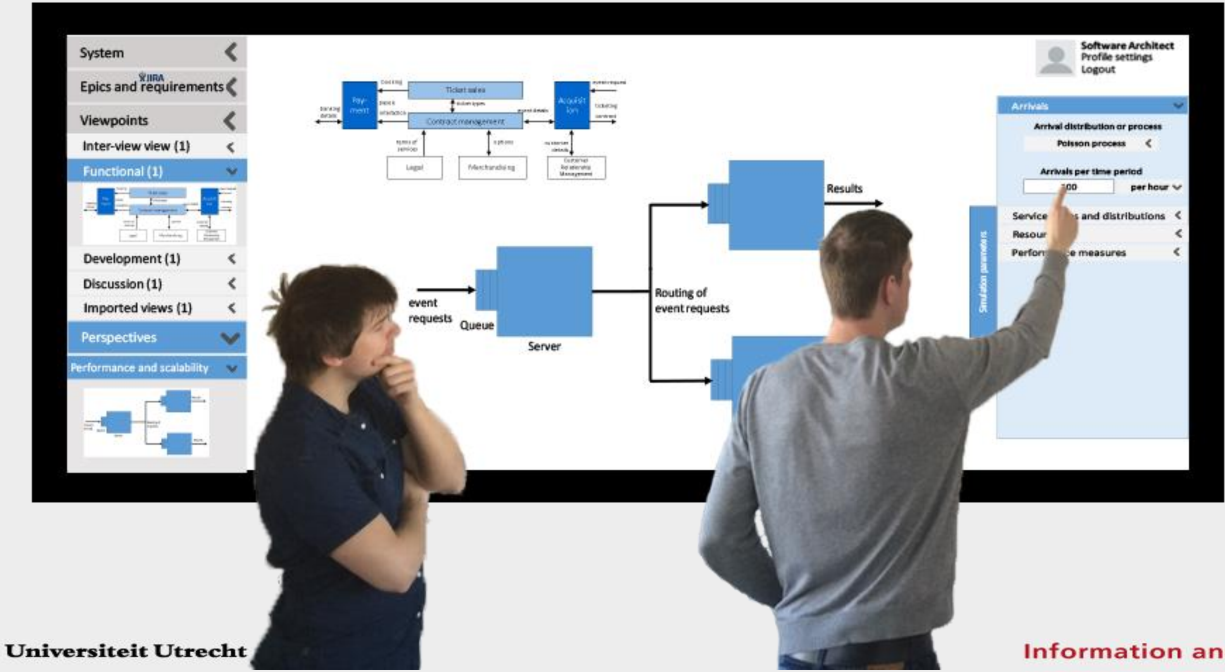
Video wall to capture design session

- Record:
  - Screenplay
  - Audio track per participant



- Text and argumentation mining
  - Extract key elements in discussion
  - Together with the screen shown at that time

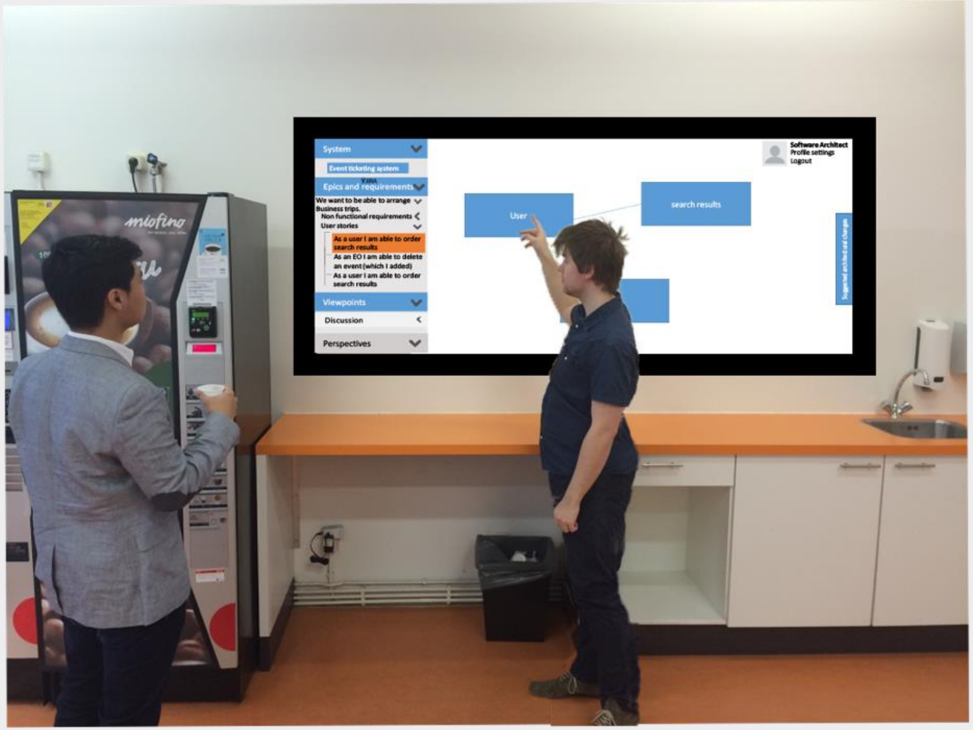
Behavior simulation



Hallway discussions

System
Event ticketing system
Epics and requirements
We want to be able to arrange Business trips.
Non functional requirements
User stories
As a user I am able to order search results
As an EO I am able to delete an event (which I added)
As a user I am able to order search results
Viewpoints
Discussion
Perspectives
User
search results

Informal options discussion at the Coffee corner



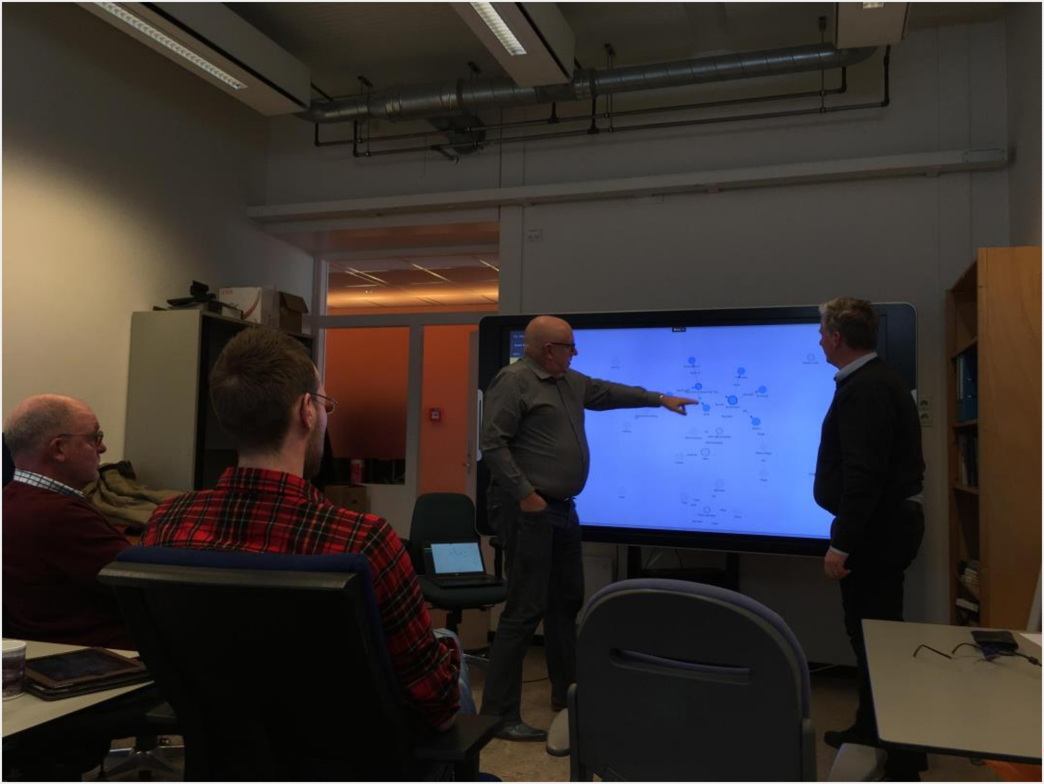
We want to be able to arrange Business trips.

As a user I am able to order search results

As an EO I am able to delete an event(which I added)

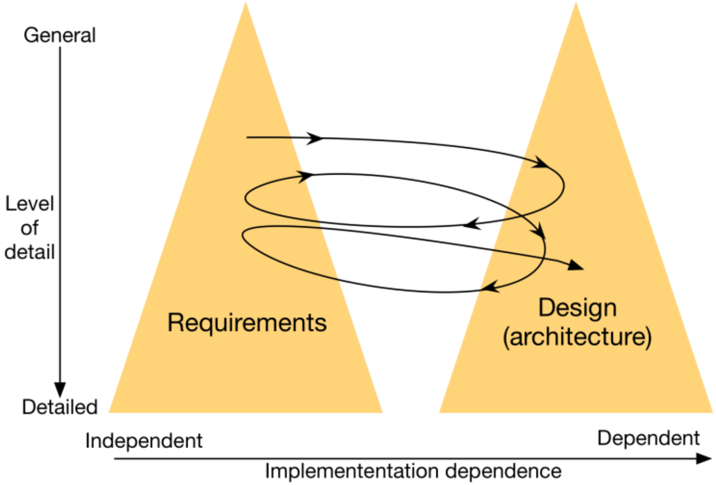
As a user I am able to order search results

Team discussions



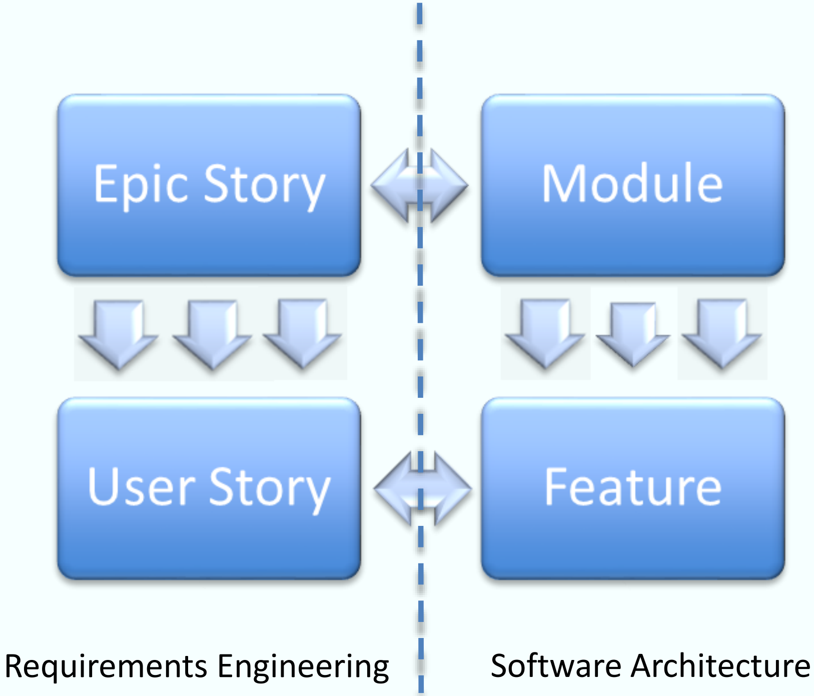
RE and SA processes

- SPM is closely linked to requirements engineering (Ebert, 2007)
- SA demands good requirements engineering

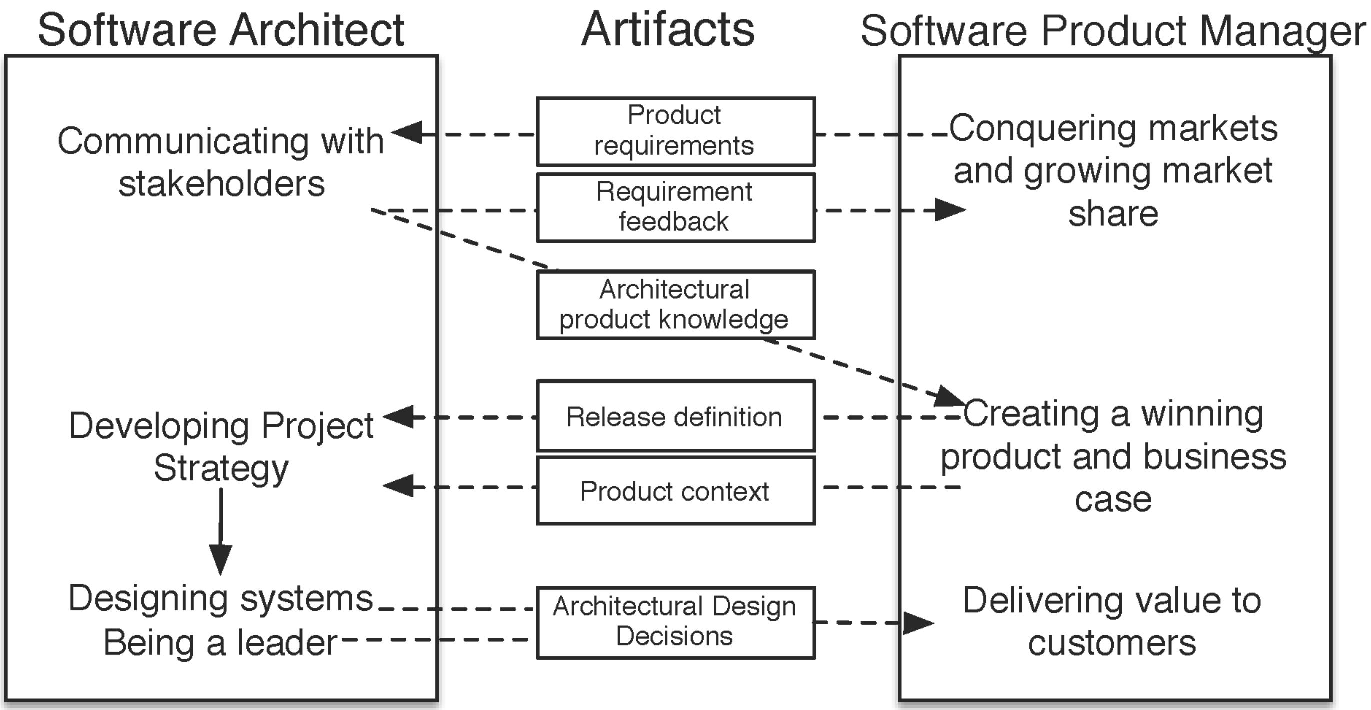


Twin Peaks of Requirements and Architecture (Nuseibeh, 2001)

The RE4SA model



Reciprocal Contributions Model


Software Architect
Artifacts
Software Product Manager
Communicating with stakeholders
Developing Project Strategy
Designing systems
Being a leader
Product requirements
Requirement feedback
Architectural product knowledge
Release definition
Product context
Architectural Design Decisions
Conquering markets and growing market share
Creating a winning product and business case
Delivering value to customers

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Brainstorming on your product

You and your team have zillions of ideas?!

- *Functional on the market and customers.*
- *Technical on the software technologies you master, or which you would like to use.*
- *Organizational on the start-up you would like to start.*

W1 – Brainstorm (15 mins.)

Exercise: Just write down any idea you have on the specifications of the product:

- *Requirements and Functional domains*
- *Different roles*
- *Features*
- *Technology*
- *User stories*
- *Etc, etc.*

Only functional and technical ideas, please. Others follow in other lectures.

Create a google slide set you share with SjaakBrinkkemper@gmail.com

Note, that you can write concurrently with your team!

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What are Jobs-to-be-Done?

