POLITECNICO DI TORINO

e-Lite

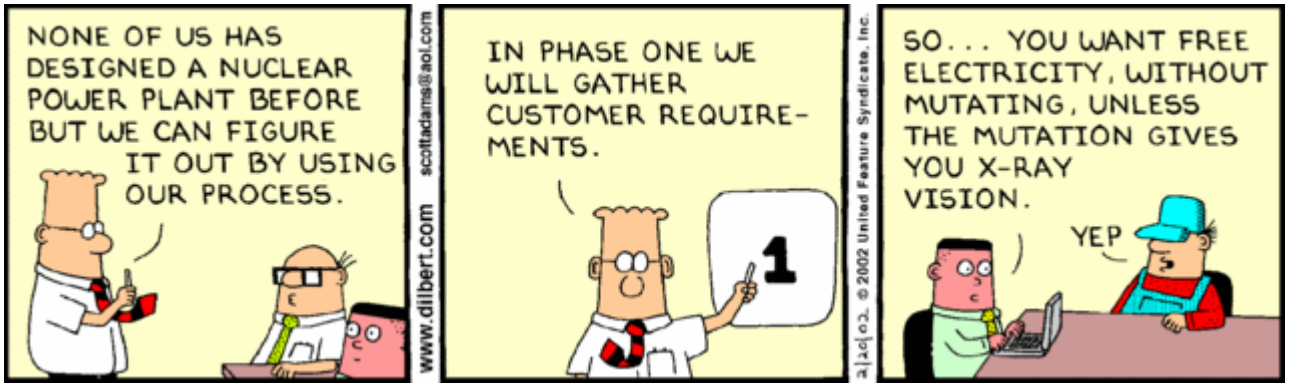
AmI Design Process

01QZP - Ambient intelligence

Fulvio Corno

Politecnico di Torino, 2018/2019

Design Process



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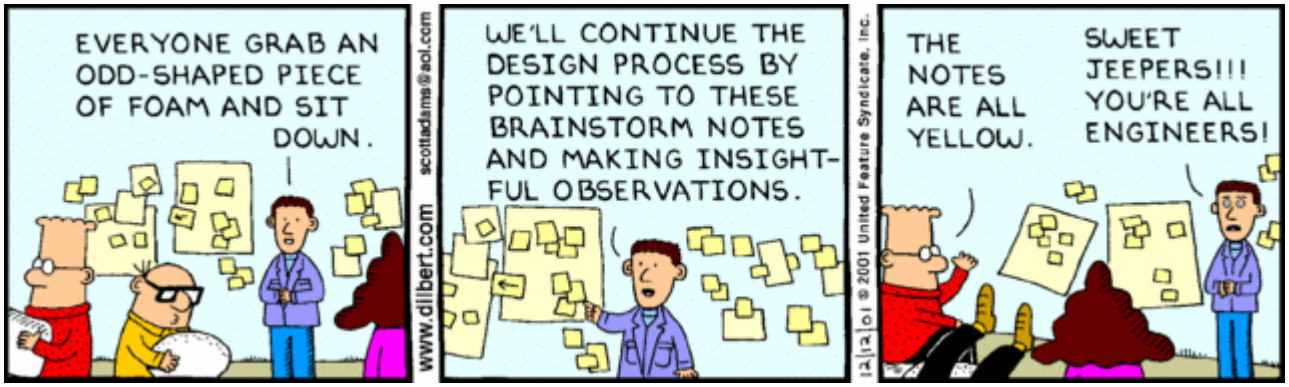


http://dilbert.com/strips/comic/2001-12-12/

Design process (in Engineering)

- The engineering design process is the formulation of a plan to help an engineer build a product with a specified performance goal. [Wikipedia]

- The engineering design process is the formulation of a plan to help a team of engineers build a system with specified performance and functionality goals. [improved]

Summary

- General design process
- Main steps of the process
  - Step 1: Problem Statement
  - Step 2: Requirements & Features Elicitation
  - Step 3: Requirements & Features Identification
  - Step 4: Architecture Definition
  - Step 5: Component Selection
  - Step 6: Design & Implementation
  - Step 7: Test and Validation
- Simplified process adopted in the AmI course

Deadline ahead

- Before 17/03
  - Group composition
  - Summary Description
  - Even >1 proposal
- Do not wait until the last minute
  - May help forming groups
  - We'll monitor in real time
- Discussion: 18/03
- Final deadline: 24/03

GROUP NUMBER XX

Team Members
•Team member 1, email, GitHub username, role in the project
•Team member 2, email, GitHub username, role in the project
•Team member 3, email, GitHub username, role in the project
•[Team member 4, email, GitHub username, role in the project]

Project Acronym: XXXYYYZZZ

Project Title
this is the title

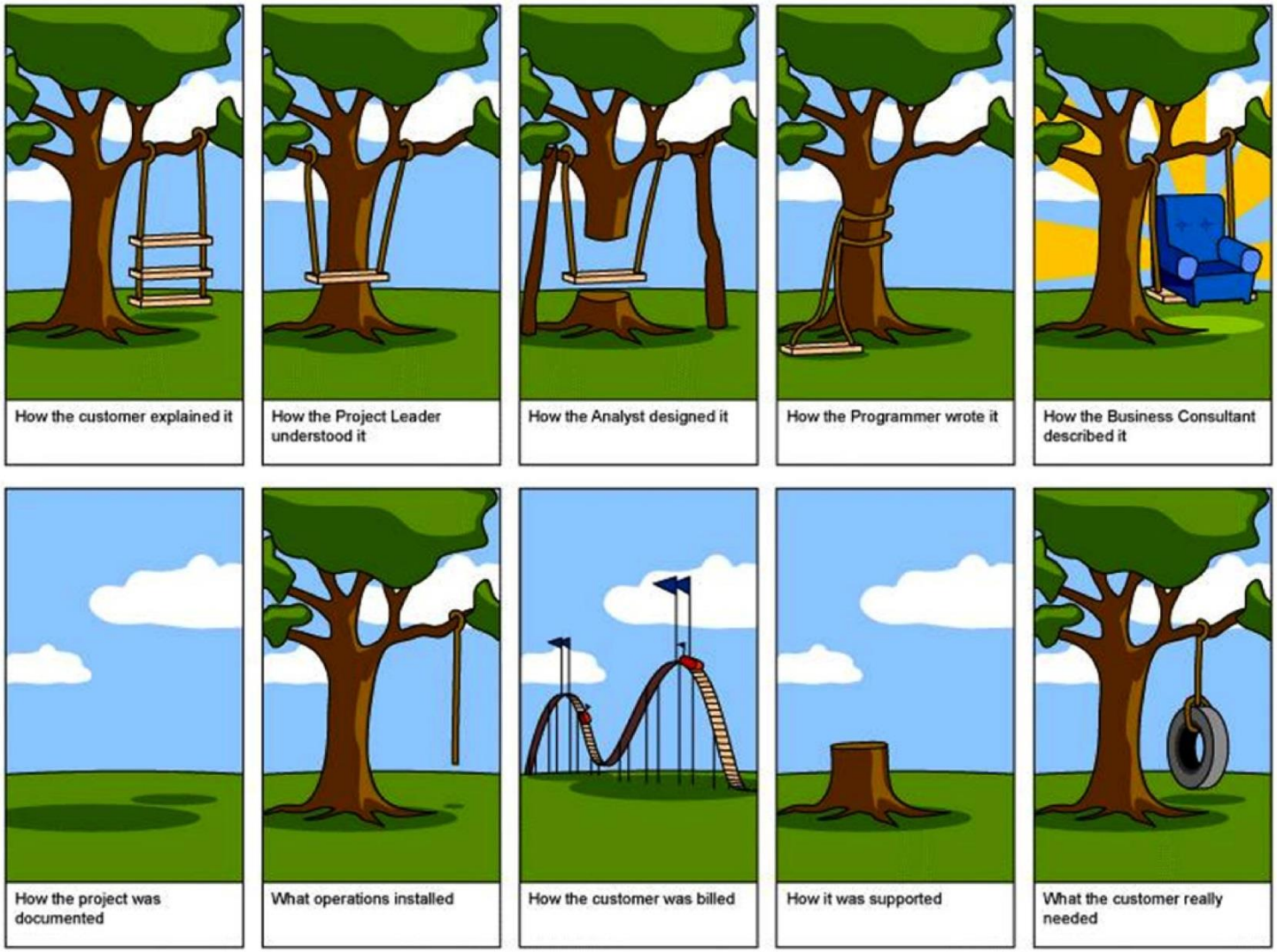
Description
5-10 lines describing the project from the users' point of view. Don't mention technologies nor devices.