- Dr. Clayton Christensen: Disruptive Innovation Theory

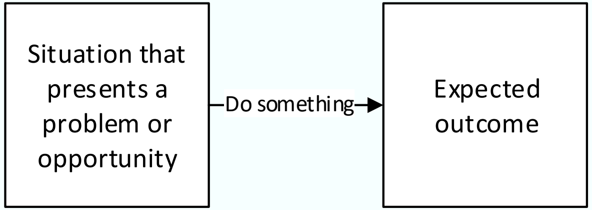
  "When people find themselves needing to get a job done, they essentially hire products to do that job for them"

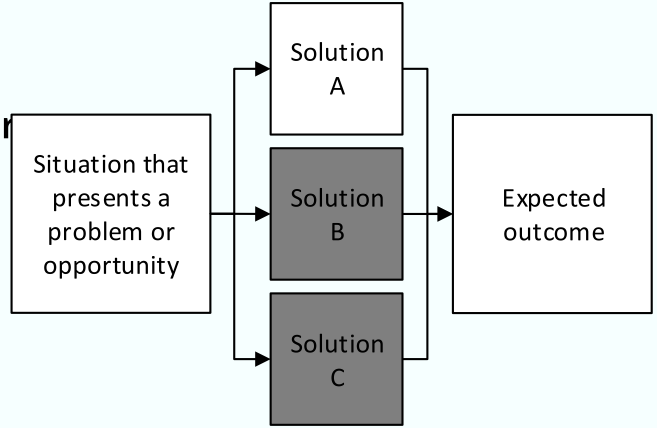
- Jobs-to-be-Done is a collection of principles that helps to discover and understand interactions between ***customers***, their ***motivations*** and the ***products*** they use. (2016)

Job is shorthand for Job-to-be-Done

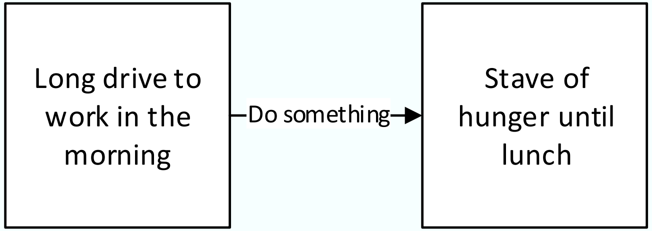
Template: *"Help me <verb> <noun phrase>."*

Example: *"Help me organize events"*





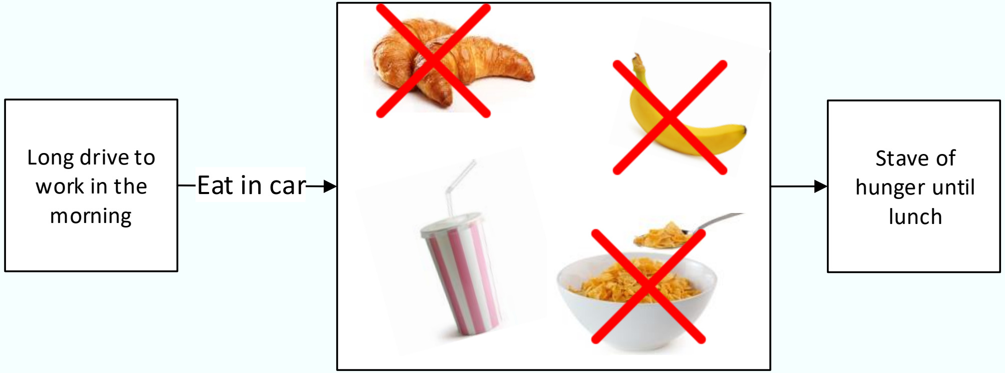
The ‘Job’ of an early morning milkshake



Long drive to work in the morning

Do something

Stave of hunger until lunch



Long drive to work in the morning

Eat in car

Stave of hunger until lunch

Job: Help me stave of hunger until lunch.

Jobs – Event ticketing case

Job-1: Help me organize a multi-podium event with an attractive line-up of artists.

Job-2: Help me arrange secure payments for the visitors of my event

Job-3: Help me organize a variety of event types

Job-4: Help me build a community of visitors of my events

Open research question: Should we distinguish primary jobs and secondary jobs?

Primary Job: Help me organize a variety of event types

Secondary Job: Help me build a community of visitors of my events

The secondary job is part of the primary job.

W2 - Jobs

Exercise: Identify and write some Jobs for your product idea.

We expect 3 to 5 per product.

You can make a sequential order for the jobs of the first release (Minimal viable product) and the later releases.

Use the template.

Job-1: Help me organize a multi-podium event with an attractive line-up of artists.

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Epic Stories

2013: Alan Klement introduced the template for Epic Stories as an alternative or replacement to User Stories.

- *When [situation], I want (to) [motivation], so that (I can) [expected outcome]*
- Emphasize the motivational and situational context that drives customer behavior.

"When I am configuring a radiator and I am trying to produce a specific amount of heating power,

I want to quickly determine what configuration of radiators will produce the required heat, so that I won't

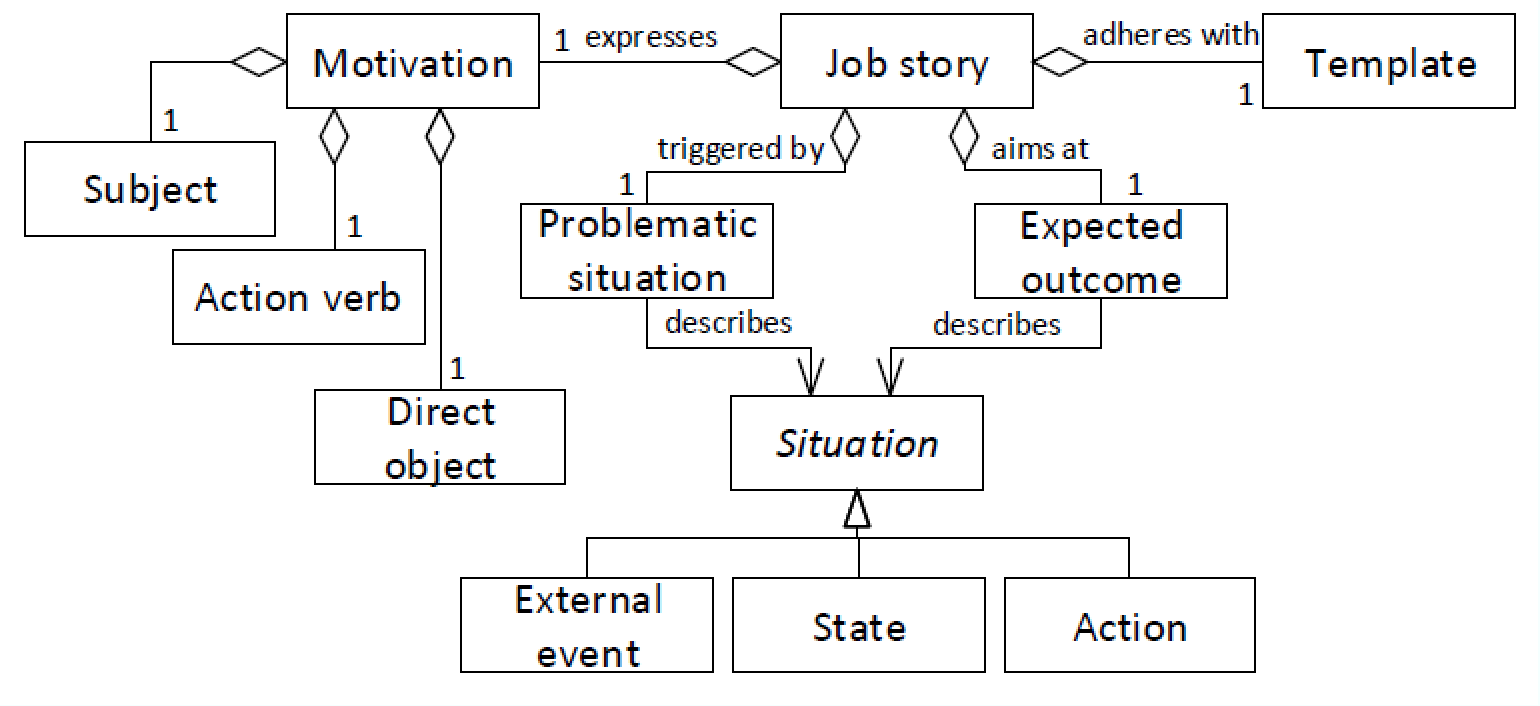
have to waste time looking for the optimal configuration."

Klement introduced the template as Job Story, however due to the existing notion of epics in Scrum development, we renamed it into Epic Story.

Conceptualization of Epic Stories

- Small community of practice in Epic Stories
- Klement template: When … I want to … so that … .
- Research project of UU at Stabiplan (Maxim van der Keuken)
- Identified 131 Epic Stories in public domain; 113 according to template
- Created Conceptual Model of Epic Stories
- When <problematic situation> I want to <motivation> so that <expected outcome>
- Problematic situations & Expected outcome are either:
    - Action, State, or External Events
- Varying statistics on the 113 JSs. (topic for further research)

Conceptual model of Epic Stories



Epic Stories – Event ticketing case

Job-1: Help me organize a multi-podium event with an attractive line-up of artists.

Epic:

“When I am organizing a multi-podium event and I am contracting artists to configure the line-up,
I want to keep a good overview of the artist configuration on the podiums, so that I can see the options
for an optimal experience of the event visitors”

Job-2: Help me arrange secure payments for the visitors of my event

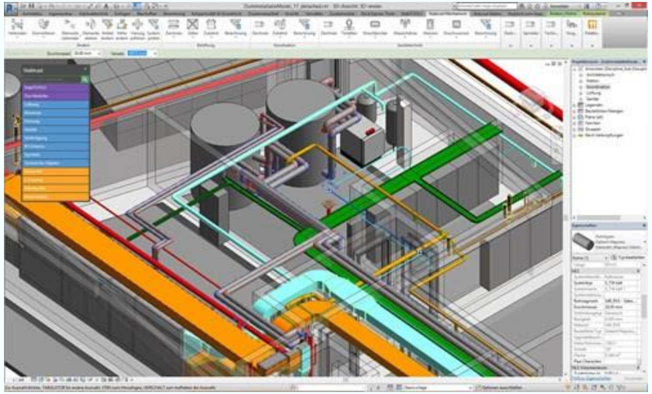
Epic:

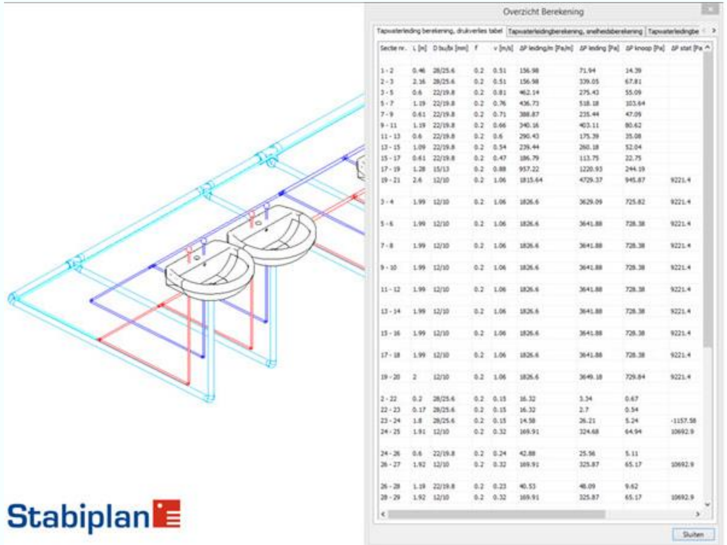
“When I am organizing any type of event, I want to my prospective visitors to have an adequate number of
secure payment options, so that I have no problems with fraud and cumbersome customer services.”

Case Study: Stabiplan (ModelComp)

Computer Aided Design (CAD) software for the modeling installations for mechanics, electronics and plumbing (MEP).

- Expands Autodesk AutoCAD and Revit products.
- 170 employees (65 in R&D)
- 3800 customers





Overzicht Berekening

Tapwaterleiding berekening, drukverlies tabel | Tapwaterleidingberekening, snelheidsberekening | Tapwaterleidingbe

Sectie nr.	L [m]	D bu/bi [mm]	f	v [m/s]	ΔP leiding/m [Pa/m]	ΔP leiding [Pa]	ΔP knoop [Pa]	ΔP stat [Pa
1 - 2	0.46	28/25.6	0.2	0.51	156.98	71.94	14.39	
2 - 3	2.16	28/25.6	0.2	0.51	156.98	339.05	67.81	
3 - 5	0.6	22/19.8	0.2	0.81	462.14	275.43	55.09	
5 - 7	1.19	22/19.8	0.2	0.76	436.73	518.18	103.64	
7 - 9	0.61	22/19.8	0.2	0.71	388.87	235.44	47.09	
9 - 11	1.19	22/19.8	0.2	0.66	340.16	403.11	80.62	
11 - 13	0.6	22/19.8	0.2	0.6	290.43	175.39	35.08	
13 - 15	1.09	22/19.8	0.2	0.54	239.44	260.18	52.04	
15 - 17	0.61	22/19.8	0.2	0.47	186.79	113.75	22.75	
17 - 19	1.28	15/13	0.2	0.88	957.22	1220.93	244.19	
19 - 21	2.6	12/10	0.2	1.06	1815.64	4729.37	945.87	9221.4
3 - 4	1.99	12/10	0.2	1.06	1826.6	3629.09	725.82	9221.4
5 - 6	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
7 - 8	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
9 - 10	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
11 - 12	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
13 - 14	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
15 - 16	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
17 - 18	1.99	12/10	0.2	1.06	1826.6	3641.88	728.38	9221.4
19 - 20	2	12/10	0.2	1.06	1826.6	3649.18	729.84	9221.4
2 - 22	0.2	28/25.6	0.2	0.15	16.32	3.34	0.67	
22 - 23	0.17	28/25.6	0.2	0.15	16.32	2.7	0.54	
23 - 24	1.8	28/25.6	0.2	0.15	14.58	26.21	5.24	-1157.58
24 - 25	1.91	12/10	0.2	0.32	169.91	324.68	64.94	10692.9
24 - 26	0.6	22/19.8	0.2	0.24	42.88	25.56	5.11	
26 - 27	1.92	12/10	0.2	0.32	169.91	325.87	65.17	10692.9
26 - 28	1.19	22/19.8	0.2	0.23	40.53	48.09	9.62	
28 - 29	1.92	12/10	0.2	0.32	169.91	325.87	65.17	10692.9

Stabiplan

Case Study: Stabiplan

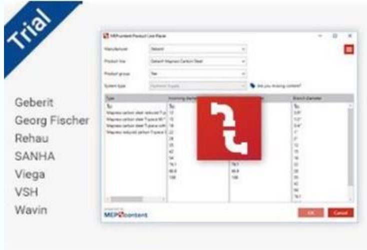
StabiCad: Large monolithic desktop product

Company strategic goal: Expand to the global market via a portfolio of *apps.*

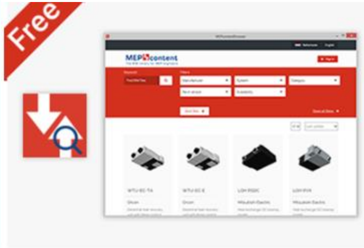
- Independent products with limited functionality.

`What functionality should be included in the apps to incite users to adopt it?'