https://docs.google.com/document/d/1HUxItyx1alU59Bmnjuz1WtKS0rePtmCner8uaIfjQu8

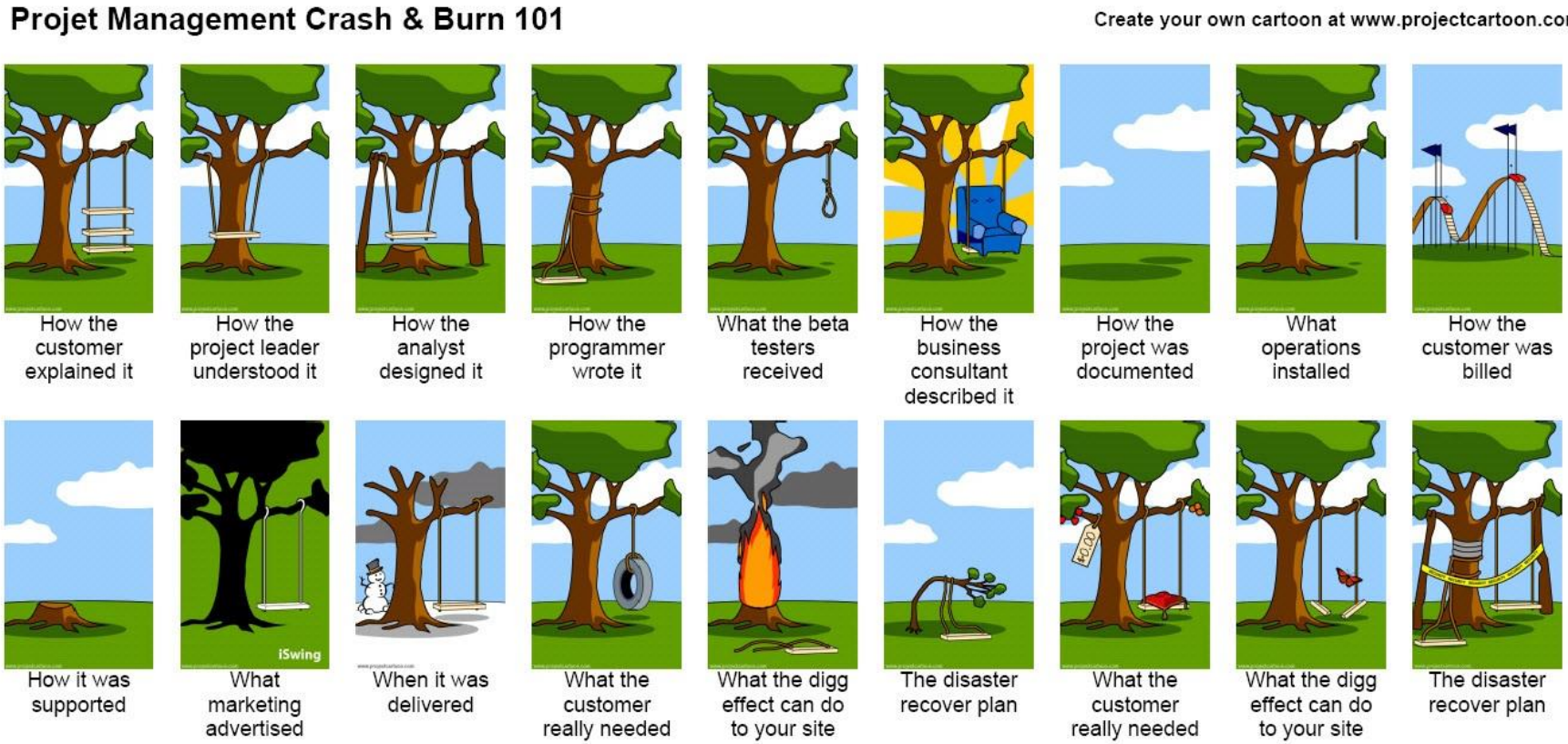
AmI Design Process

GENERAL DESIGN PROCESS

The all-too-common problem



Still more accurate…



Goals

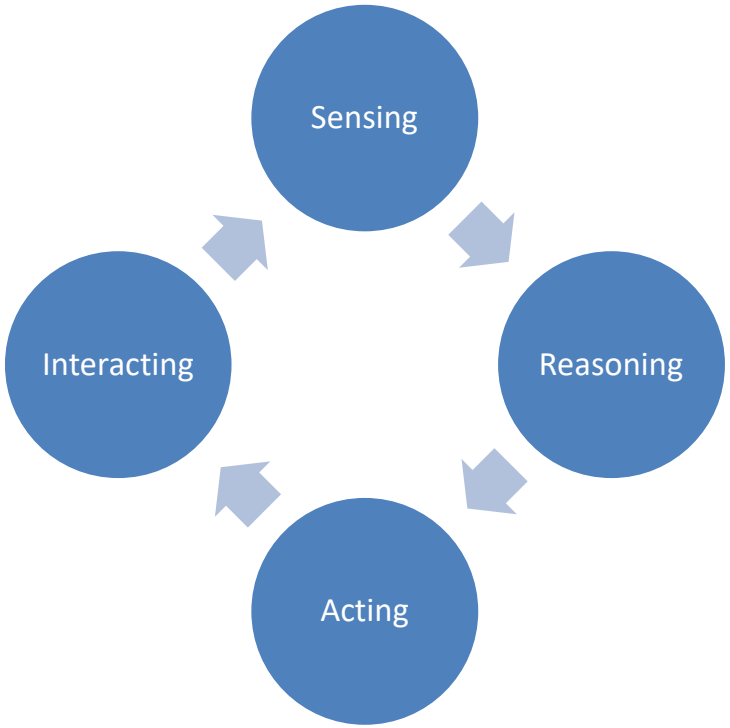
- To select **one** possible approach, among the many ones proposed, to design and realize an AmI system
- To analyze and formalize **one** possible flow of activities
- To understand the activity and the output of the main **steps**

- To define a scaled-down version compatible with the time constraints we have in the AmI course

What we want to achieve

- From initial idea…

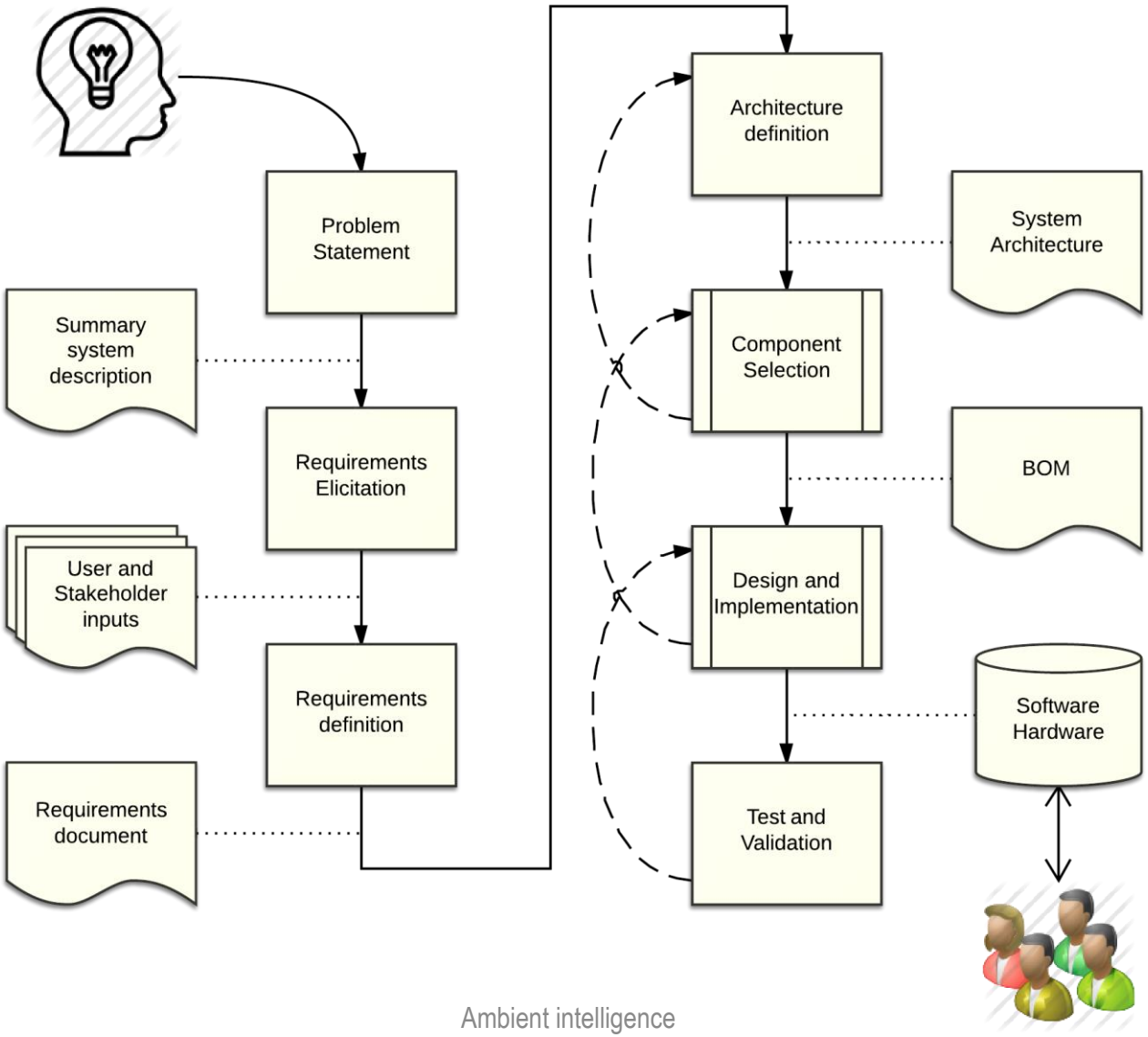
- …to working AmI system



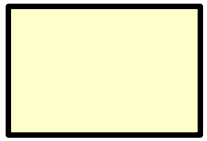
Assumptions

- The approach should be **technology-neutral**, i.e., the best fitting technologies will be selected **during** the process, and will **not** be defined **a-priori**
- When existing solutions/devices are **available and suitable** for the goal, aim at **integrating** them. When **no** suitable existing solution exists, consider developing/prototyping some **ad-hoc** device(s)