- The apps should address customers' Jobs-to-be-Done?
- Focus on app related to radiators



MEPCONTENT PRODUCT LINE PLACER (PLIP) FOR PIPING



MEPCONTENT BROWSER

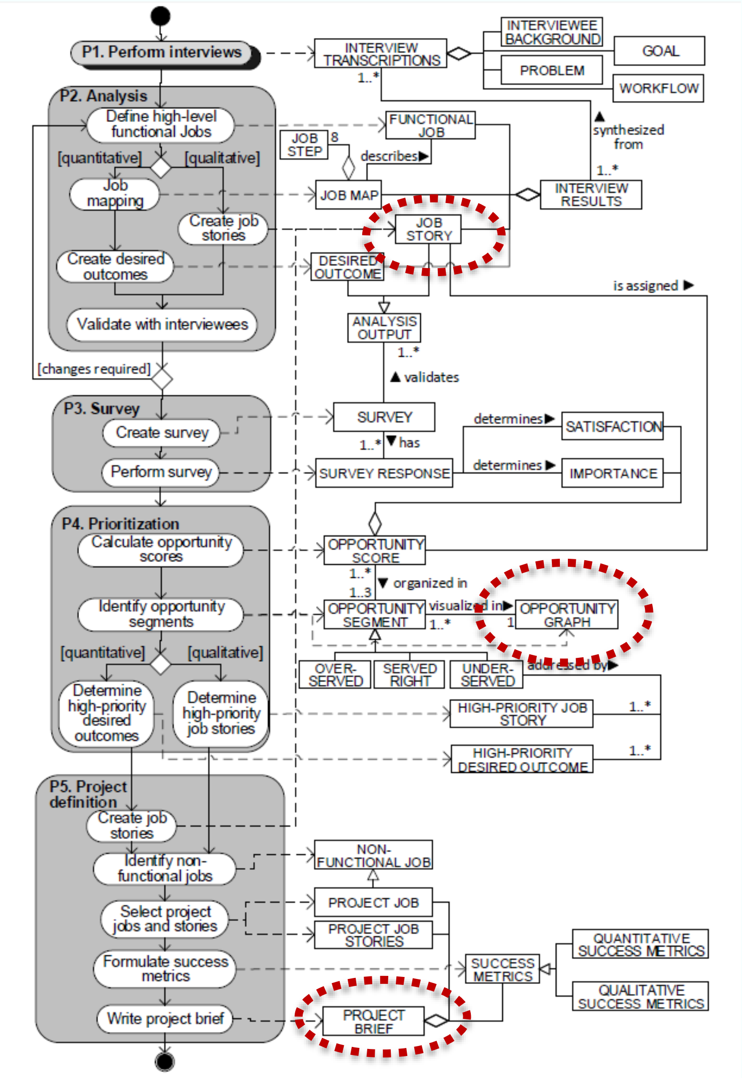
SANHA PRODUCT LINE PLACER

Integrated Epic Story meth

Combination of existing approaches, used to define high-level requirements for a development project.

Five phases:

- P.1 Interview phase
- P2. Analysis phase
- P3. Survey phase
- P4. Prioritization phase
- P5. Project definition phase



W3 – Epic stories

Exercise: Identify and write some Epic Stories for your product idea, based on the Jobs you created in W2.

We expect 3 to 5 per Job.

You do not have to do this for all Jobs. Restrict yourselves to the most prominent ones.

Use the template.

***When** [situation], **I want (to)** [motivation], **so that (I can)** [expected outcome]*

*“When I am organizing a multi-podium event and I am contracting artists to configure the line-up,
I want to keep a good overview of the artist configuration on the podiums, so that I can see the options
for an optimal experience of the event visitors”*

P2. Analysis phase:
Analyze the workflow, context and motivations of the interviewees to formulate initial Jobs and Job Stories.

Case:

- In the interviewees’ workflow we identified four functional Jobs:

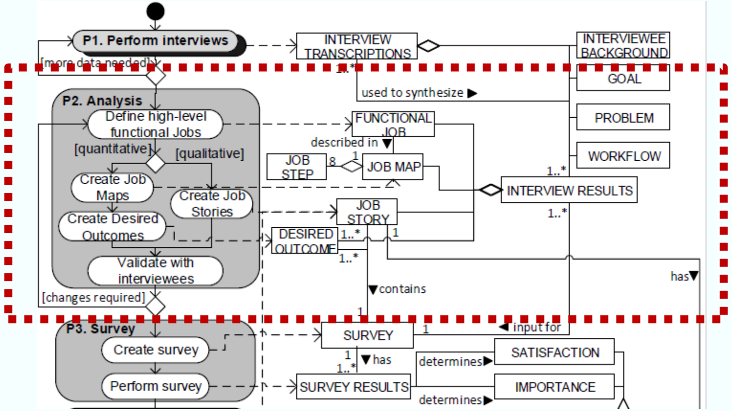
  J1: Help me configure radiators

  J2: Help me place radiators

  J3: Help me model piping systems

  J4: Help me create bills of materials

- We created Job Stories that highlight different parts of each Job, based on contextual information obtained in the



Help me model piping systems

When I have modeled a piping system and something changes in the project that forces me to make changes to the piping system, **I want** to be able to change the pipe system easily, **so that** I won't have to model the whole system again.

***When** [situation], **I want (to)** [motivation], **so that (I can)** [expected outcome]*

P5. Project definition phase

Select the Jobs and Job Stories for development, and create a project brief that can facilitate the follow-up development project.

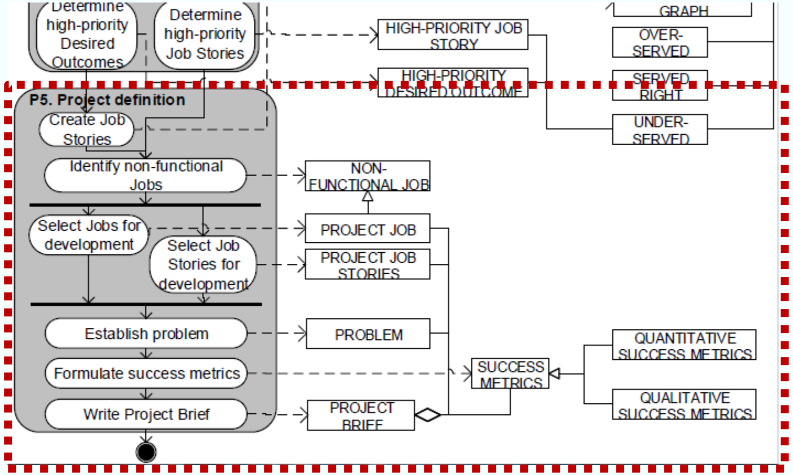
Case:

To help define concrete apps based on the high priority Job Stories, we re-categorized the Job Stories based on *non-functional Jobs,* instead of *functional Jobs.*

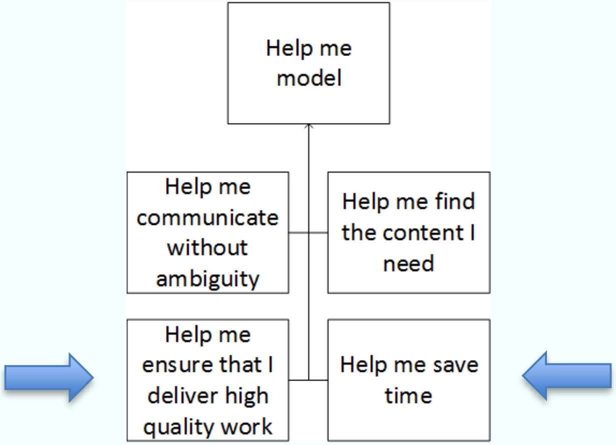
Why?

- By getting a functional task done, a customer is looking to achieve a “deeper” benefit → non-functional Jobs!

Research issue: Is it good practice to distinguish functional and quality jobs?



Determine high-priority Desired Outcomes
Determine high-priority Job Stories
HIGH-PRIORITY JOB STORY
GRAPH
OVER-SERVED
SERVED RIGHT
UNDER-SERVED
HIGH-PRIORITY DESIRED OUTCOME
P5. Project definition
Create Job Stories
Identify non-functional Jobs
NON-FUNCTIONAL JOB
Select Jobs for development
Select Job Stories for development
PROJECT JOB
PROJECT JOB STORIES
Establish problem
PROBLEM
Formulate success metrics
SUCCESS METRICS
QUANTITATIVE SUCCESS METRICS
QUALITATIVE SUCCESS METRICS
Write Project Brief
PROJECT BRIEF



Help me model
Help me communicate without ambiguity
Help me find the content I need
Help me ensure that I deliver high quality work
Help me save time

P5. Project definition phase

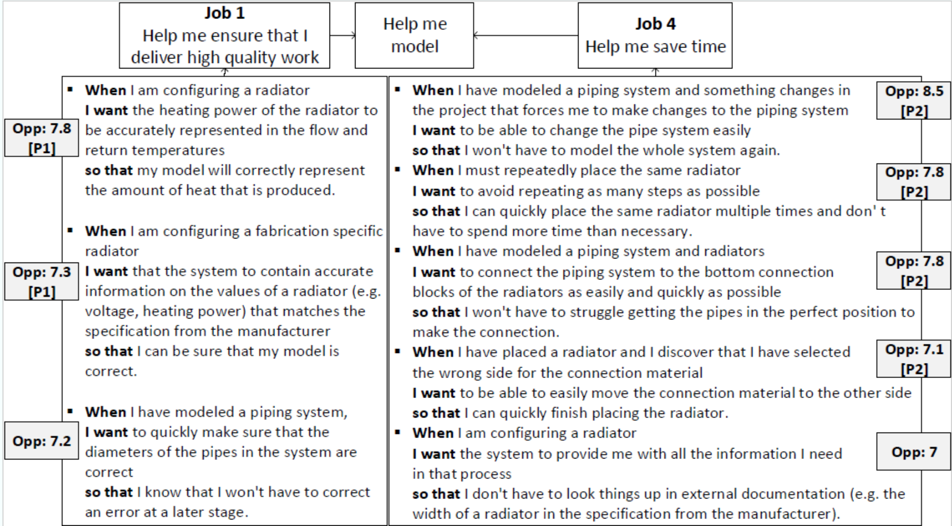
Select the Jobs and Job Stories for development, and create a project brief that can facilitate the follow-up development project.

Case:

We selected two non-functional Jobs to each address with an app, based on the number of related high-priority Job Stories.

We defined the scope of the apps based on concrete problems that relate to the Job.

- P1: Ensuring correct parametrical information.
- P2: Changing existing piping systems.



Job 1
Help me ensure that I deliver high quality work

Help me model

Job 4
Help me save time

- **When** I am configuring a radiator **I want** the heating power of the radiator to be accurately represented in the flow and return temperatures **so that** my model will correctly represent the amount of heat that is produced. — **Opp: 7.8 [P1]**
- **When** I am configuring a fabrication specific radiator **I want** that the system to contain accurate information on the values of a radiator (e.g. voltage, heating power) that matches the specification from the manufacturer **so that** I can be sure that my model is correct. — **Opp: 7.3 [P1]**
- **When** I have modeled a piping system, **I want** to quickly make sure that the diameters of the pipes in the system are correct **so that** I know that I won't have to correct an error at a later stage. — **Opp: 7.2**

- **When** I have modeled a piping system and something changes in the project that forces me to make changes to the piping system **I want** to be able to change the pipe system easily **so that** I won't have to model the whole system again. — **Opp: 8.5 [P2]**
- **When** I must repeatedly place the same radiator **I want** to avoid repeating as many steps as possible **so that** I can quickly place the same radiator multiple times and don' t have to spend more time than necessary. — **Opp: 7.8 [P2]**
- **When** I have modeled a piping system and radiators **I want** to connect the piping system to the bottom connection blocks of the radiators as easily and quickly as possible **so that** I won't have to struggle getting the pipes in the perfect position to make the connection. — **Opp: 7.8 [P2]**
- **When** I have placed a radiator and I discover that I have selected the wrong side for the connection material **I want** to be able to easily move the connection material to the other side **so that** I can quickly finish placing the radiator. — **Opp: 7.1 [P2]**
- **When** I am configuring a radiator **I want** the system to provide me with all the information I need in that process **so that** I don't have to look things up in external documentation (e.g. the width of a radiator in the specification from the manufacturer). — **Opp: 7**

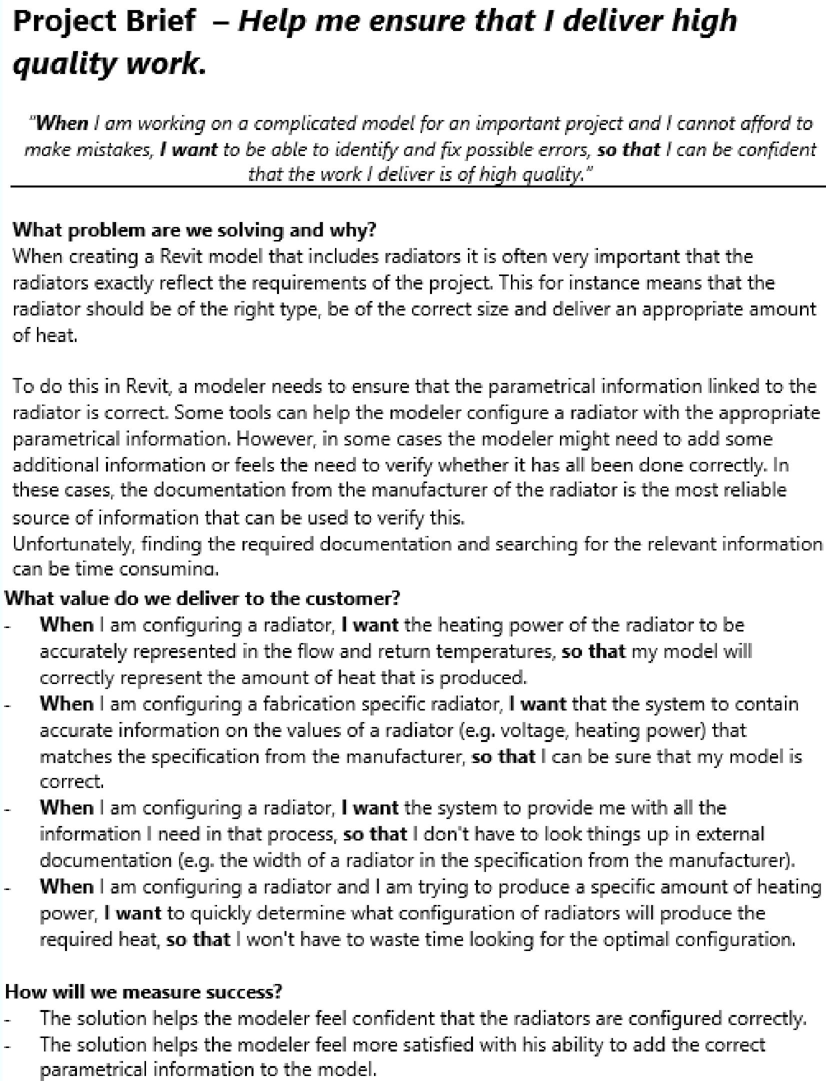
P5. Project definition phase

Select the Jobs and corresponding Epic Stories for development, and create a project brief that can facilitate the follow-up development project.

Case:

We created a *Project Brief* for each Job, to serve as input for the design process.

- Single page document, used as a basis for design and development (Intercom).
- Creates a shared understanding of the problem among different stakeholders.



Project Brief – *Help me ensure that I deliver high quality work.*

> *"**When** I am working on a complicated model for an important project and I cannot afford to make mistakes, **I want** to be able to identify and fix possible errors, **so that** I can be confident that the work I deliver is of high quality."*

What problem are we solving and why?

When creating a Revit model that includes radiators it is often very important that the radiators exactly reflect the requirements of the project. This for instance means that the radiator should be of the right type, be of the correct size and deliver an appropriate amount of heat.

To do this in Revit, a modeler needs to ensure that the parametrical information linked to the radiator is correct. Some tools can help the modeler configure a radiator with the appropriate parametrical information. However, in some cases the modeler might need to add some additional information or feels the need to verify whether it has all been done correctly. In these cases, the documentation from the manufacturer of the radiator is the most reliable source of information that can be used to verify this.

Unfortunately, finding the required documentation and searching for the relevant information can be time consuming.

What value do we deliver to the customer?

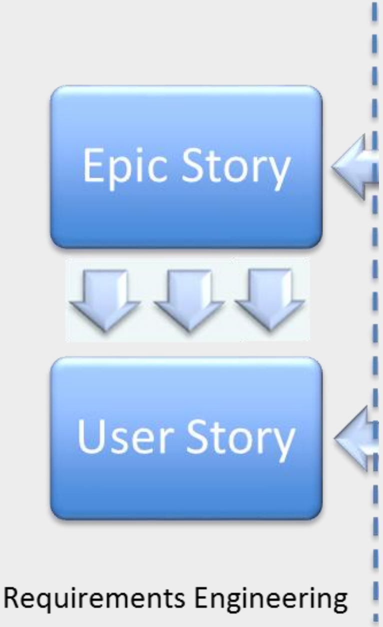
- **When** I am configuring a radiator, **I want** the heating power of the radiator to be accurately represented in the flow and return temperatures, **so that** my model will correctly represent the amount of heat that is produced.
- **When** I am configuring a fabrication specific radiator, **I want** that the system to contain accurate information on the values of a radiator (e.g. voltage, heating power) that matches the specification from the manufacturer, **so that** I can be sure that my model is correct.
- **When** I am configuring a radiator, **I want** the system to provide me with all the information I need in that process, **so that** I don't have to look things up in external documentation (e.g. the width of a radiator in the specification from the manufacturer).
- **When** I am configuring a radiator and I am trying to produce a specific amount of heating power, **I want** to quickly determine what configuration of radiators will produce the required heat, **so that** I won't have to waste time looking for the optimal configuration.

How will we measure success?

- The solution helps the modeler feel confident that the radiators are configured correctly.
- The solution helps the modeler feel more satisfied with his ability to add the correct parametrical information to the model.

Program of this Workshop

- Rationale
- Overview of the approach
  - W1 - Brainstorm
  - W2 - Jobs
  - W3 - Epic Stories
  - W4 - User Stories
  - W5 - Modules
  - W6 - Features
  - W7 – Reflection
- Discussion


Epic Story

User Story

Requirements Engineering

User stories
the GRIMM project

This part is based on the PhD dissertation research of Garm Lucassen

What is a user story?

- “As a Visitor, I want to purchase an event ticket”
- “As a visitor, I want to search for new events by favorited organizers so that I am the first to know of new events”
- “As a Visitor, I want to be notified when an event is close to becoming sold out, so that I do not miss the event”

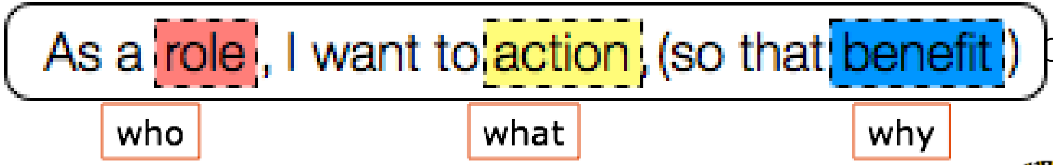
What is a user story?

- User stories represent customer requirements in a card, leading to conversation and confirmation (Jeffries, 2001)

- User stories only capture the *essential* elements of a requirement:
  - *who* it is for
  - *what* it expects from the system
  - *why* it is important (optional?)

- Simple format used by 70% of practitioners

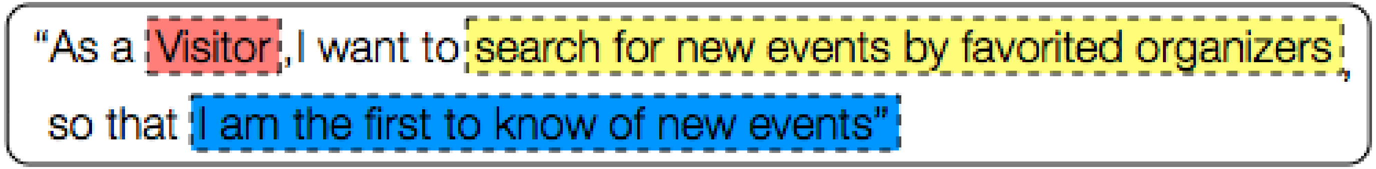
(Lucassen et al., 2016)



As a role, I want to action (so that benefit)

Connextra)

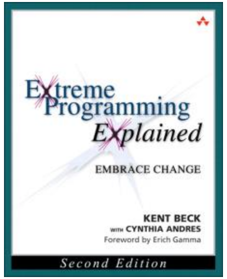
What is a user story?

- “As a Visitor, I want to purchase an event ticket”
- 

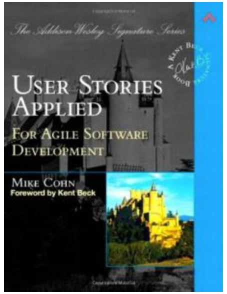
  “As a Visitor, I want to search for new events by favorited organizers, so that I am the first to know of new events”
- “As a Visitor, I want to be notified when an event is close to becoming sold out, so that I do not miss the event”

History

- First mention in Kent Beck’s 1999 book *Extreme Programming Explained*
  - Unstructured text
  - Similar to use cases
  - Restricted in size



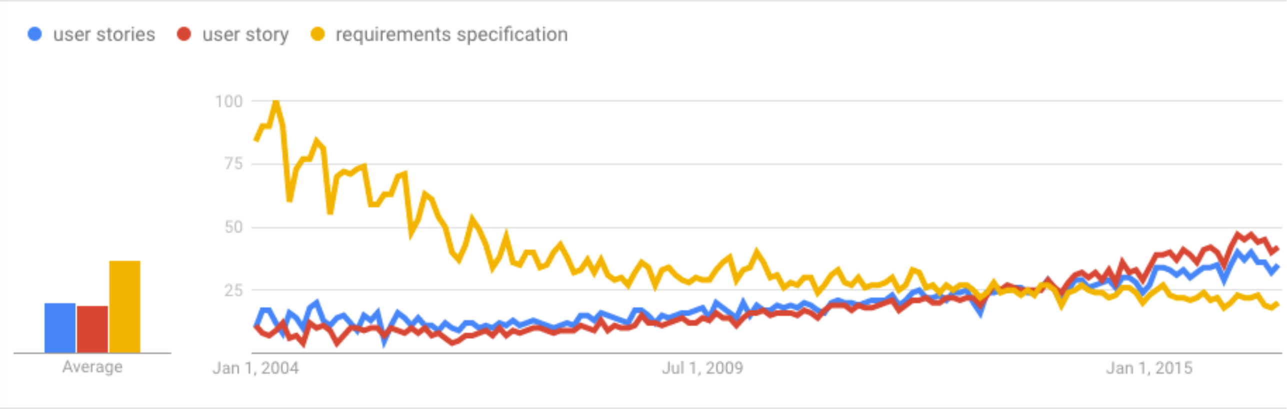
- Jeffries 2001: card, conversation, confirmation


The Addison-Wesley Signature Series
USER STORIES APPLIED
FOR AGILE SOFTWARE DEVELOPMENT
MIKE COHN
Foreword by Kent Beck

- Widespread popularity after Mike Cohn’s *User Stories Applied* in 2004

Popularity

- 45% of practitioners employ user stories (Kassab, 2015)
- In agile: 90%! (Wang, 2015)



Worldwide. 2004 - present.

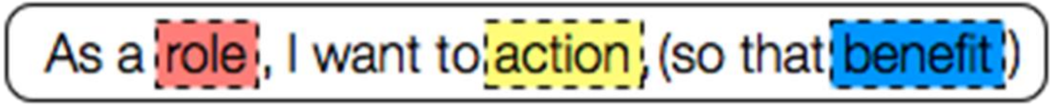
Industry survey

- Survey w/182 responses & 21 follow-up interviews

(Lucassen et al. 2016a)
http://bit.ly/us_effective

- Use of user stories
  - Development Methods
  - Templates
- Perception of user story effectiveness
  - Impact on productivity?
  - Impact on work deliverable quality?

Conceptual model and User story quality framework

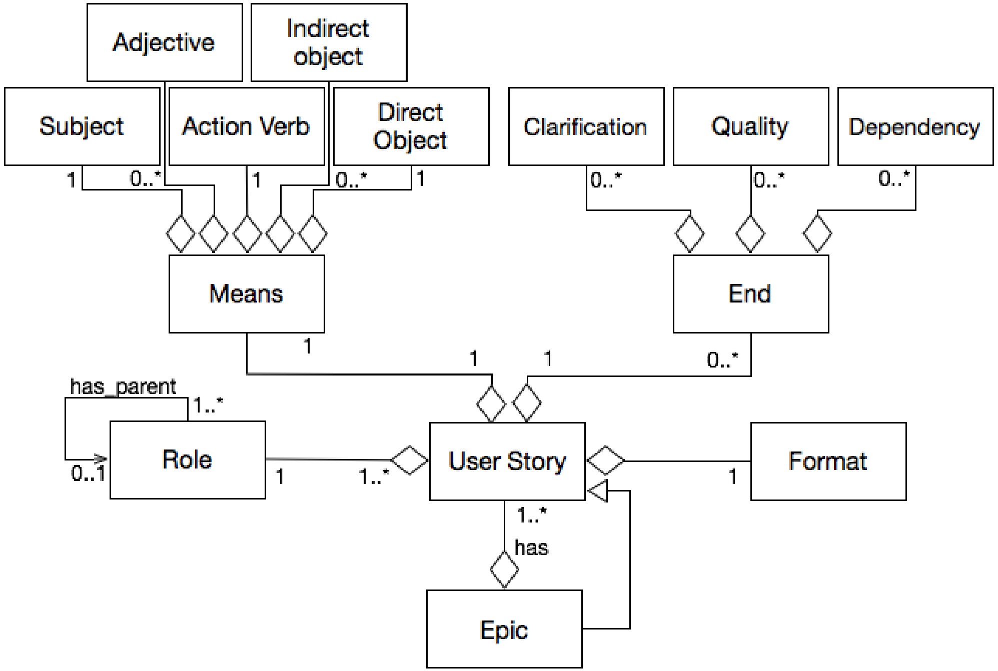


As a role, I want to action (so that benefit)

Lucassen, G., Dalpiaz, F., van der Werf, J. M. E., & Brinkkemper, S. (2016b) Improving agile requirements: the Quality User Story framework and tool. Requirements Engineering Journal, 1-21.

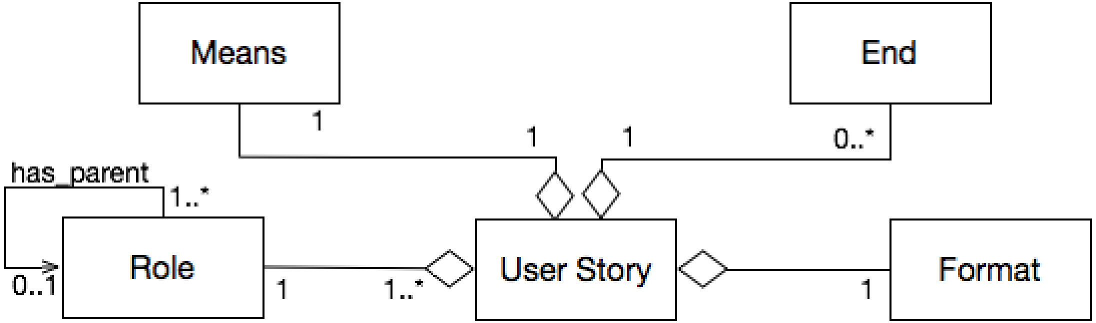
http://bit.ly/improving_us

Conceptual model



Conceptual model

"As a User, I want to search for new events by favorited organizers, so that I am the first to know of new events"



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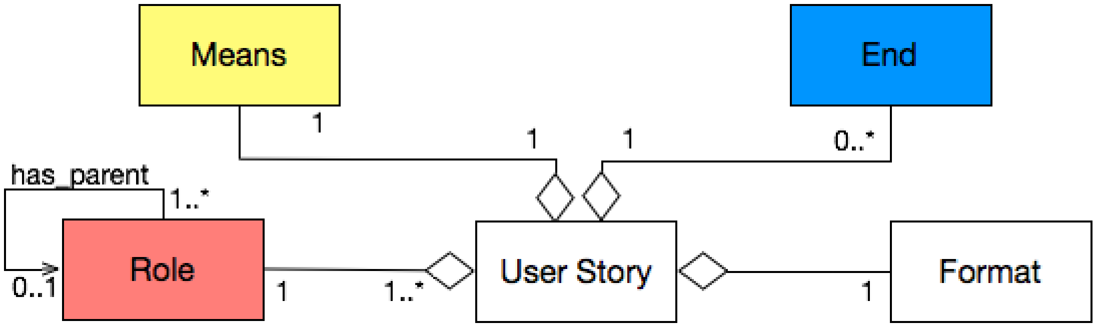
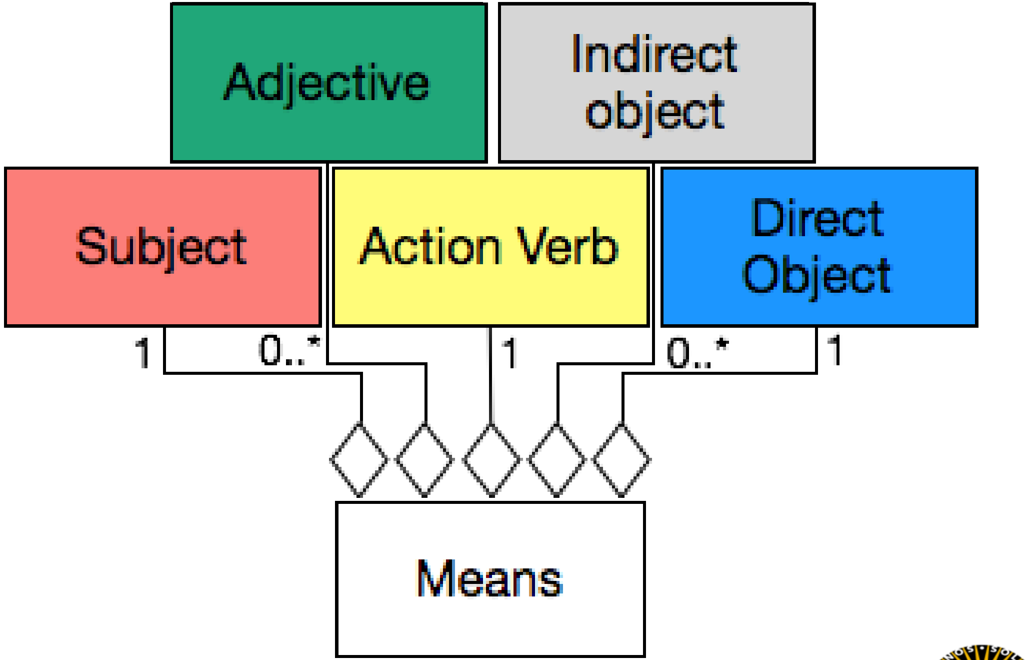


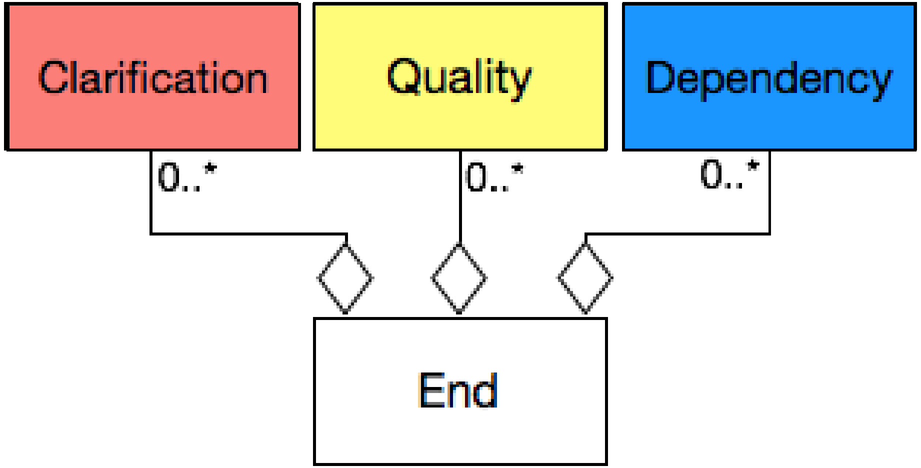
Means concepts

"I want to search for new events by favorited organizers"