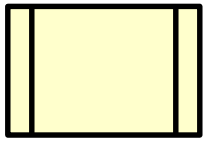
Proposed process



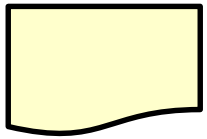
Legend



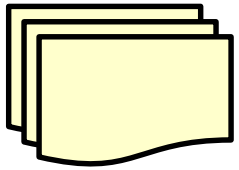
Activity



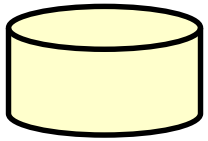
Complex activity



Document

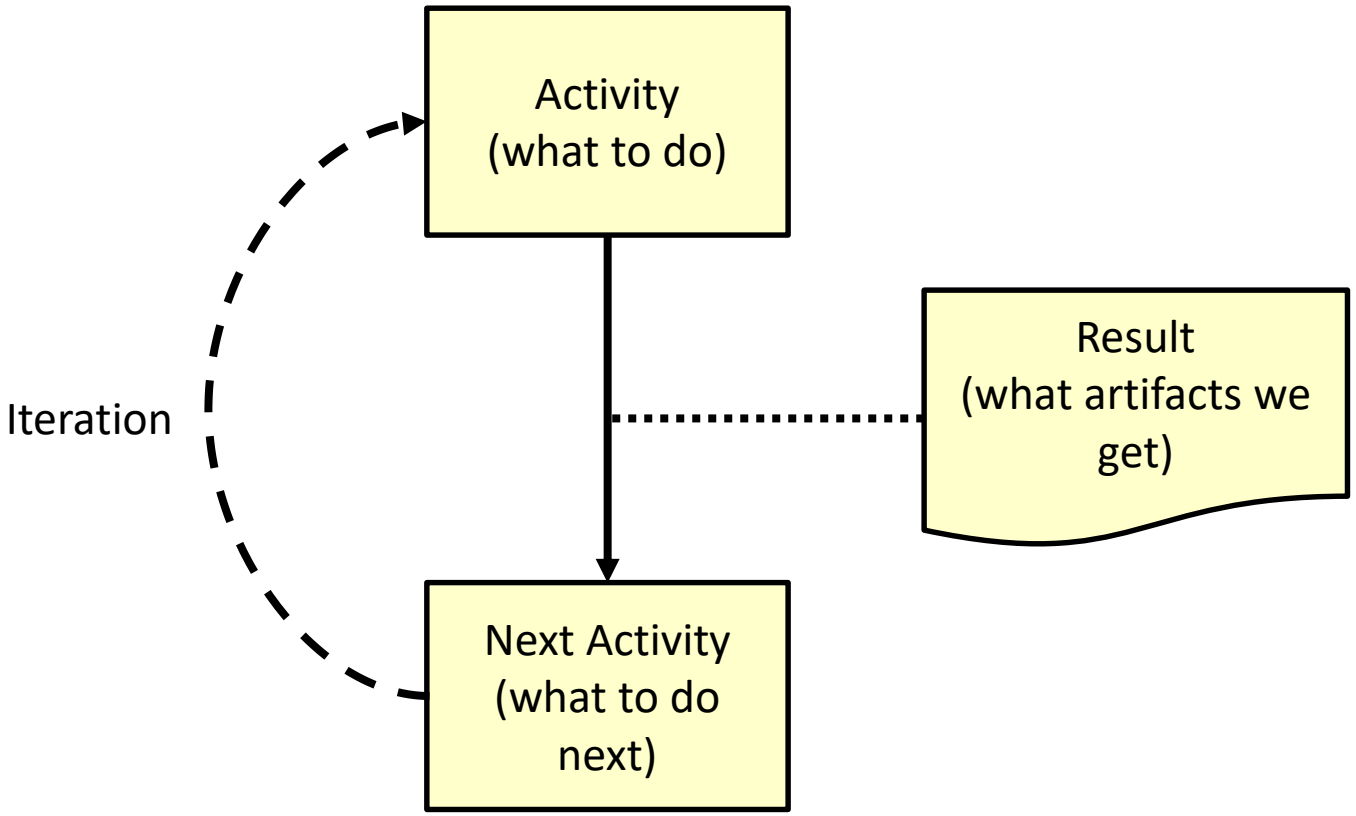


Documents



Tools

Composition of each step



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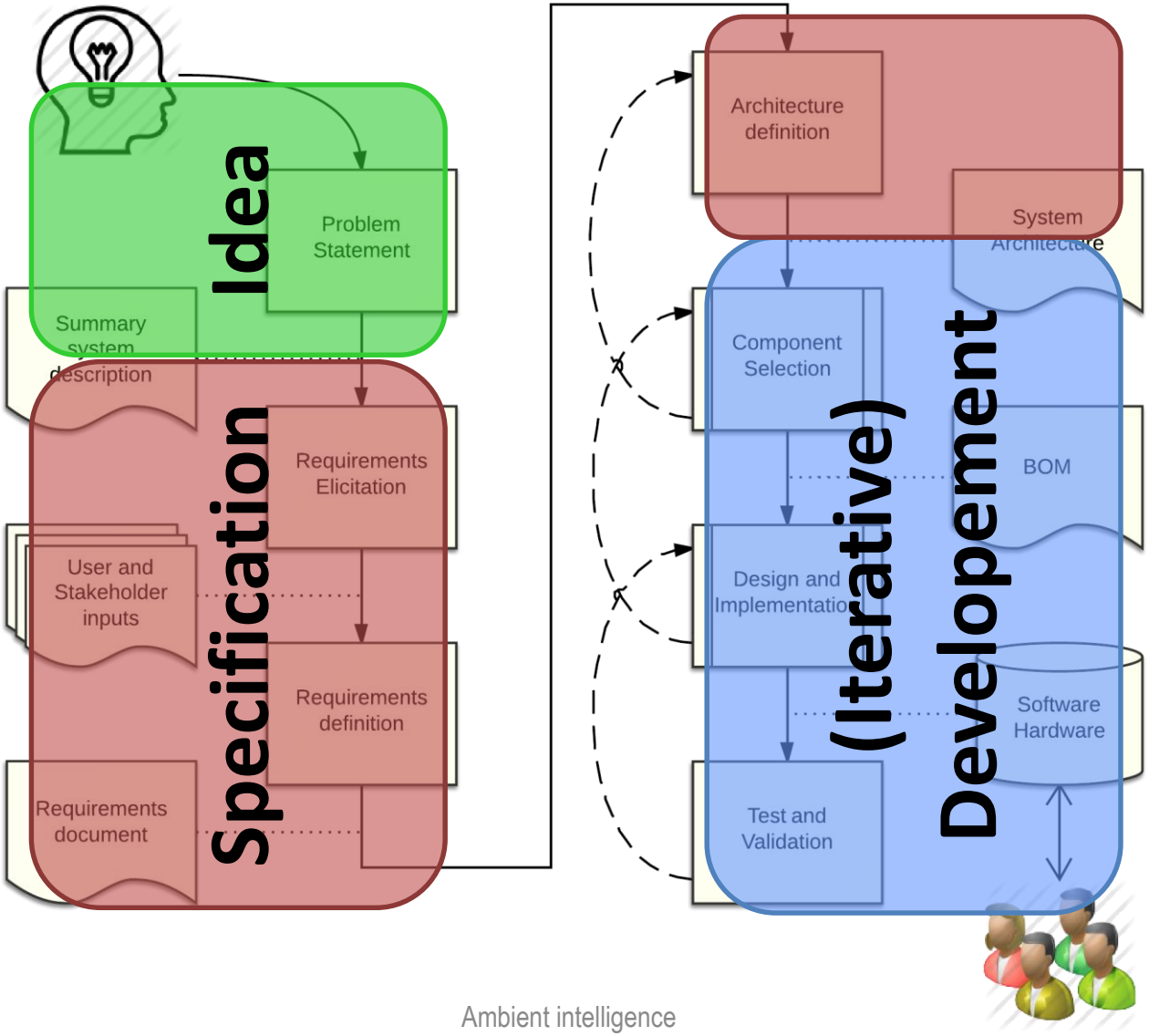
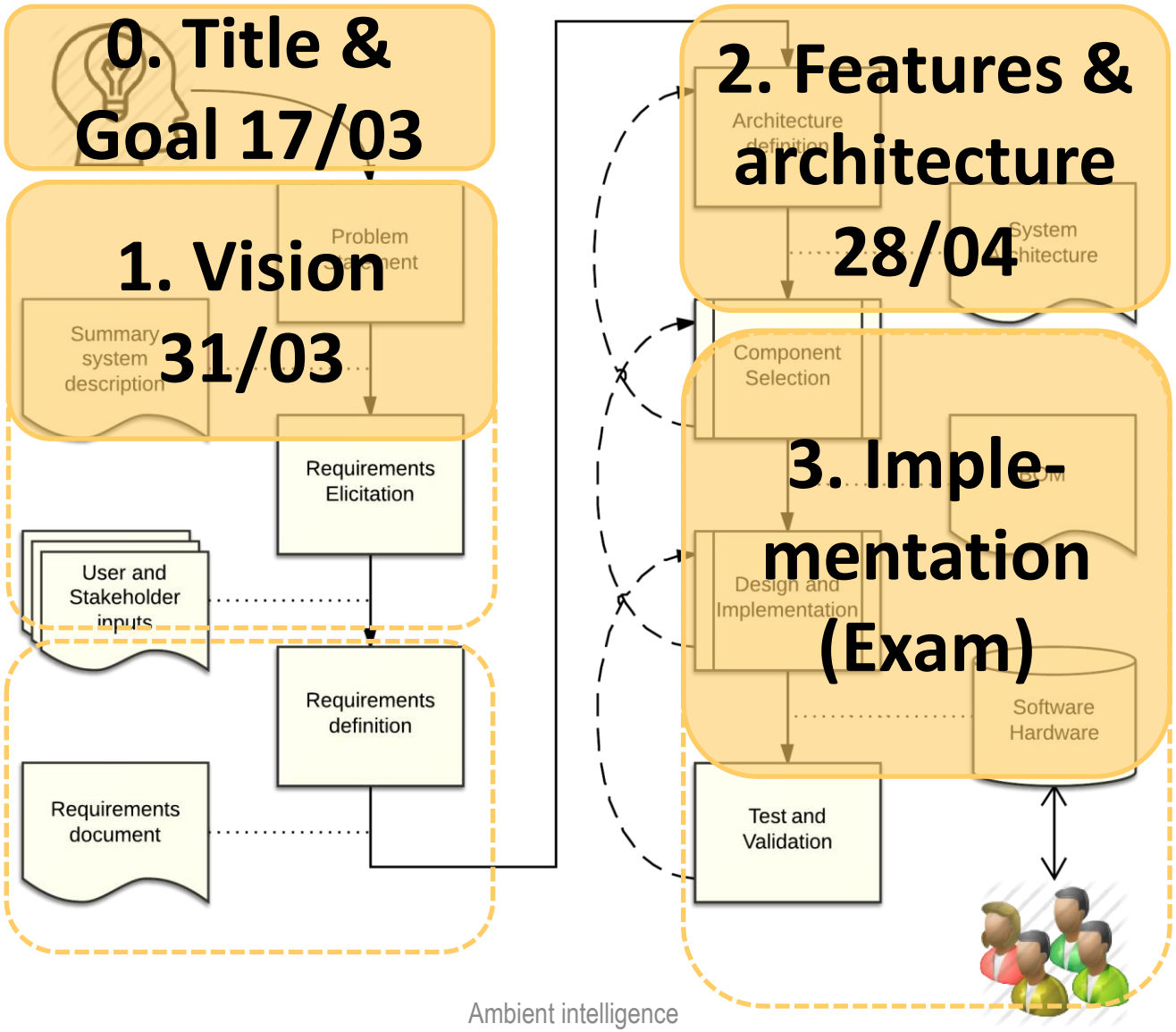
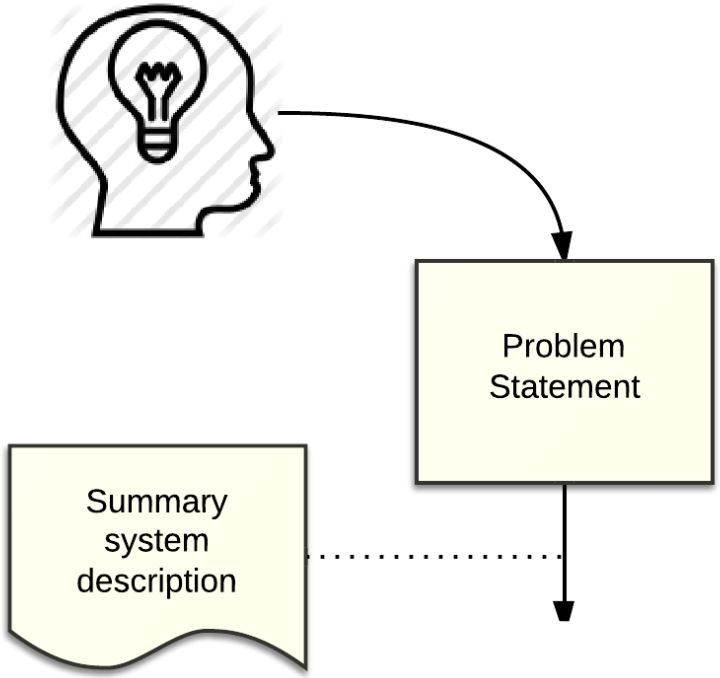


Simplified process & Deadlines



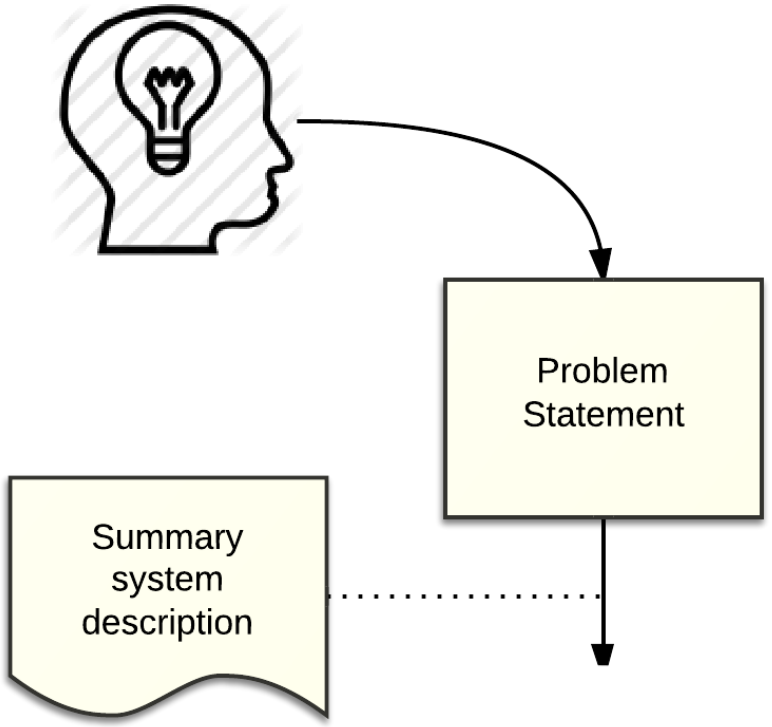


AmI Design Process

STEP 1: PROBLEM STATEMENT

Problem Statement

- Define what **problems** need to be solved/tackled
- Identify the **benefits**
  - For the users
  - For the environment
- Create a **brief summary** of **what the system does for the users**



Summary System Description

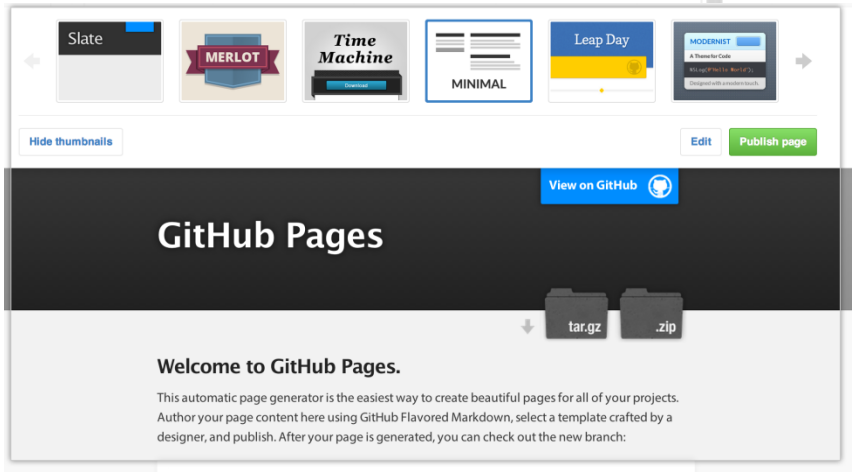
- ½ page – 1 page max of “vision”
- Absolutely **avoid** describing the **technology** or making some technical choices
- Define the target environment
- Define your **users**
- Describe **how** the environment supports the users, from the user point of view
- Try to **hint** at AmI features (Sensitive, Responsive, Adaptive, Transparent, Ubiquitous, Intelligent)
- Imagine “selling” it to a non-engineer (find someone to read it)