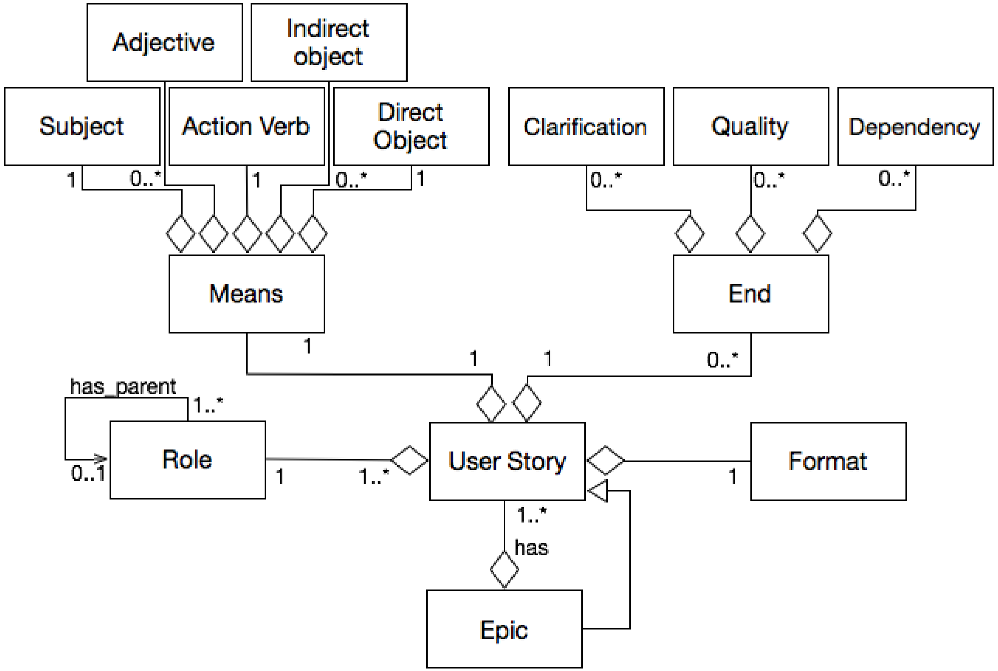


Ends concepts

“so that I am the first to know of new events”

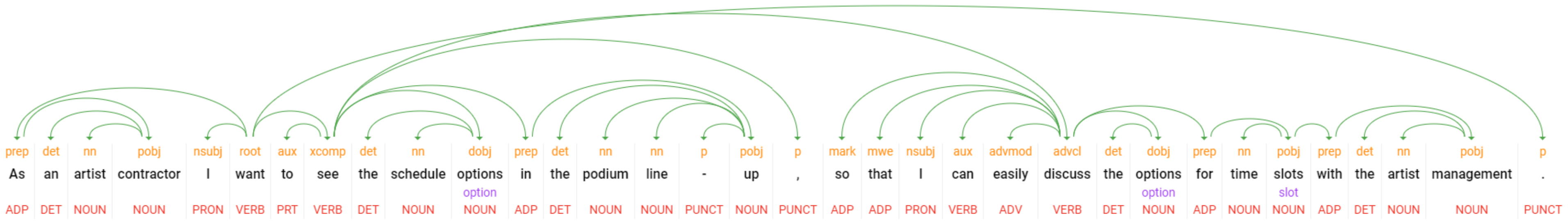


Conceptual model



Universiteit Utrecht

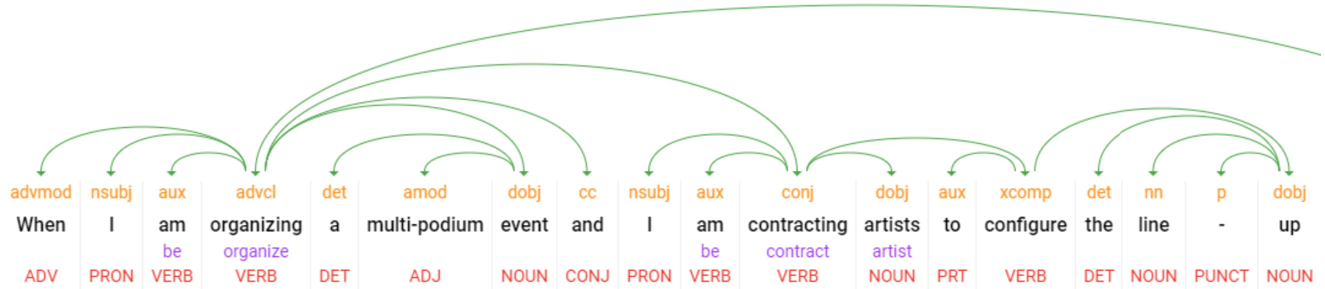
Google language tooling

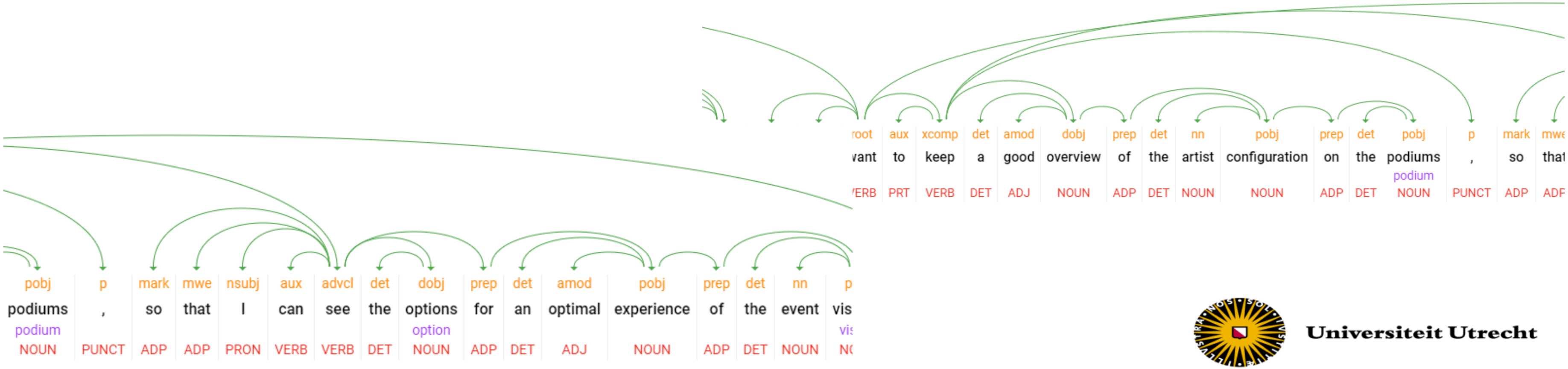


prep	det	nn	pobj	nsubj	root	aux	xcomp	det	nn	dobj	prep	det	nn	nn	p	pobj
As	an	artist	contractor	I	want	to	see	the	schedule	options	in	the	podium	line	-	up
										option						
ADP	DET	NOUN	NOUN	PRON	VERB	PRT	VERB	DET	NOUN	NOUN	ADP	DET	NOUN	NOUN	PUNCT	NOUN

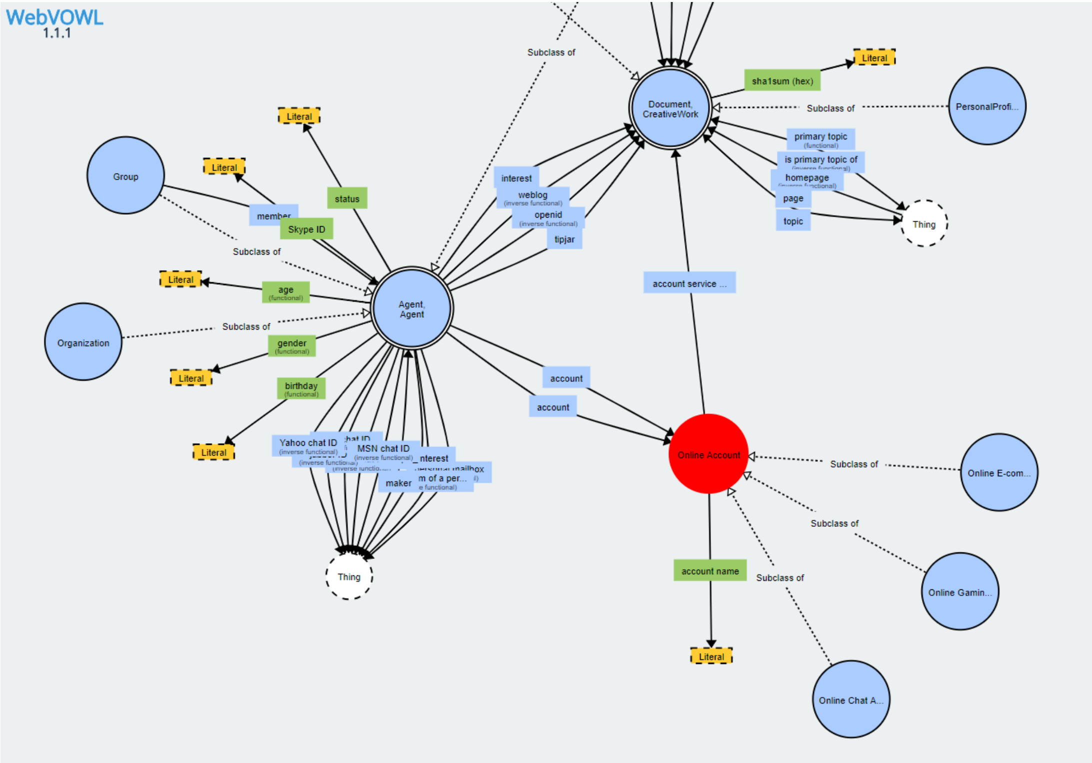
p	mark	mwe	nsubj	aux	advmod	advcl	det	dobj	prep	nn	pobj	prep	det	nn	pobj	p
,	so	that	I	can	easily	discuss	the	options	for	time	slots	with	the	artist	management	.
								option			slot					
PUNCT	ADP	ADP	PRON	VERB	ADV	VERB	DET	NOUN	ADP	NOUN	NOUN	ADP	DET	NOUN	NOUN	PUNCT

Larger sentences

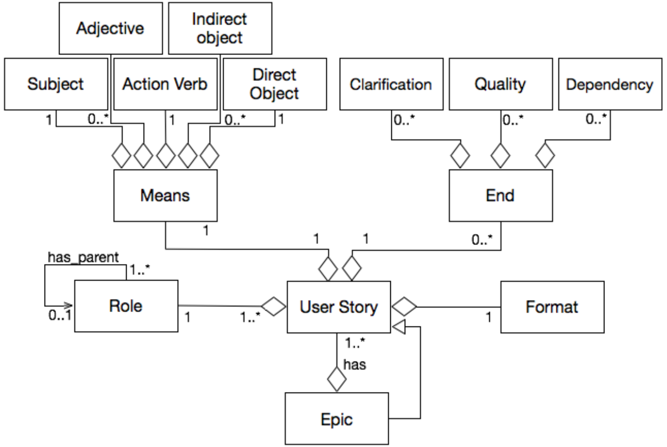

advmod nsubj aux advcl det amod dobj cc nsubj aux conj dobj aux xcomp det nn p dobj
When I am organizing a multi-podium event and I am contracting artists to configure the line - up
be organize be contract artist
ADV PRON VERB VERB DET ADJ NOUN CONJ PRON VERB VERB NOUN PRT VERB DET NOUN PUNCT NOUN


root aux xcomp det amod dobj prep det nn pobj prep det pobj p mark mwe
want to keep a good overview of the artist configuration on the podiums , so that
podium
VERB PRT VERB DET ADJ NOUN ADP DET NOUN NOUN ADP DET NOUN PUNCT ADP ADP
pobj p mark mwe nsubj aux advcl det dobj prep det amod pobj prep det nn p
podiums , so that I can see the options for an optimal experience of the event vis
podium option vis
NOUN PUNCT ADP ADP PRON VERB VERB DET NOUN ADP DET ADJ NOUN ADP DET NOUN NO

Ontology tooling



Quality problems in practice

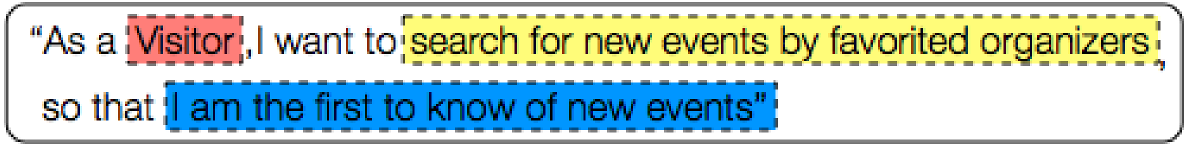


- Model captures correct stories

- Stories from practitioners:
  - Too long
  - Unnecessary information
  - Too little information
  - Inconsistent
  - Irrelevant
  - Ambiguous

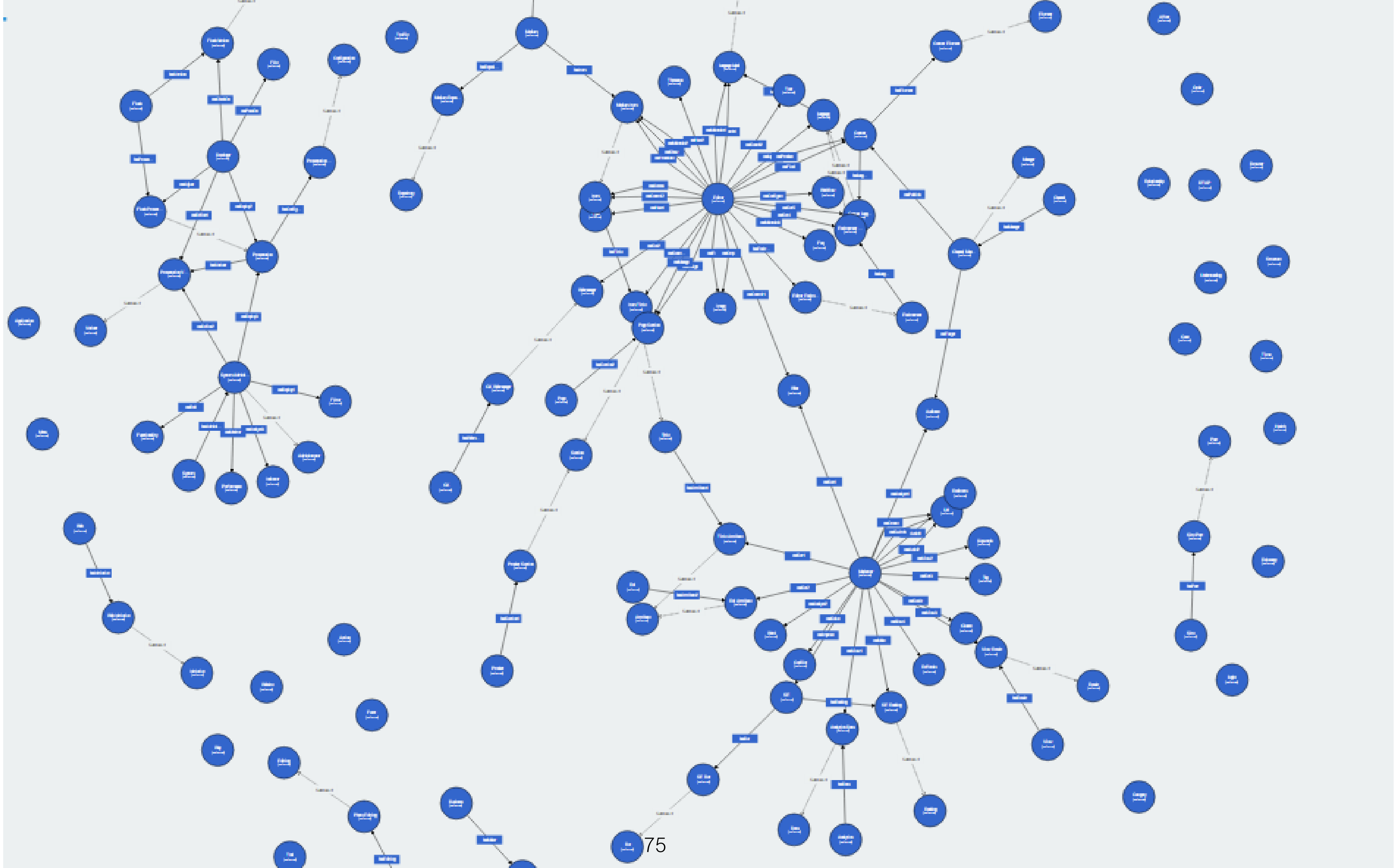
Going from…

- “As a Visitor, I want to buy an event ticket”



“As a Visitor ,I want to search for new events by favorited organizers, so that I am the first to know of new events”

- “As a Visitor, I want to be notified when an event is close to becoming sold out, so that I do not miss the event”



W4 – User stories

Exercise: Identify and write some User Stories for your product idea, based on the Jobs and Epic Stories you created in W2 and W3.

We expect 3 to 5 per Epic Story for this workshop. Later about 20-30 can be the refinement of an Epic Story.

You do not have to do this for all Jobs and Epic Stories. Restrict yourselves to the most prominent ones.

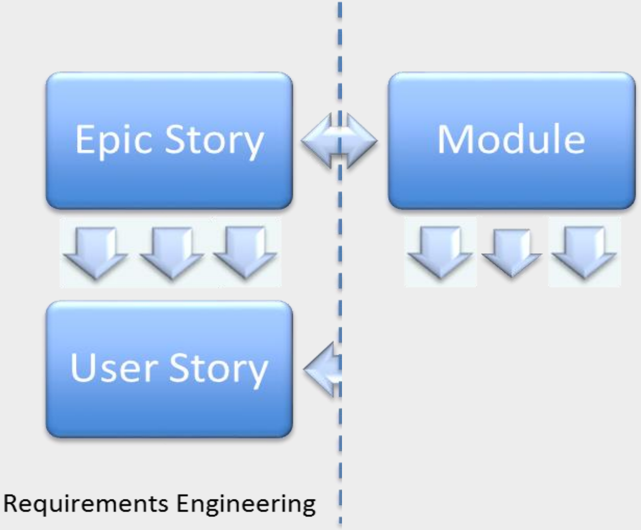
Use the template.

> *“As a <role>, I want <action>, so that <benefit>”*

“As a Visitor, I want to be notified when an event is close to becoming sold out, so that I do not miss the event”

Program of this Workshop

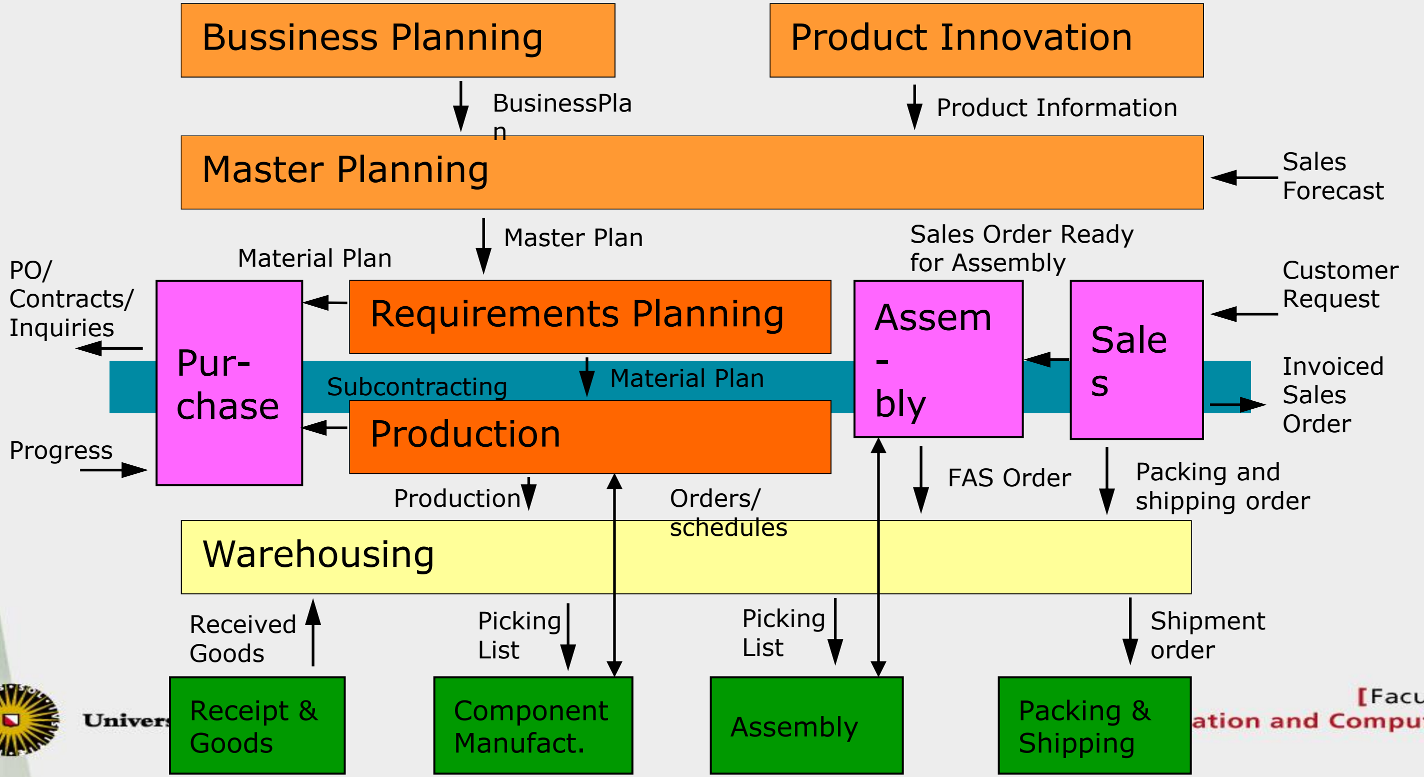
- Rationale
- Overview of the approach
  - W1 - Brainstorm
  - W2 - Jobs
  - W3 - Epic Stories
  - W4 - User Stories
  - W5 - Modules
  - W6 - Features
  - W7 – Reflection
- Discussion



Functional Architectures

- A functional view is an architectural model from a usage perspective
- So the functional architecture should resemble the enterprise functions of the customer organisation or user context
    - Names of modules should resemble the names of enterprise functions
    - Flows in functional architecture resemble the interactions in the customer domain
- Standard functional architecture is called Reference Architecture

Functional Architecture for ERP product

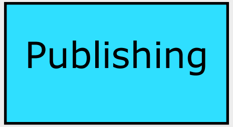


Usage of the Functional architecture

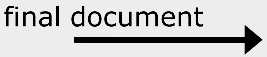
- Structure for processes in Software Product Management: Functional Architecture Framework (FAF)?

- Consider practical issues like:
  - How to manage the product vision for future, subsequent releases?
  - How to register incoming requirements from customers and prospects?
  - How to assign work to development teams?
  - How to manage large volumes of requirements in a distributed company?

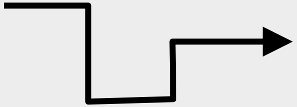
Notation of FAs



- Module or sub-module: business function consisting of a set of continuous processes
  - Color is used for categorization
  - All words start with Capital

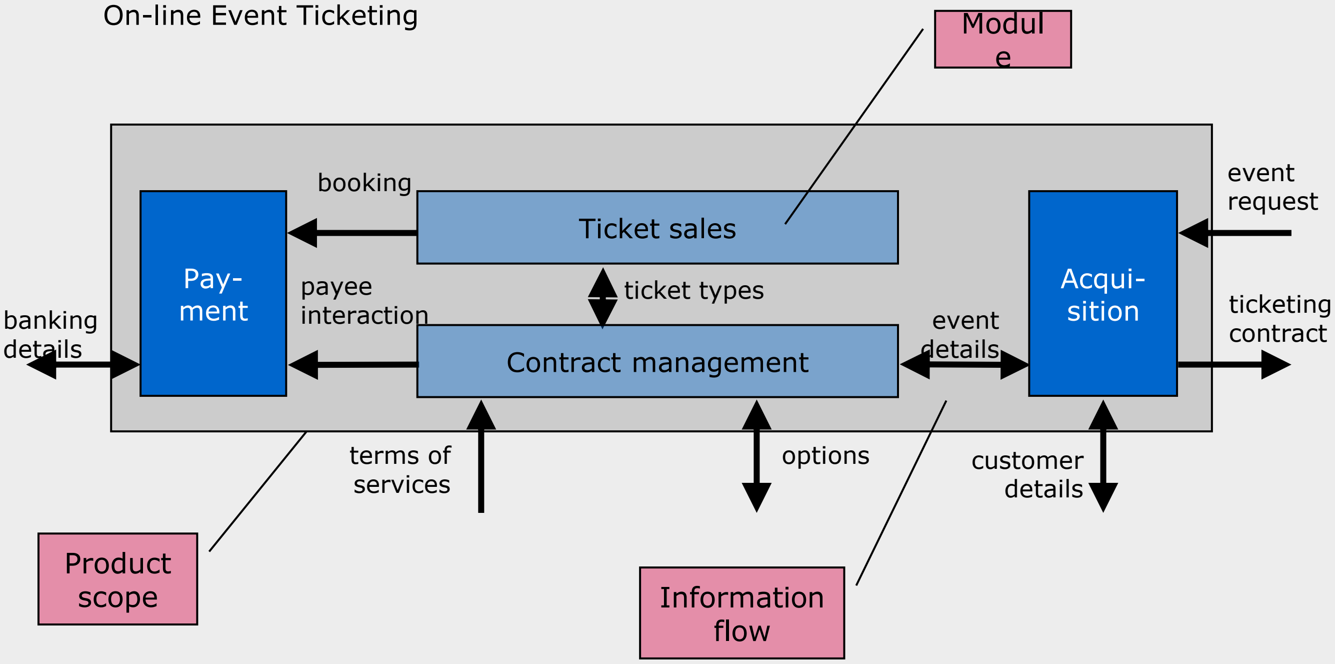


- Flow: transfer of data between modules
  - all lower case

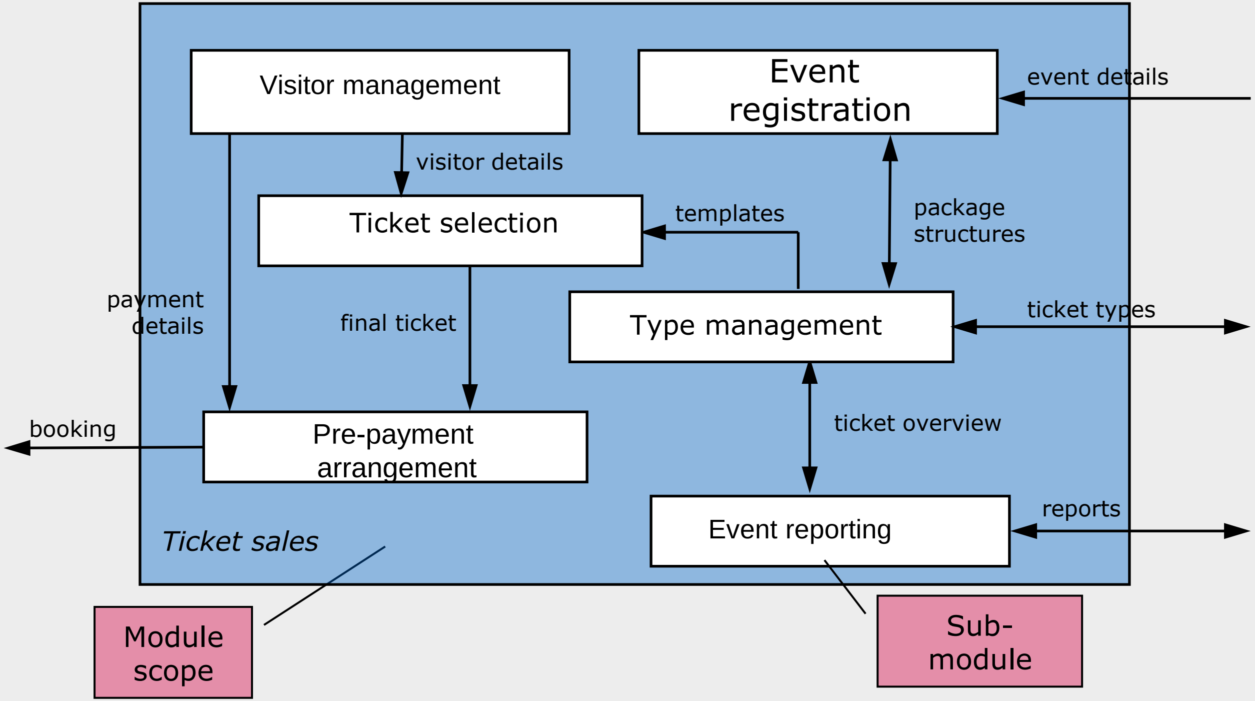


- Scenario: continuous process
  - as overlay on FA

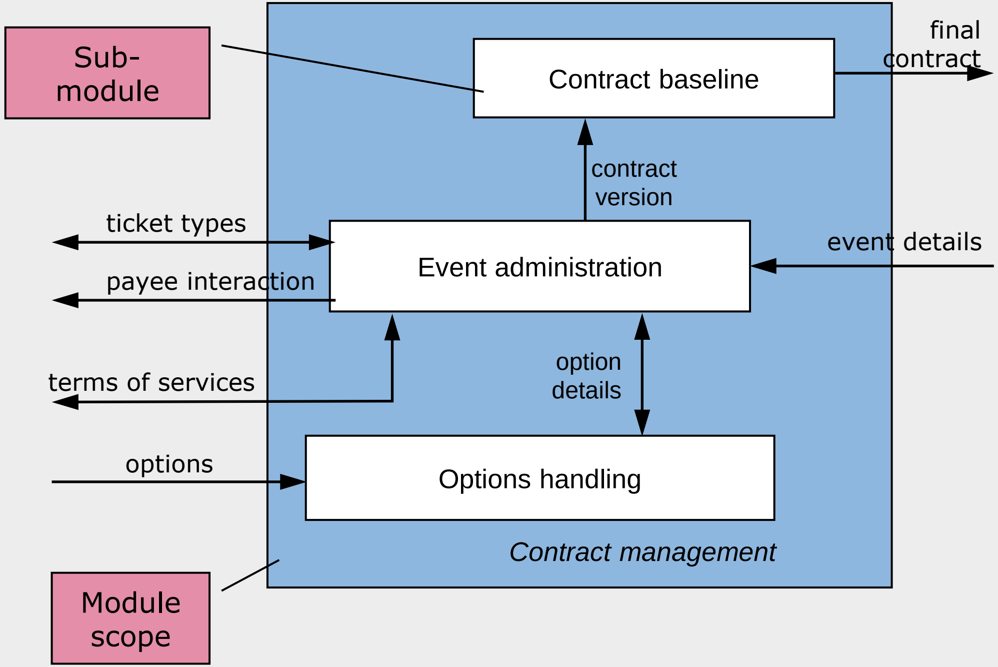
Product: Functional architecture



FA on module level: Ticket sales



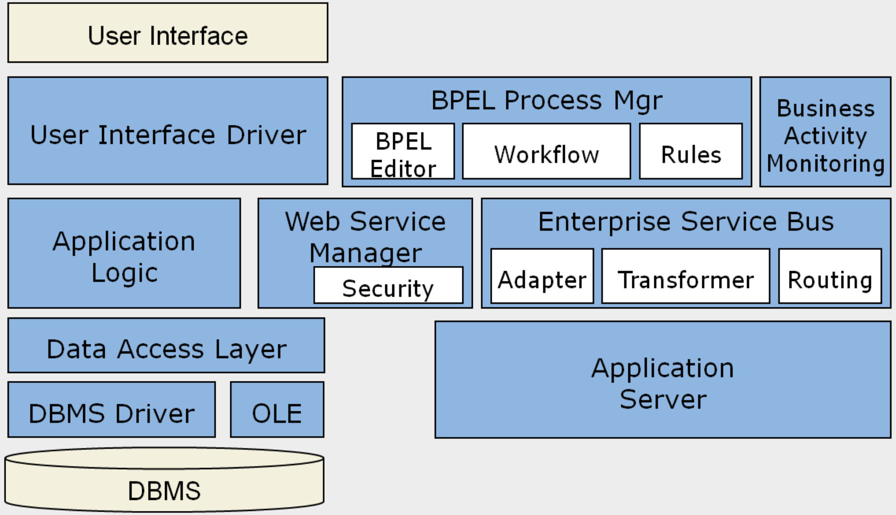
FA of Contract management



FA of Technical systems

FAs can also be provided for technical systems

Example:



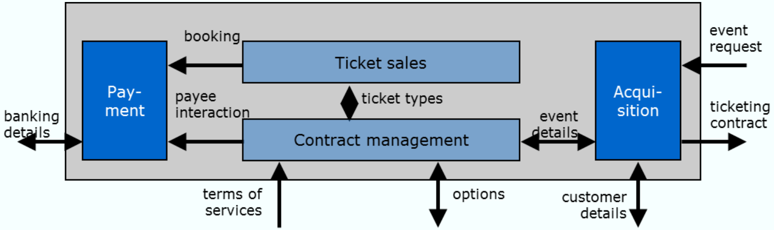
W5 – Modules

Exercise: Identify and draw some Modules for your product idea, based on the Jobs, Epic Stories and User Stories you created in W2, W3, and W4.