Tips

- No technology
  - But we must know it's feasible, somehow
- Start simple
  - Few features, few users
  - But full AmI features
- Pitch it
  - Why users should be happy to use it
  - Tell a story…
- Google it
  - Search for similar ideas / products / articles
- Involve users
  - Describe, discuss, ask, **LISTEN**
  - Users know better (except when they don't)

Deliverable 1

- Before 31/03
- Set-up project web site
- Develop your «Vision»
- Integrate the «Vision» on the website
  - In the website content, not as a separate document
  - Conforming to the available checklist
- You'll receive feedback on 01/04 (in LADISPE)

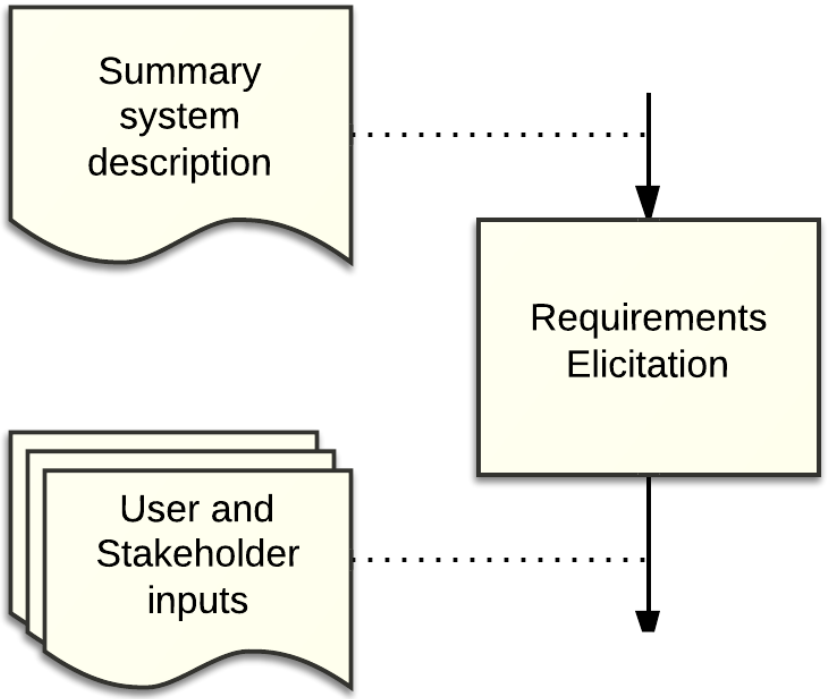


Vision: «WakeKill»

- Each user requires their own personalized wake-up experience. Users will never miss a wake-up call, every morning will be a pleasing experience and they will never be late. Your house, your devices, your calendars, will team up to personalize the optimum wake-up call, personalized to you, and personalized to your day's schedule, location, and mood.
- The system will exploit different means to wake up users in the morning. It will combine ringing, turning on the lights, the radio, and other methods, according to the available devices and to user preferences. It will automatically adjust time according to the user's agenda. When the user is not at home (e.g., hotel) it avoids activating at-home devices, and only users user devices. It will detect when the user actually wakes up (or is already up).

WakeKill

I absolutely love the user experience that WakeKill gives me

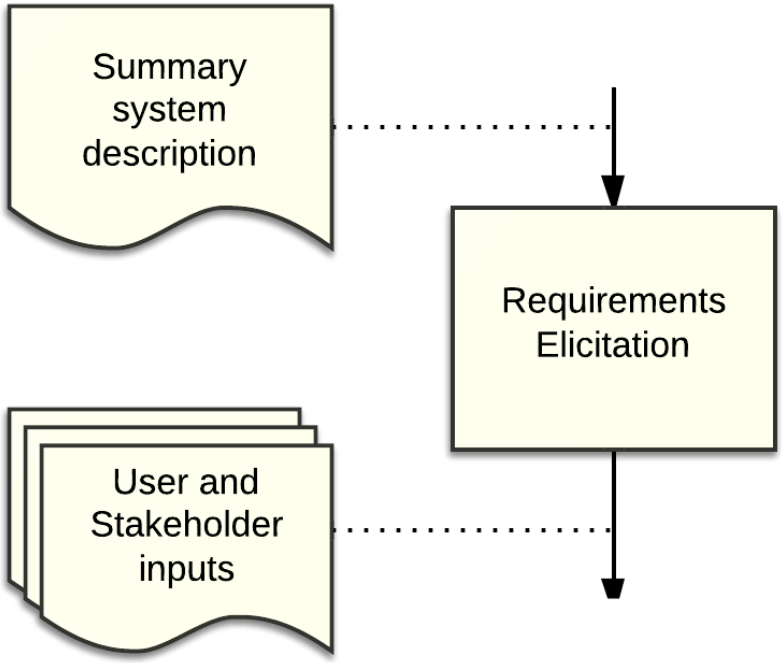


AmI Design Process

STEP 2: REQUIREMENTS ELICITATION

Elicitation

- Consider the needs and the opinions of
  - Users of the system
  - Stakeholders for the system
- Collect and evaluate carefully and objectively
- If needed, adapt your vision



Elicitation

- Consid
  the op
  - User
  - Stak
    syste
- Collect
  careful
- If neec
  vision

Due to time restrictions, this step is **not formally required** in the AmI course.
In the course, just try to get as many user inputs as possible, even in an informal and unstructured way, and consider them in building your vision.

It is, however, **essential** for successful ICT products.

Roles

Users

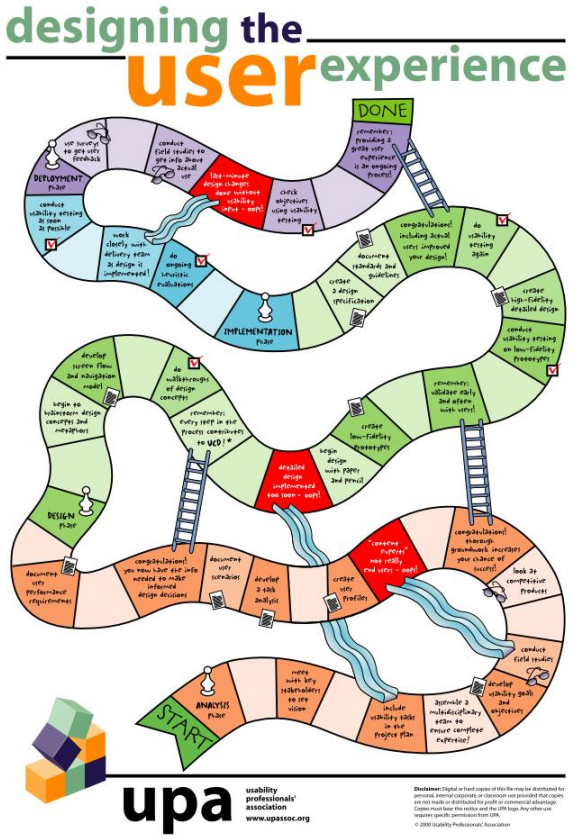
- Persons that will be the final targets of the system and will interact with the system
- Or, at least, persons with similar characteristics to the actual final targets
- Don’t need to understand how the system works
- Need to understand how they will interact

Stakeholders

- Persons (or institutions) that will have an interest in the success of the system
- May not be users
- “Interest” may be economic, better efficiency, user satisfaction, higher control or security, better understanding, …
- May be involved in funding the system

Users know better

- Serving users should be the cornerstone of AmI
- “User Centered Design” (UCD) is a methodology that includes a set of techniques for involving users throughout the design process



http://www.mprove.de/script/00/upa/_media/upaposter_85x11.pdf

Listening to users…

http://dilbert.com/strip/2010-01-13

http://dilbert.com/strip/2012-05-07

UCD requirements

- ISO standard Human-centered design for interactive systems (ISO 9241-210, 2010)
  - The design is based upon an explicit understanding of users, tasks and environments.
  - Users are involved throughout design and development.
  - The design is driven and refined by user-centered evaluation.
  - The process is iterative.
  - The design addresses the whole user experience.
  - The design team includes multidisciplinary skills and perspectives.

UCD tools and techniques

Conceptual tools

- Personas
  - a fictional character with all the characteristics of a “typical” user
- Scenario
  - a fictional story about the "daily life of" or a sequence of events with personas as the main character
- Use Case
  - the interaction between an individual and the rest of the world as a series of simple steps for the character to achieve his or her goal

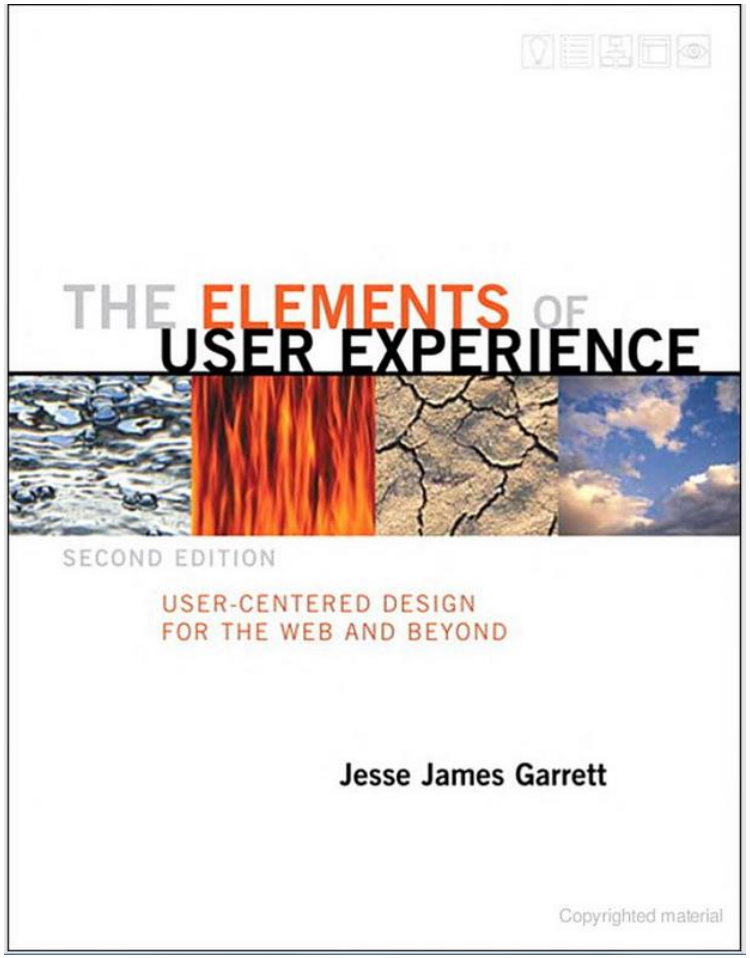
Design techniques

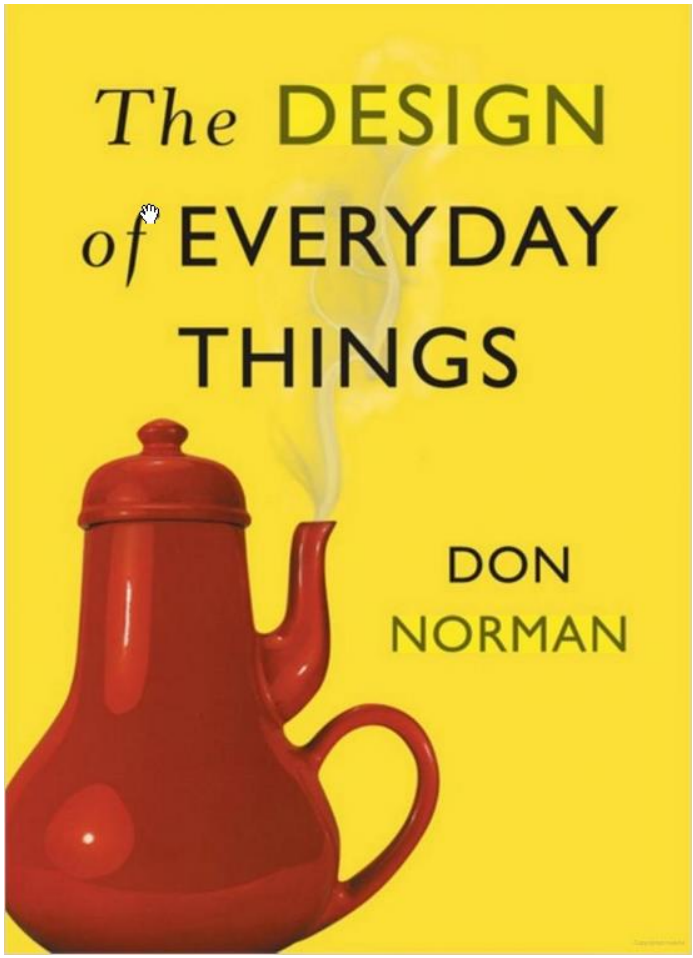
- Field research
- Focus groups
- Interviews
- Design walkthroughs
- Low-fi and Hi-fi prototypes
- Mock-up evaluation
- Usability testing

Result

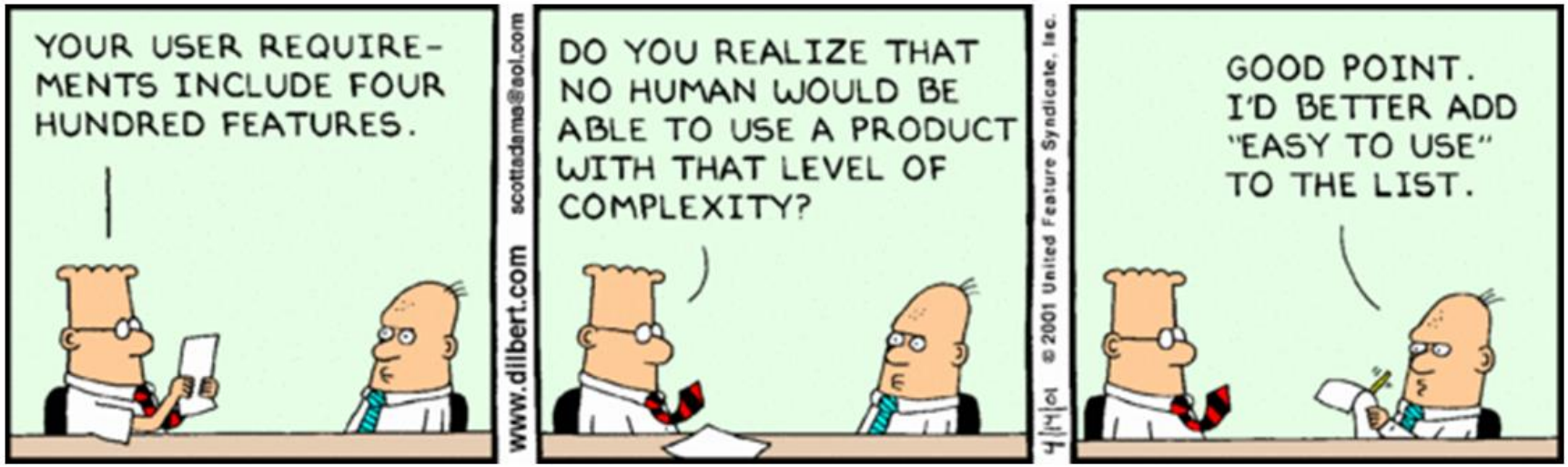
- Increased awareness of user perception in your proposed system
- Priority for different system features (some will be abandoned, some will be new)
- Gather design constraints (price, size, aesthetics,
- Mediate user inputs with product strategy
- Transform “a good idea” into “a system that users want”

Guru References





Beware…


YOUR USER REQUIREMENTS INCLUDE FOUR HUNDRED FEATURES.
DO YOU REALIZE THAT NO HUMAN WOULD BE ABLE TO USE A PRODUCT WITH THAT LEVEL OF COMPLEXITY?
GOOD POINT. I'D BETTER ADD "EASY TO USE" TO THE LIST.
www.dilbert.com scottadams@aol.com
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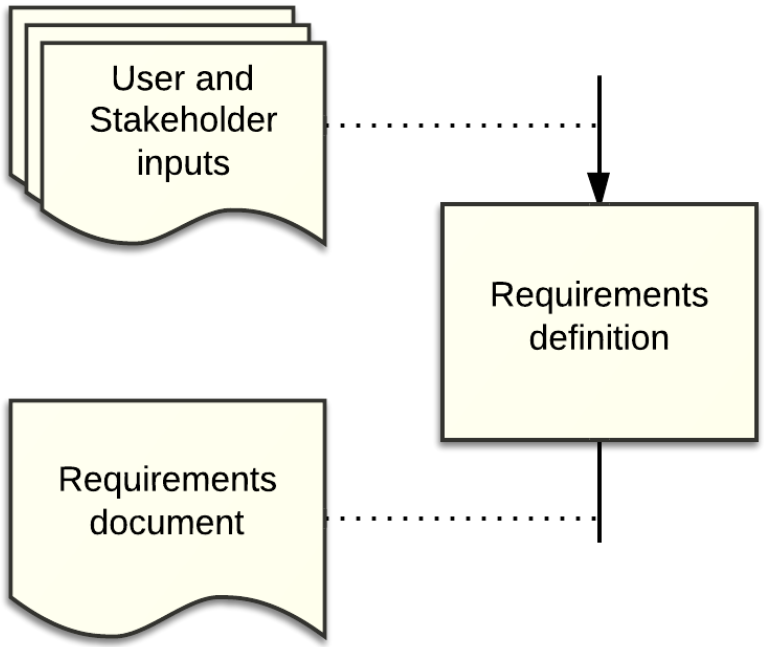
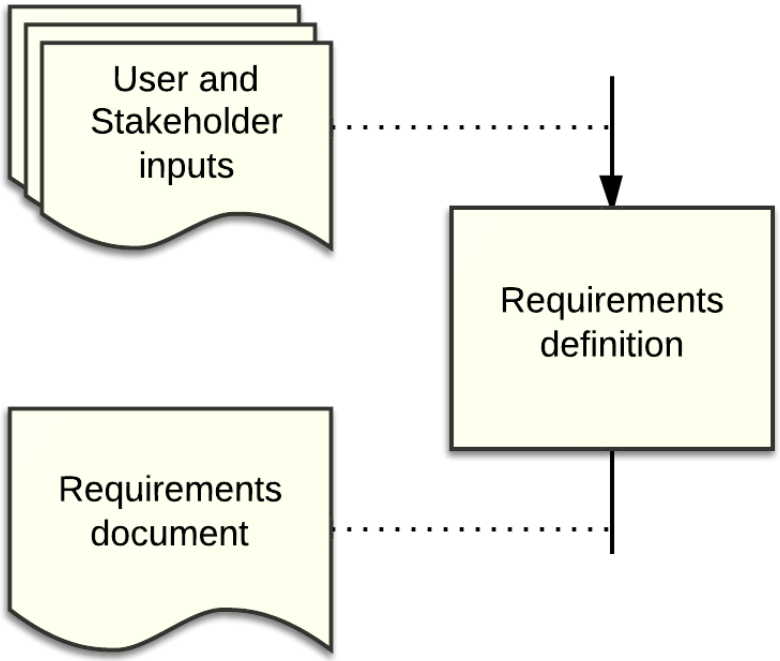


AmI Design Process

STEP 3: REQUIREMENTS IDENTIFICATION

Formalizing requirements

- The initial vision and user inputs must be “distilled” into a set of requirements
- Strategic choices: what is in, what is out
- Describes what the system does, and the external constraints
- Might be used as a “specification contract”



Types of requirements

- Functional requirements (FR)
  - Statements of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situations.
- Non-functional requirements (NFR)
  - Aka Quality requirements
  - constraints on the services or functions offered by the system such as timing constraints, constraints on the development process, standards, etc.
- Domain requirements
  - Requirements that come from the application domain of the system and that reflect characteristics of that domain.

Good requirements

Correct

Unambiguous

Complete

Consistent

Ranked

Verifiable

Modifiable

Traceable

Requirements vs. Features

Requirement

- A requirement is a capability that a product must possess or something a product must do in order to ultimately satisfy a customer need.
  - more granular
  - written with the *implementation* in mind

Feature

- A feature is a set of related requirements that allows the user to satisfy a business objective or need.
  - "higher-level" objective
  - more focused on *business/user needs*
  - something you'll print on a detailed datasheet
  - intended to be shared with your customers

http://pmblog.accompa.com/2009/07/13/features-vs-requirements-requirements-management-basics/
https://www.aha.io/roadmapping/guide/requirements-management/what-are-product-features

Product Features

- User-visible behaviors
  - data, information, acting, …
- User-callable functionality
  - commands, requests, …
- Information sensed
  - not the sensor, but the associated information
- Available customizations & preferences
- Environment modified behaviors

User Stories, Use Cases, User Narratives

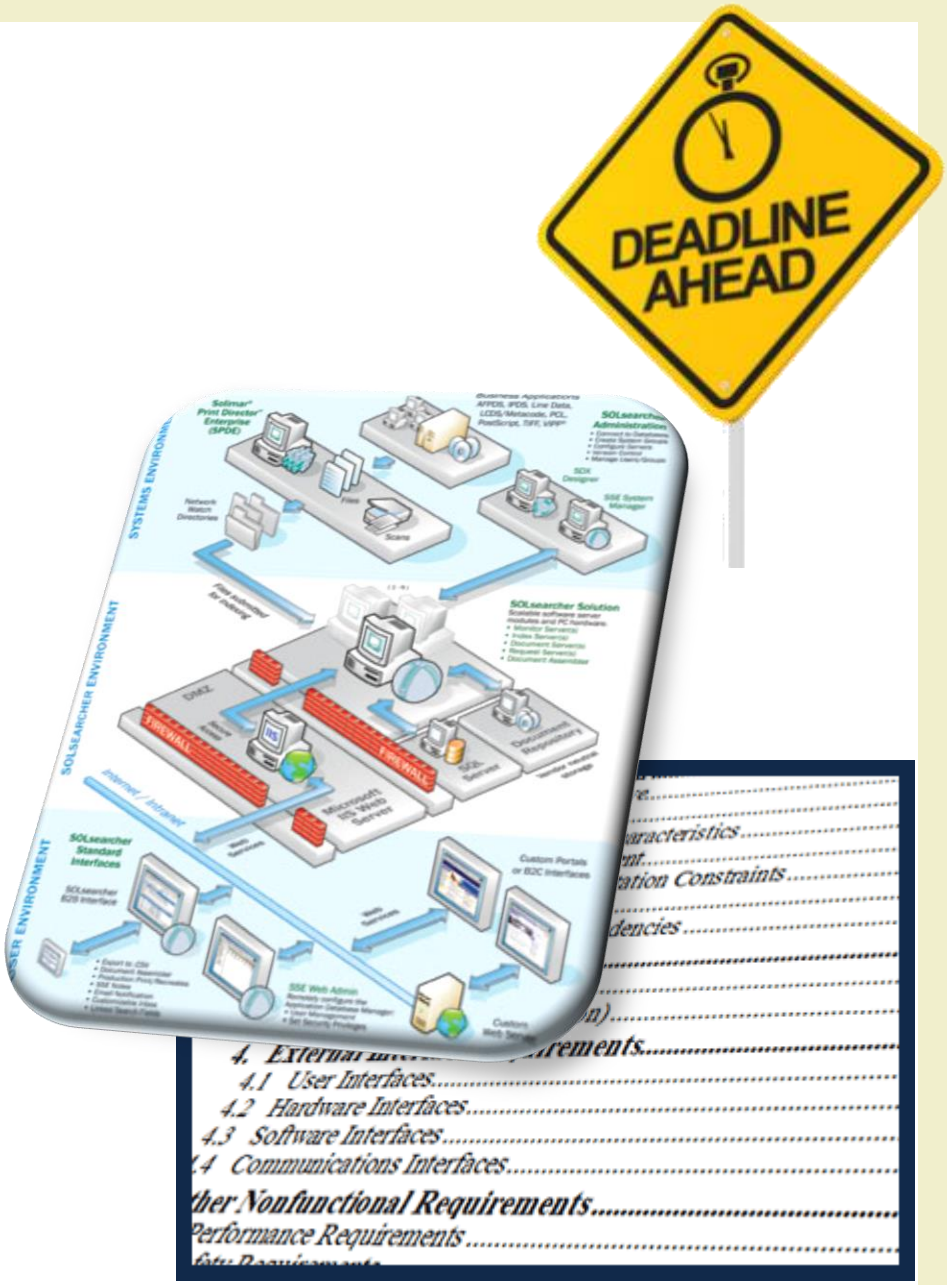
- Features may be illustrated by describing how a user is exploiting them, to reach some user goal
- A user X wants to achieve result Y so that he may get the benefit Z
  - Example: as an avid restaurant visitor I want to see unbiased reviews of a restaurant near a specific location so that I can decide where to go for dinner
  - Enabling feature: Unbiased reviews for restaurants
- User Stories are useful to put feature in context, and see how they interact.