We expect about 1 Module per Epic Story for this workshop. The Jobs define the product scope.

You do not have to do this for all Jobs and Epic Stories. Restrict yourselves to the most prominent ones.

Use the notational conventions.



Program of this Workshop

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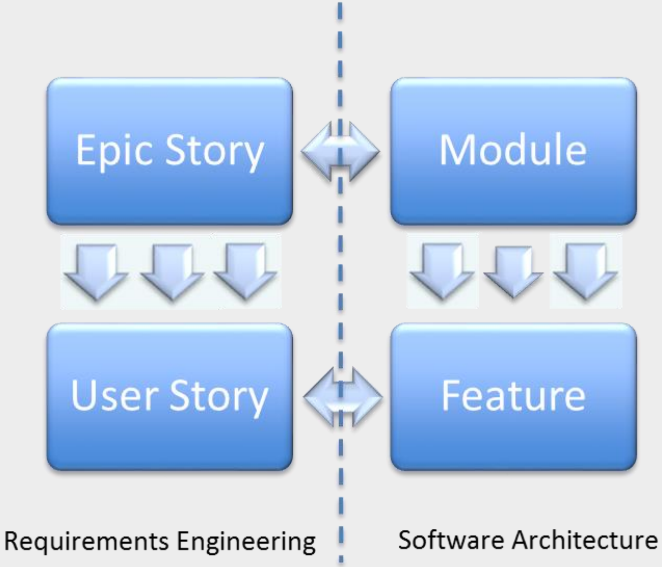
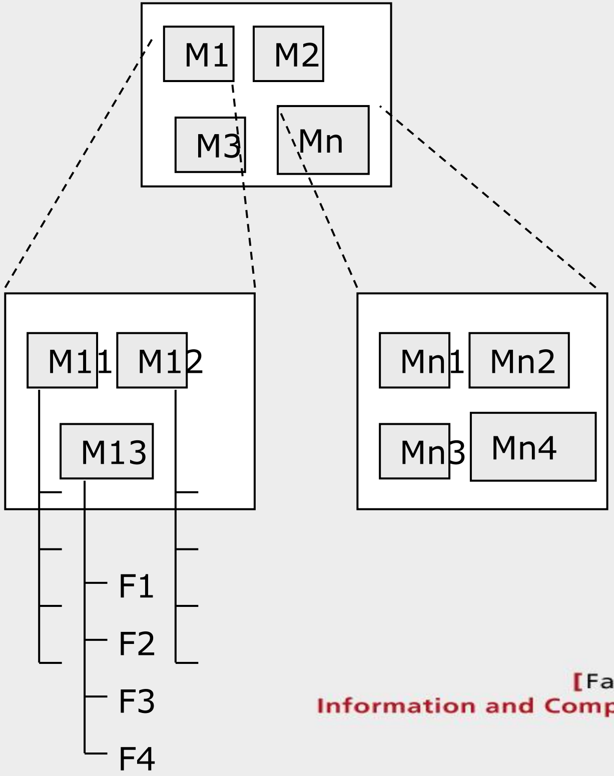
  - W5 - Modules
  - W6 - Features
  - W7 – Reflection
- Discussion

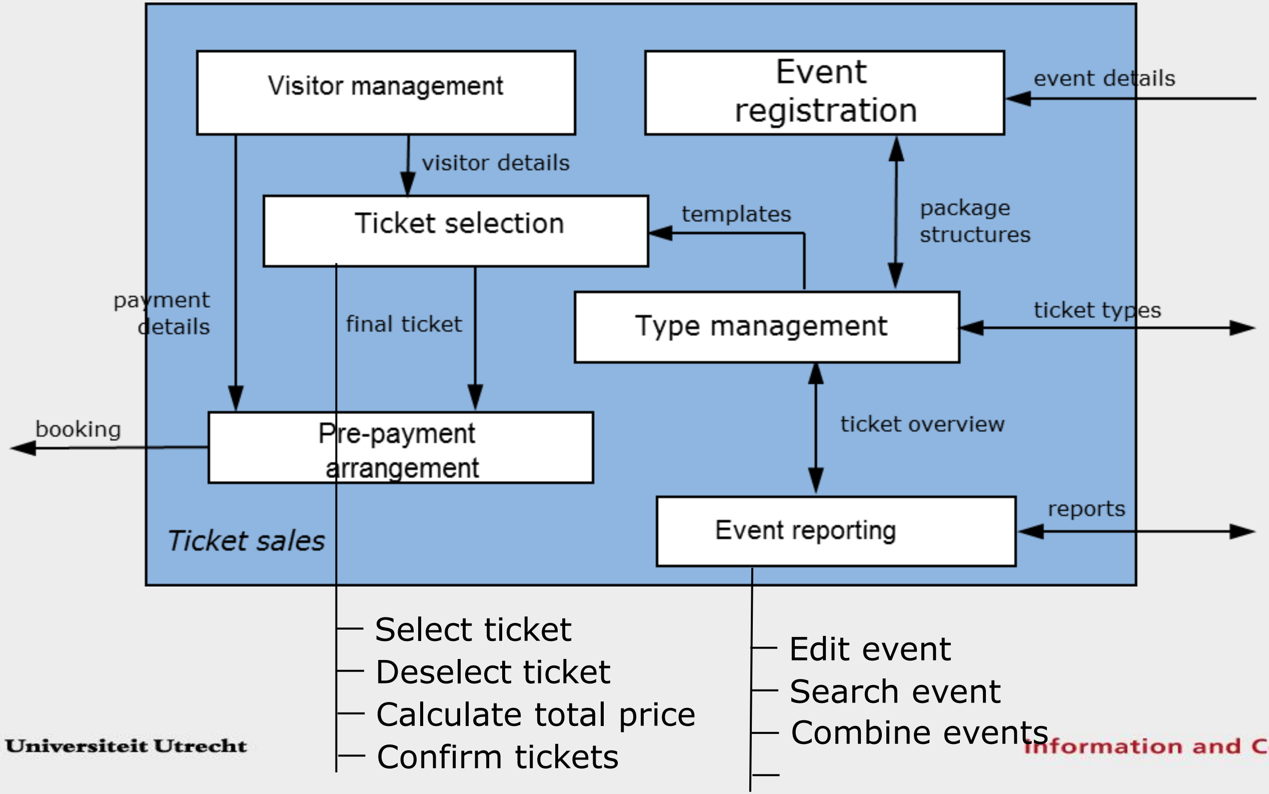


Functional Decomposition for Feature Identification

- The modules in a functional architecture are modelled in 2 or 3 layers
- At the lowest level the module consists of features
- Definition: *Feature* is a discrete unit of unique and attractive functionality of a product that delivers measurable benefit to customers
- The lowest level modules are elaborated in a feature model



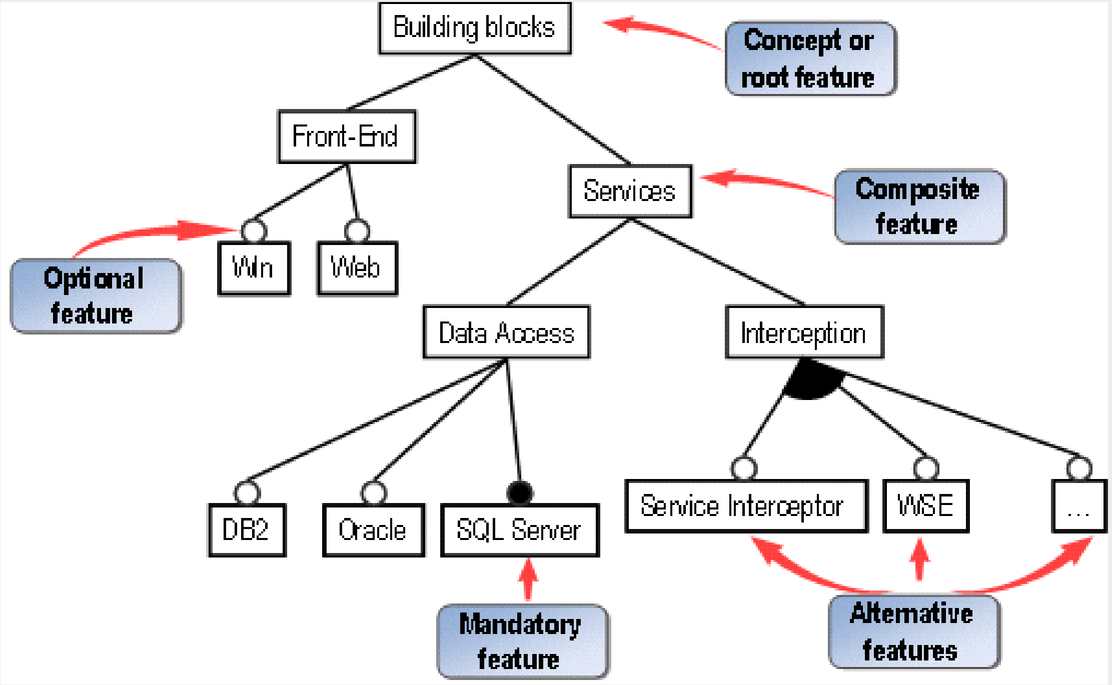
Case: Event Ticketing



- Select ticket
- Deselect ticket
- Calculate total price
- Confirm tickets

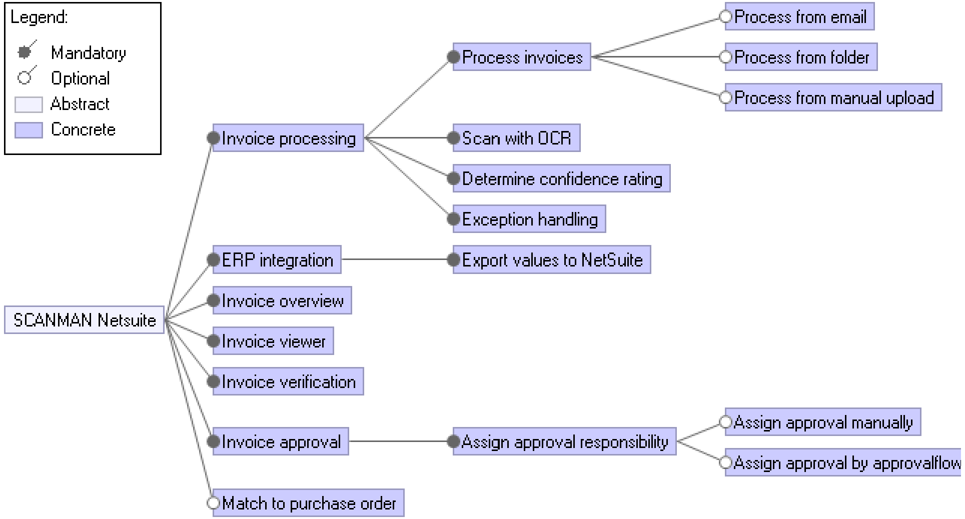
- Edit event
- Search event
- Combine events

Feature model diagram (vertical view)



Note: this feature model does not obey our naming conventions!

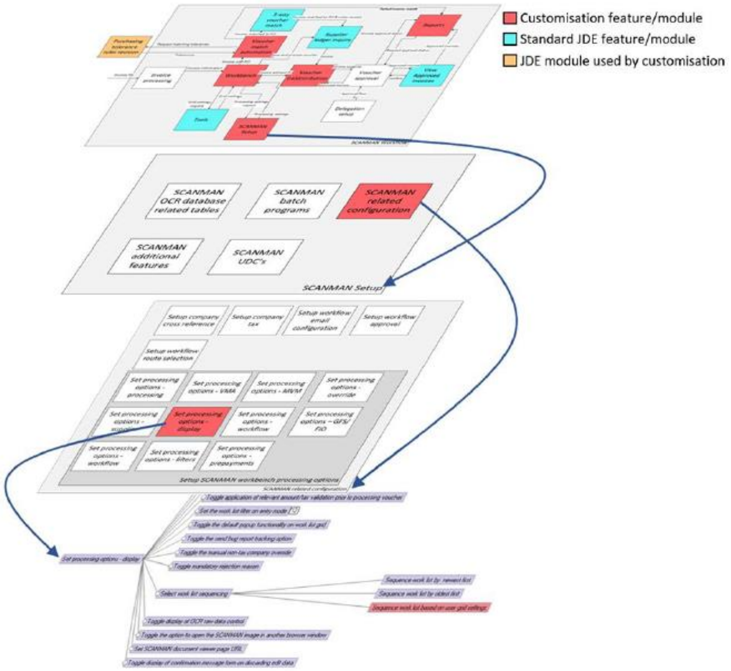
Feature diagram (horizontal view)



Legend:
- ● Mandatory
- ○ Optional
- Abstract
- Concrete

- SCANMAN Netsuite
  - ● Invoice processing
    - ● Process invoices
      - ○ Process from email
      - ○ Process from folder
      - ○ Process from manual upload
    - ● Scan with OCR
    - ● Determine confidence rating
    - ● Exception handling
  - ● ERP integration
    - ● Export values to NetSuite
  - ● Invoice overview
  - ● Invoice viewer
  - ● Invoice verification
  - ● Invoice approval
    - ● Assign approval responsibility
      - ○ Assign approval manually
      - ○ Assign approval by approvalflow
  - ○ Match to purchase order

3D view of Modules and Features



Customisation feature/module
Standard JDE feature/module
JDE module used by customisation
Purchasing tolerance rules revision
3-way voucher match
Voucher match automation
Supplier ledger inquiry
Reports
Invoice processing
Workbench
Voucher Redistribution
Voucher approval
View Approved Invoices
Tools
SCANMAN Setup
Delegation setup
SCANMAN OCR database related tables
SCANMAN batch programs
SCANMAN related configuration
SCANMAN additional features
SCANMAN UDC's
SCANMAN Setup
Setup company cross reference
Setup company tax
Setup workflow email configuration
Setup workflow approval
Setup workflow route selection
Set processing options - processing
Set processing options - VMA
Set processing options - MVM
Set processing options - override
Set processing options - suppliers
Set processing options - display
Set processing options - workflow
Set processing options - GFS/FIO
Set processing options - workflow
Set processing options - filters
Set processing options - prepayments
Setup SCANMAN workbench processing options
SCANMAN related configuration
Set processing options - display
Toggle application of relevant amount/tax validation prior to processing voucher
Set the work list filter on entry mode
Toggle the default popup functionality on work list grid
Toggle the send bug report tracking option
Toggle the manual non-tax company override
Toggle mandatory rejection reason
Select work list sequencing
Sequence work list by newest first
Sequence work list by oldest first
Sequence work list based on user grid settings
Toggle display of OCR raw data control
Toggle the option to open the SCANMAN image in another browser window
Set SCANMAN document viewer page URL
Toggle display of confirmation message form on discarding edit data