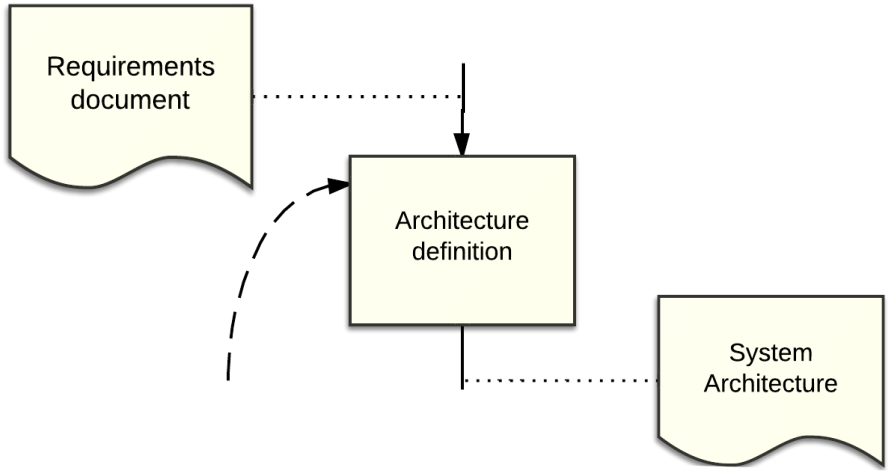
Features (Examples)

- Define a default alarm hour
- Correct the alarm hour according to Google Calendar first appointment
- Two working modes: at home and away
- In away mode, the smartphone rings
- In home mode, music and lights are used in addition to alarm
- Alarm detects when I wake up
- May define preferred music playlist
- May associate home devices

Deliverable 2

- Before 28/04
- **Features**
- **Architecture**
- We'll provide a checklist
- Upload on the website
  - Integrate, no separate download
- You'll receive feedback on 29/04



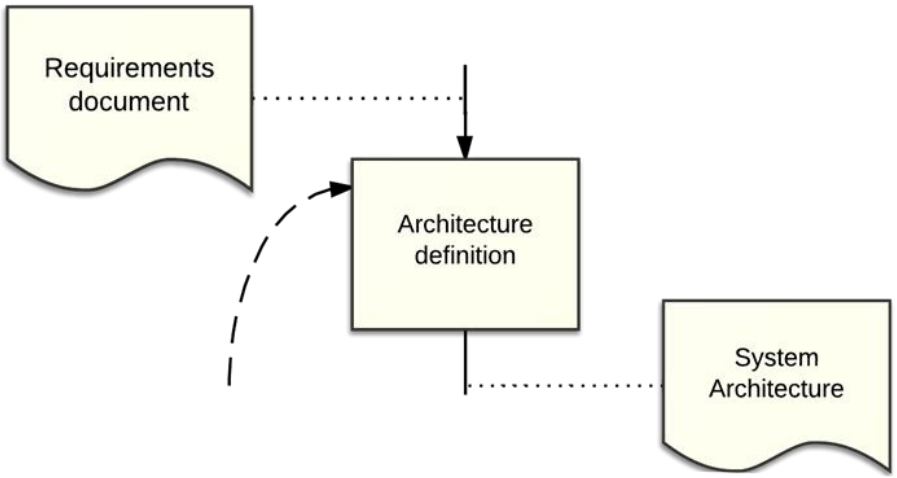


AmI Design Process

STEP 4: ARCHITECTURE DEFINITION

Defining the Architecture

- System Architecture
- Hardware Architecture
- Software Architecture
- Network Architecture



System Architecture

- What are the main system components, what is their nature, and what kind of information they exchange with the environment, the user, and other components?

- Computational nodes (One? Many?)
- Sensors/actuators (which physical interactions? Where installed? How interconnected?)
- User interfaces (Where? What functions?)
- Which functions are deployed on which nodes?

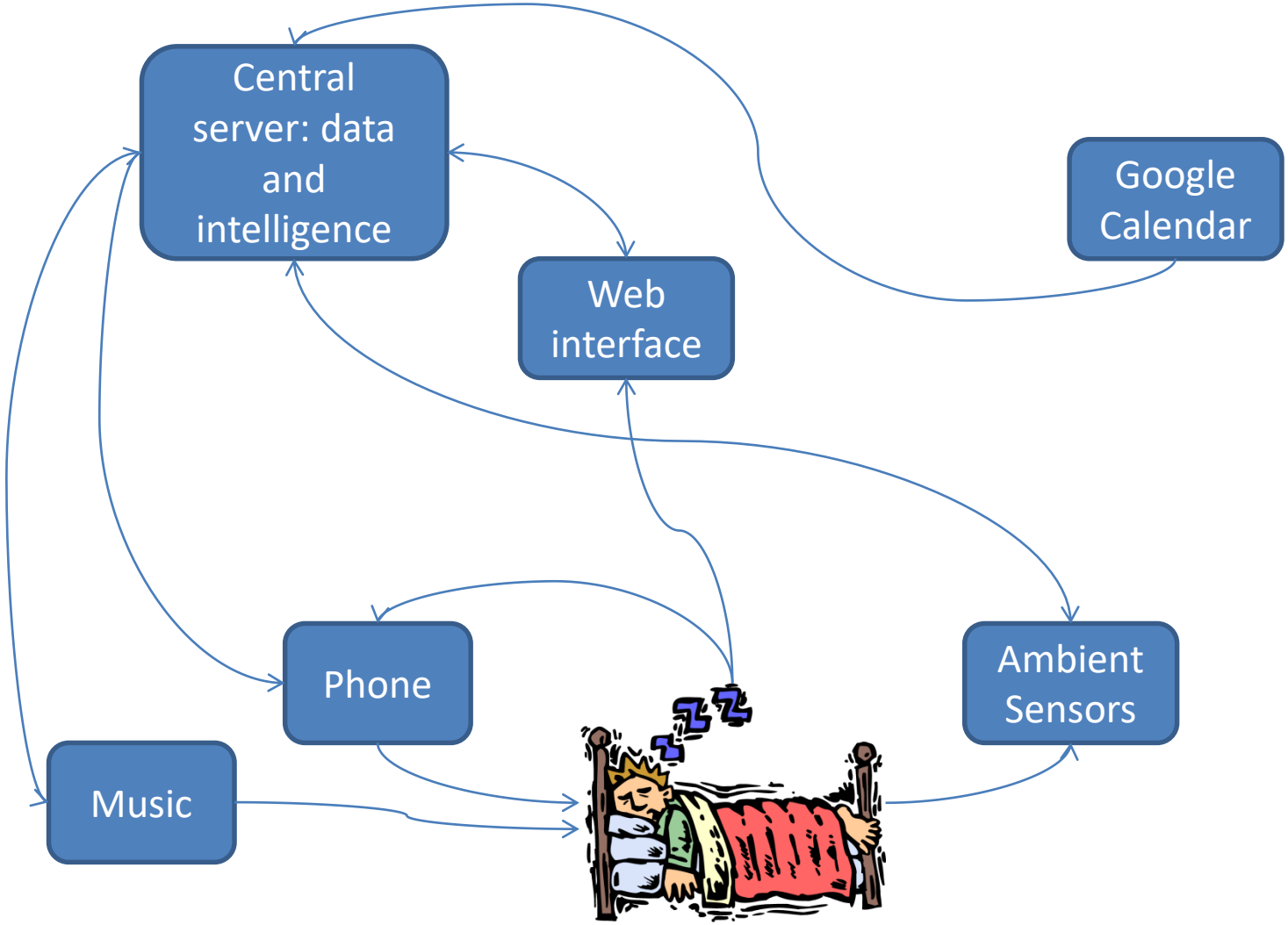
Hardware Architecture

- Computational nodes
- Devices (sensors/actuators)
  - types, function, location
  - not yet brand & model
- User interface devices
  - type, function, location

Software Architecture

- Major software architectural modules
  - what functions (mapped to a subset of functional requirements)
  - where are running (deployment)
  - how they interact (APIs)
- May be existing components, or new SW to be developed
- Adopted libraries and frameworks

Example System Architecture



Example Hardware Architecture

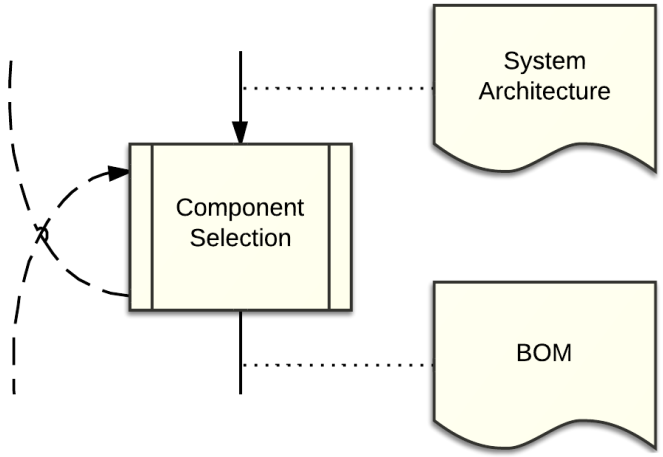
- Ambient sensors
  - Movement sensors in the room
  - Weight/movement sensors under the bed
  - Local gateway (raspberry?) for integrating sensor data
- Mobile Phone (any, Android 4+)
- Server (data storage, interaction with cloud services, web interface generation, intelligence)
  - Anywhere in the web, always-on system.
  - Raspberry-PI? PC? Virtual cloud server?
- Music server (raspberry PI + audio amplifier)

Example Software Architecture

- Data sensor collection software (on local gateway)
  - Sends data to central server
  - Some local processing for detecting situations ???
- Music server software (on local gw)
  - Accept commands from central server
- App (on mobile phone)
  - Settings
  - Ringing
  - Relaying user info (GPS, accelerometer) to central server
- Web application (on central server)
  - User settings
  - Analytics and statistics
- Data storage (on central server)
  - Store sensor data and calendar data
- Intelligent core (on central server)
  - Receive inputs, analyze data, decide what action to perform, send commands to devices

Example Network Architecture

- Local Gateway on home LAN, connected to Internet via ADSL NAT
  - Port forwarding, open tunnel or VPN for being reached BY the central server
- Wireless sensors (e.g., Z-Wave), connected to local gateway (acting as a mesh controller)
- Phone connected to local wi-fi or to 3G network (all functions supported in both cases?). Connects to central server, only
- Central server: world-accessible public IP address

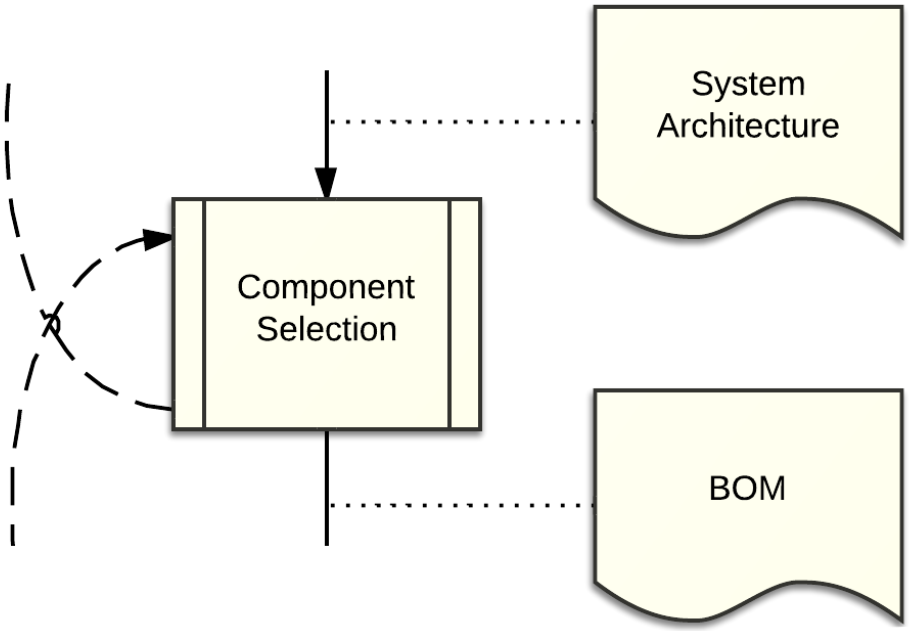


AmI Design Process

STEP 5: COMPONENT SELECTION

Selecting components

- Identifying actual products to populate the chosen architecture description
- Evaluating cost-integration-functionality-design tradeoffs
- Identifying needs for DIY HW and for SW development
- Usually iterates over the definition of the architecture



Selecting HW components

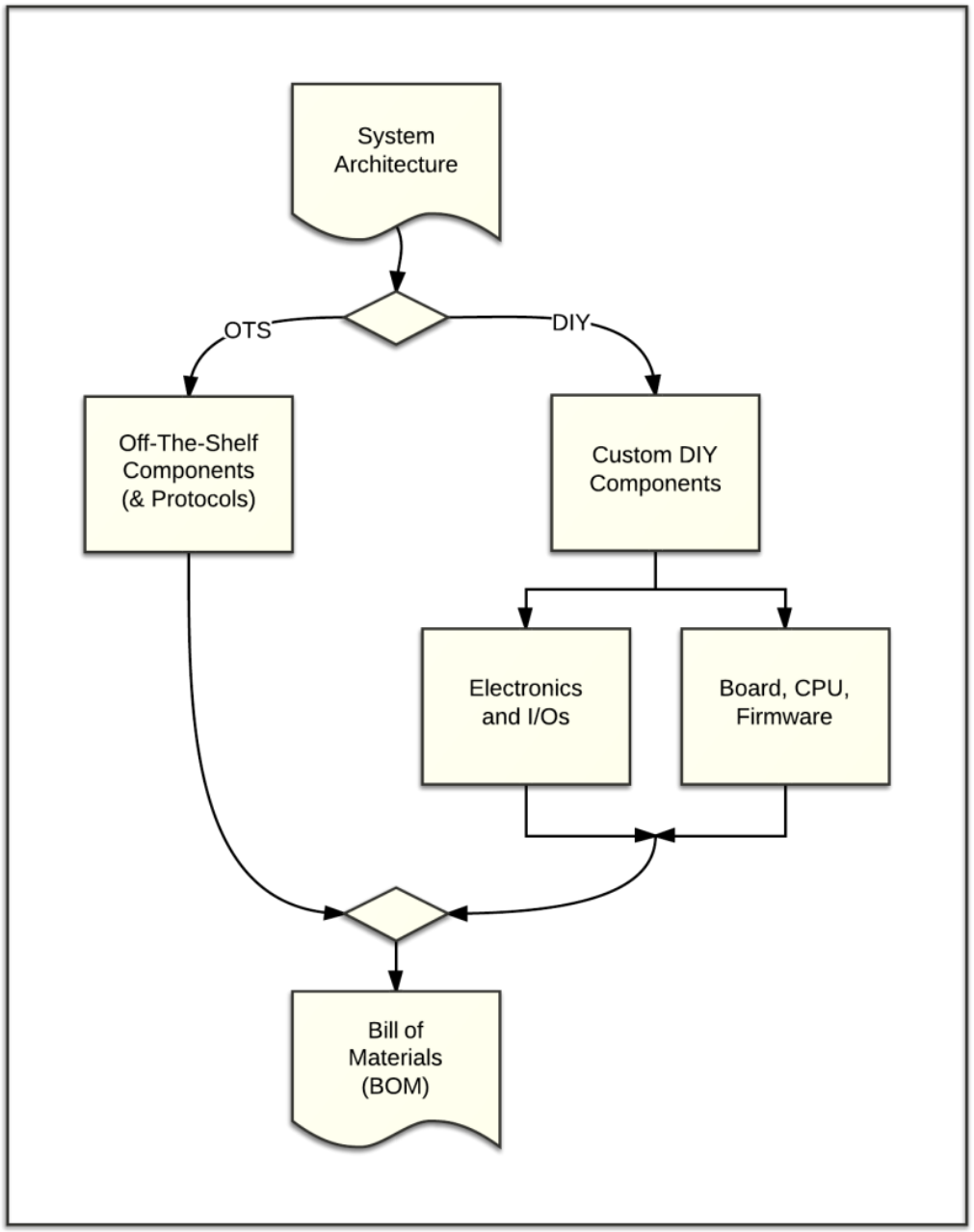
Off-the-shelf

- Which existing OTS components may fit the requirements and the design constraints (also considering budget)
- Aim at selecting, as much as possible, components that share the same communication protocol
- Includes Computational nodes

Custom

- Which components must be built with DIY techniques
- What kind of hardware (electronics, I/O, …) is needed
- What kind of computational node is required to support the hardware

Component Selection



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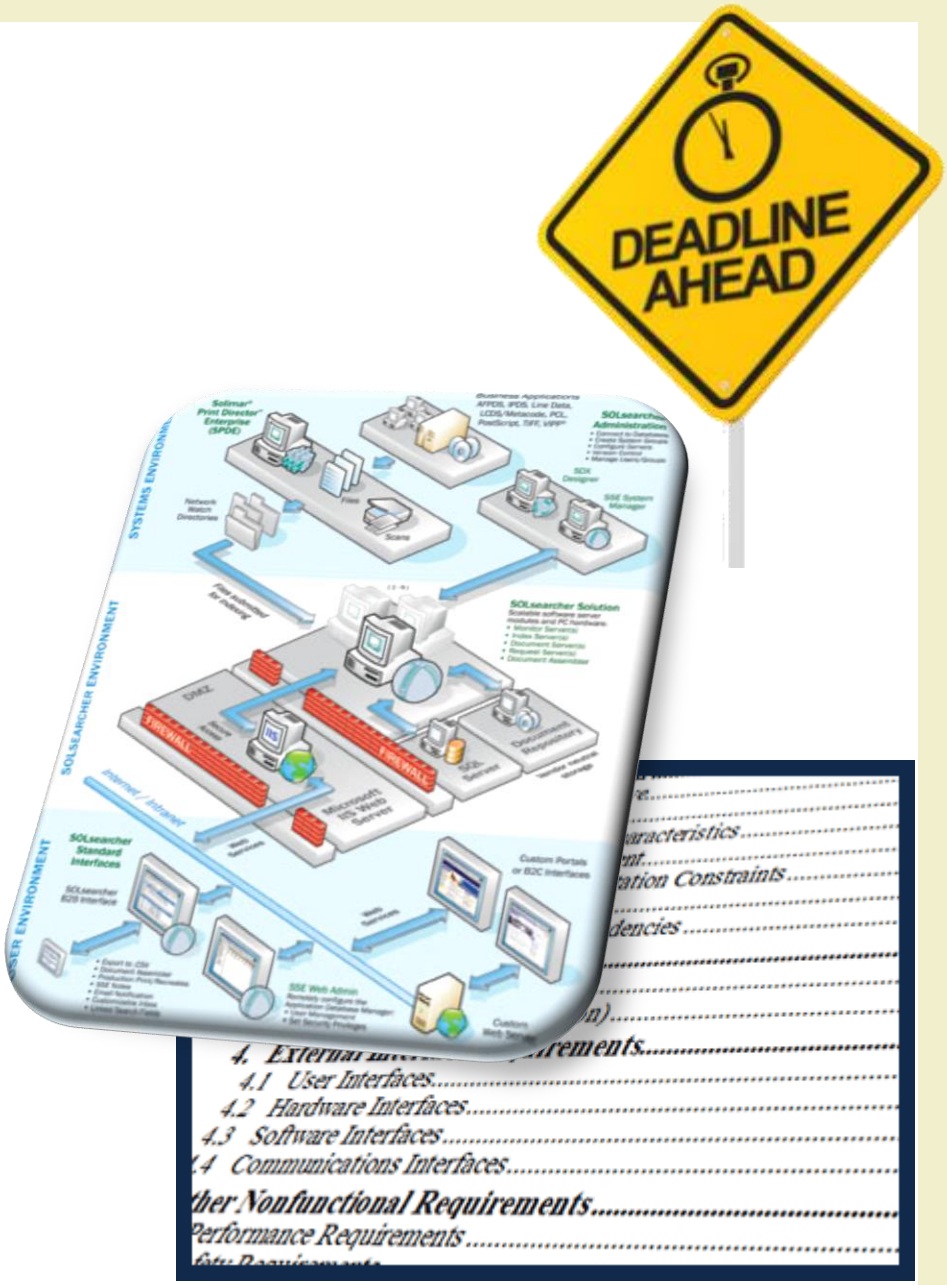
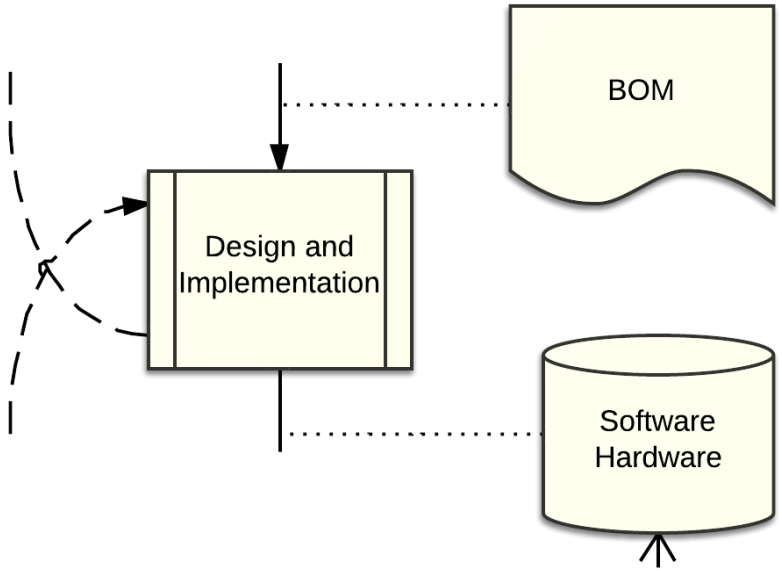
  - Integrate, no separate download
- You'll receive feedback on 29/04