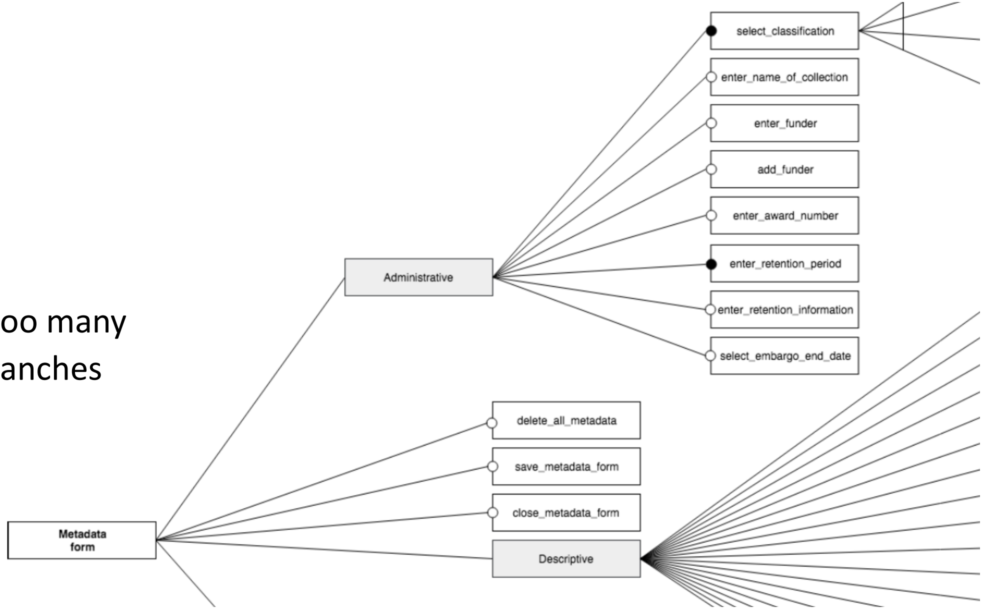
Feature diagrams

Components:

- Composite features
- Atomic features
- Decompositions: alternative & OR
- Mandatory & optional features

Guidelines:

- Root feature = Module or Sub-module
- Do not bury features too deep in the tree
- Possible to collapse atomic features if there are too many
- Try a nice balance in the depths of the feature branches



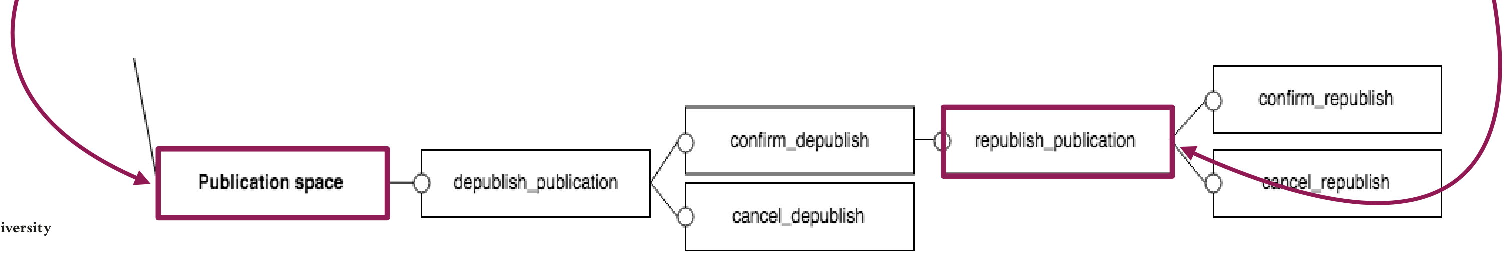
Architecture Discovery

Creating a first draft architectural design

Linking architectural components to requirements

Epic Story:
When I publish my research, I want others to be able to find my data, so that I adhere to the FAIR principles.

User Story:
As a data manager, I want to republish a depublished data package, so that I can make the package available again.



Publication space

depublish_publication

confirm_depublish

cancel_depublish

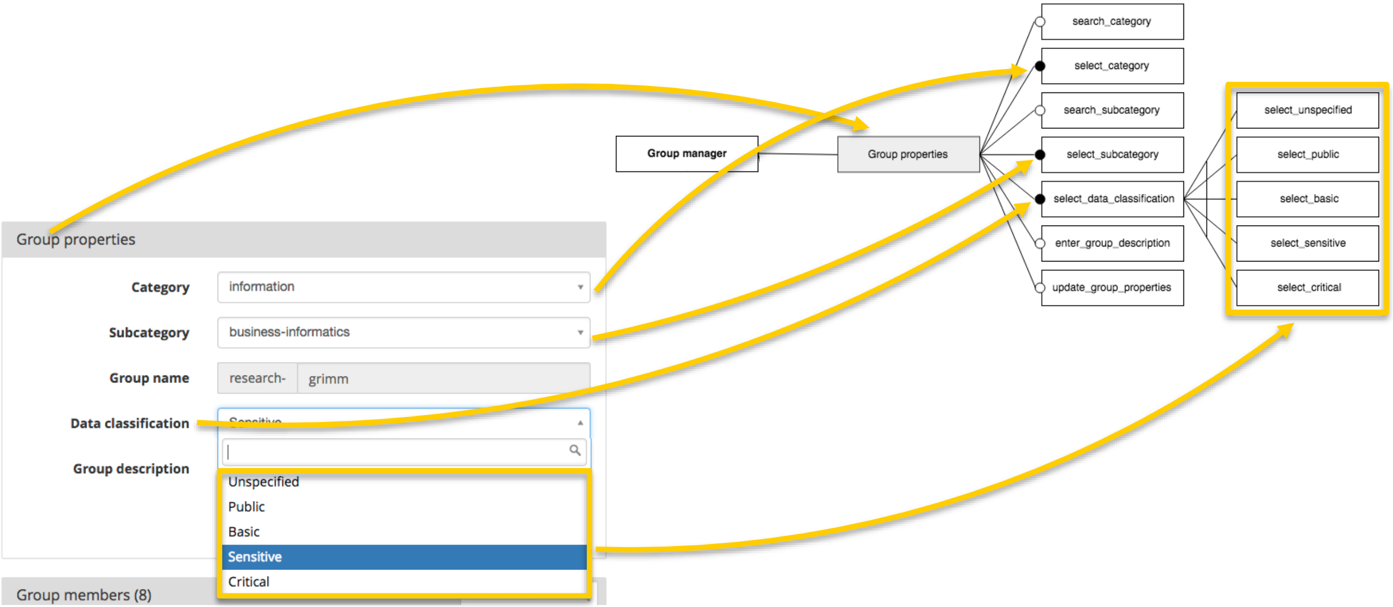
republish_publication

confirm_republish

cancel_republish

Architecture Recovery

Recovering modules and features from GUI



Group properties

Category	information
Subcategory	business-informatics
Group name	research- grimm
Data classification	Sensitive
Group description	

Unspecified
Public
Basic
Sensitive
Critical

Group members (8)

Naming conventions: Module

A Module in the Product perspective has the same name as an Enterprise function in the Reality perspective:

> Definition: An enterprise function is a collection of coherent processes, continuously performed within an enterprise and supporting its mission

- Examples: Corporate Planning, Human Resource Management, Supplier Contract Management, Shop Floor Control
- Naming standards:
  - Nouns: Planning in stead of Plan
  - Precise, determining words known in the business domain
  - Name is Capitalized

Naming conventions: Feature

A Feature in the Product perspective has the same name as a process in the Reality perspective:

> Definition: A process is an activity of which the execution can be described in terms of needed and delivered data and of which the start and end can be determined.”

- A process is the WHAT a company does and not HOW it is being done.
- Examples: Receive order, Register complaint, Print invoice, Select basic configuration

Naming standards:

- Name starts with Verb, followed by a Noun phrase: Register complaint
- Precise, determining words known in the business domain
- Only Verb is Capitalized

W6 – Features

Exercise: Identify and write some Feature for your product idea, based on the Jobs, Epic Stories, User Stories, and Modules you created in W2 – W5.

We expect 1 or 2 per User Story for this workshop.

You do not have to do this for all Jobs and Epic Stories. Restrict yourselves to the most prominent ones.

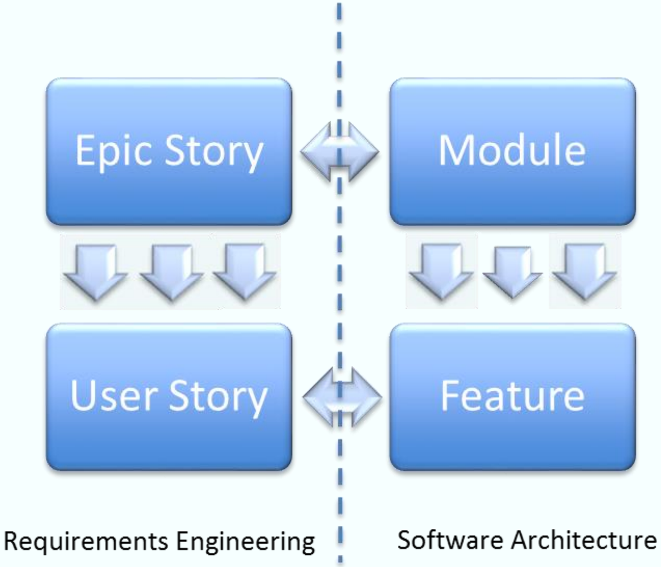
Use the naming convention.

W7 – Reflection

Exercise: What did you think of this exercise in learning to specify your product.

Use the slide in your slide set.

Later on you will finalize this work in the Prototype and architecture assignment.



Current and future MSc and PhD projects

First exploratory studies, more work to be done.

- Well-documented case studies are needed to get more insight in the value of Jobs-to-be-Done and Epic Stories.
- Investigate the relation of Epic Stories/User Stories to Modules/Features, and how to integrate this RE4SA with existing agile approaches.
- Extraction, transformation and traceability of concepts from artefacts utilizing natural language processing tools.

Questions and discussion

contact:
S.Brinkkemper@uu.nl

References (1/2)

[1] Nuseibeh, B. (2001). Weaving together requirements and architectures. Computer , 34 (3), 115–119

[2] Apel, S., Kästner, C.: An overview of feature-oriented software development. Journal of Object Technology 8(5), 49–84 (2009)

[3] Cleland-Huang, J., Gotel, O.C., Huffman Hayes, J., Mäder, P., Zisman, A.: Software traceability: trends and future directions. In: Proc. of FOSE, pp. 55–69 (2014)

[4] Mäder, P. and A. Egyed (2011). "Do software engineers benefit from source code navigation with traceability? — An experiment in software change management." In: 26th IEEE/ACM International Conference on Automated Software Engineering. IEEE. Pp. 444–447.

[5] Bouillon, E., P. Mäder, and I. Philippow (2013). "A survey on usage scenarios for requirements traceability in practice". In: International Working Conference on Requirements Engineering: Foundation for Software Quality. Springer, Berlin, Heidelberg. Pp. 158–173.

[6] Rozanski, N., & Woods, E. (2011). Software systems architecture: working with stakeholders using viewpoints and perspectives. Addison-Wesley.

[7] G. Lucassen, F. Dalpiaz, J. M. Van Der Werf, and S. Brinkkemper (2015). "Bridging the twin peaks: the case of the software industry". In: Proceedings of the Fifth International Workshop on Twin Peaks of Requirements and Architecture. IEEE Press, pp. 24–28.

[8] D. Méndez Fernández et al. (2017). "Naming the pain in requirements engineering". Empirical software engineering, vol. 22, no. 5, pp. 2298–2338.

References (2/2)

[9] D. Zowghi and N. Nurmuliani (2002). “A study of the impact of requirements volatility on software project performance”. In: Ninth Asia-Pacific Software Engineering Conference, IEEE, 2002, pp. 3–11.

[10] C. C. Venters, R. Capilla, S. Betz, B. Penzenstadler, T. Crick, S. Crouch, E. Y. Nakagawa, C. Becker, and C. Carrillo (2018). “Software sustainability: Research and practice from a software architecture viewpoint”. Journal of Systems and Software, vol. 138, pp. 174–188.

[11] Cohn, M.: User stories applied. Addison-Wesley Professional (2004).

[12] Lucassen, G., van de Keuken, M., Dalpiaz, F., Brinkkemper, S., Sloof, G.W., Schlingmann, J.: Jobs-to-be-done oriented requirements engineering: a method for defining job stories. In: Proc. of REFSQ, pp. 227–243 (2018)

[13] Klement (2013). Replacing The User Story With The Job Story https://jtbd.info/replacing-the-user-story-with-the-job-story-af7cdee10c27

[14] Brinkkemper, S., & Pachidi, S. (2010, August). Functional architecture modeling for the software product industry. In European Conference on Software Architecture (pp. 198-213). Springer, Berlin, Heidelberg.

[15] Ali, N., Baker, S., O’Crowley, R., Herold, S., Buckley, J.: Architecture consistency: State of the practice, challenges and requirements. Empirical Software Engineering 23(1), 224–258 (2018)

[16] Molenaar, S., Spijkman, T., Dalpiaz, F., Brinkkemper, S. (2020). Explicit Alignment of Requirements and Architecture in Agile Development. To appear in: Proc. Of REFSQ

Literature

Jobs and Epic Stories

- Garm Lucassen, Maxim van de Keuken, Fabiano Dalpiaz, Sjaak Brinkkemper, Gijs Willem Sloof, Johan Schlingmann: Jobs-to-be-Done Oriented Requirements Engineering: A Method for Defining Job Stories. REFSQ 2018: 227-243
- Klement, A.: When Coffee and Kale Compete. NYC Publishing (2016)
- Christensen, C. M. (2006). The ongoing process of building a theory of disruption. Journal of Product innovation management, 23(1), 39-55.

User Stories

- Garm Lucassen, Marcel Robeer, Fabiano Dalpiaz, Jan Martijn E. M. van der Werf, Sjaak Brinkkemper: Extracting conceptual models from user stories with Visual Narrator. Requir. Eng. 22(3): 339-358 (2017)
- Garm Lucassen, Fabiano Dalpiaz, Jan Martijn van der Werf, Sjaak Brinkkemper: Improving agile requirements: the Quality User Story framework and tool. Requirements Engineering, 15(1): 1-21 (2016)

Software Architecture

- Garm Lucassen, Fabiano Dalpiaz, Jan Martijn van der Werf, Sjaak Brinkkemper: Bridging the Twin Peaks - The Case of the Software Industry. TwinPeaks@ICSE 2015: 24-28
- Jan Martijn E. M. van der Werf, Rico de Feijter, Floris Bex, Sjaak Brinkkemper: Facilitating Collaborative Decision Making with the Software Architecture Video Wall. ICSA Workshops 2017: 137-140
- Sjaak Brinkkemper, Stella Pachidi: Functional Architecture Modeling for the Software Product Industry. ECSA 2010: 198-213
- Wilbert Seele, Shaheen Syed, Sjaak Brinkkemper: The Functional Architecture Modeling Method Applied on Web Browsers. WICSA 2014: 171-174
- Tomas Salfischberger, Inge van de Weerd, Sjaak Brinkkemper: The Functional Architecture Framework for organizing high volume requirements management. IWSPM 2011: 17-25