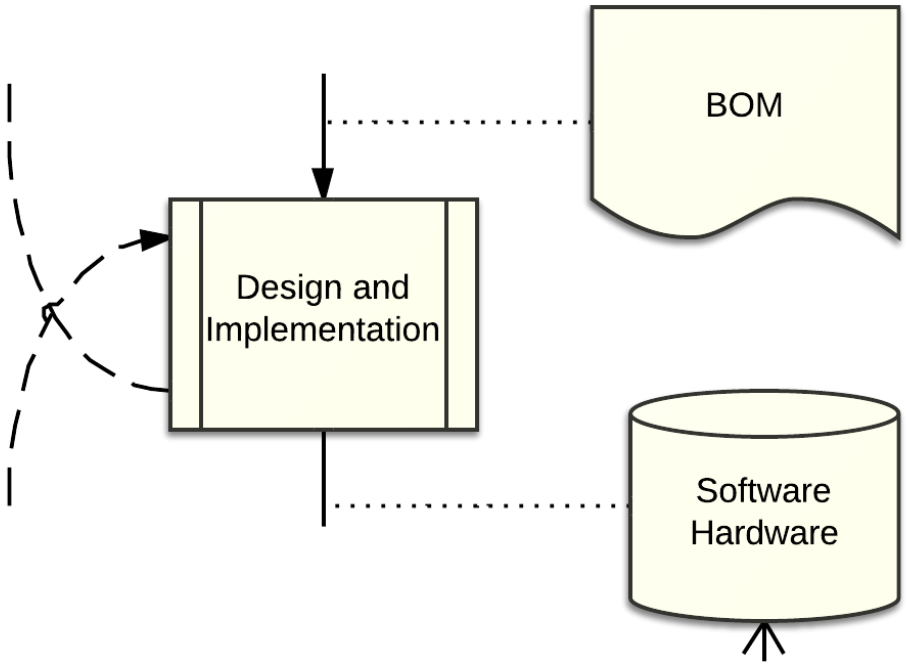


AmI Design Process

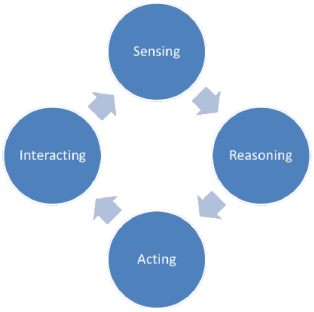
STEP 6: DESIGN & IMPLEMENTATION

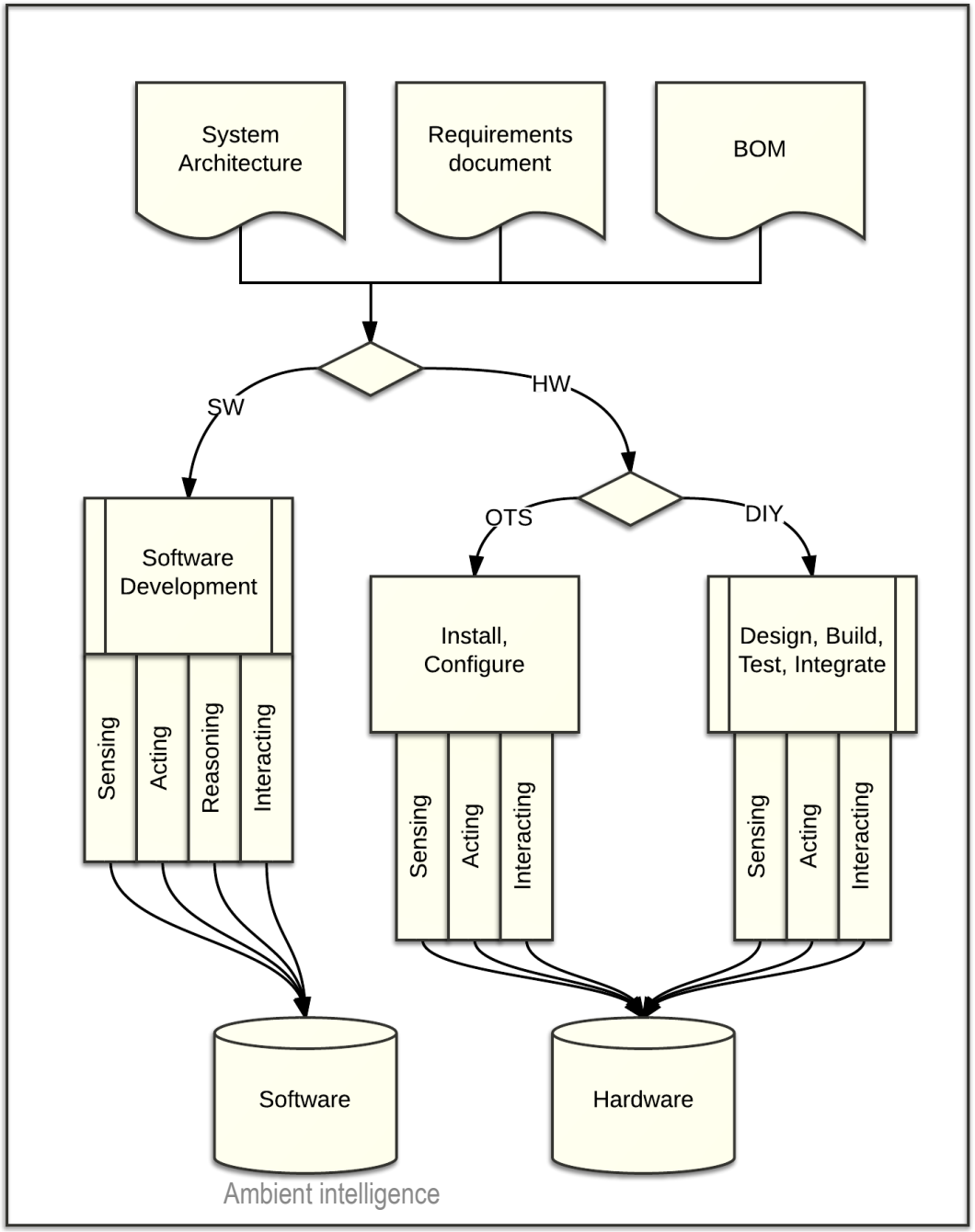
Implementation

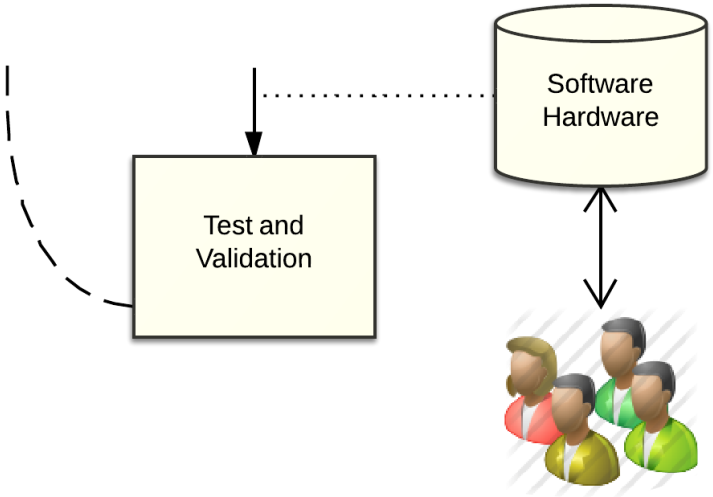
- Realize the HW and SW components defined in the previous steps
  - Implement DIY Hardware
  - Install and/or configure OTS Hardware
  - Develop Software
  - Integrate the SW architecture
- Parallel activities for different disciplines



Design and Implementation





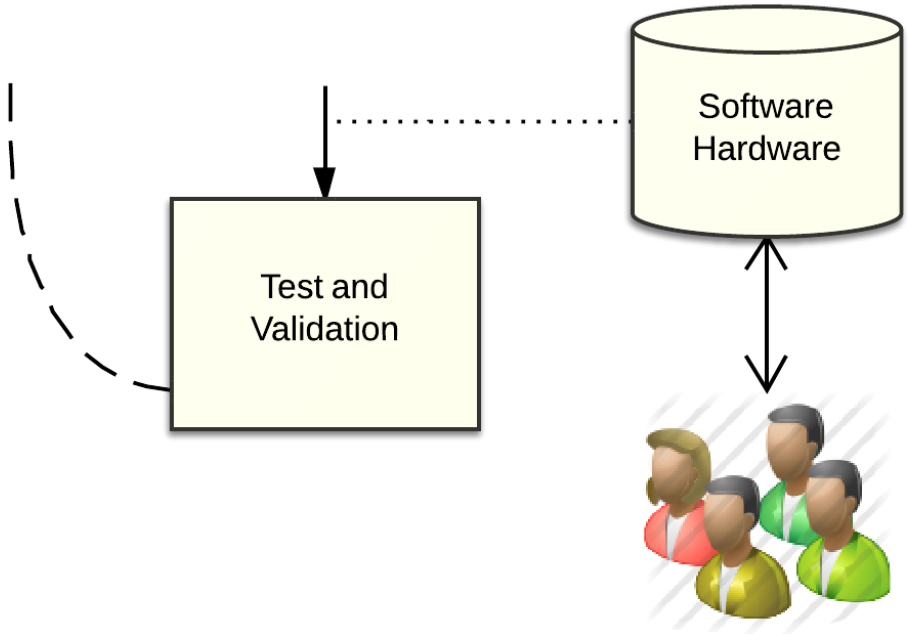


AmI Design Process

STEP 7: TEST AND VALIDATION

Testing the system

- Deploy the prototype of the system (carefully)
- Verify whether requirements are satisfied.
- Verify whether users and stakeholders are satisfied.
- Test should be executed by means of small iterative improvements



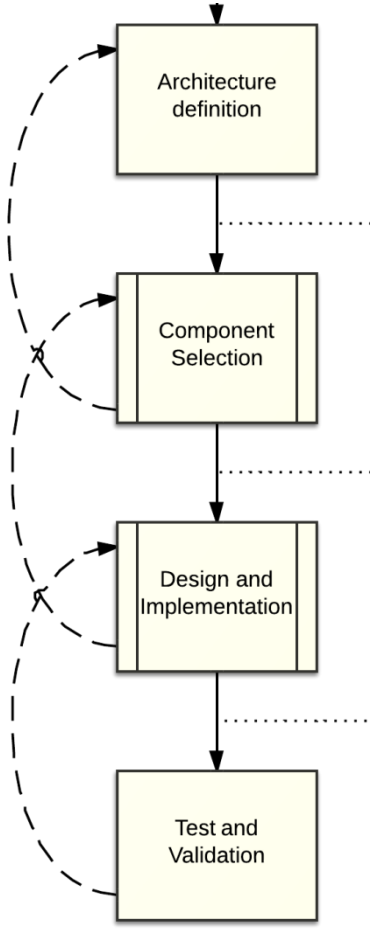
What are we testing?
(aka Verification and Validation)

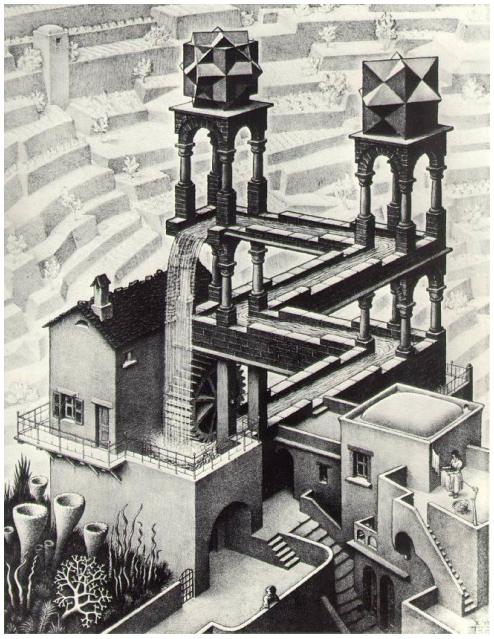
- **Verification** is intended to check that a product, service, or system meets a set of design specifications.
- Test with respect to the Requirements document
- «Am I building the system right?»

- **Validation** is intended to ensure a product, service, or system result in a product, service, or system that meets the operational needs of the user
- Test with respect to Users and Stakeholders inputs
- «Am I building the right system?»

Loops and iterations

- Every design steps should be re-considered, if the need arises
- “Agile” methodologies encourage iterative discovery of system design
- Suggestion: loop over small improvements.
- Aim at a minimal working system, then add features





Practical issues

- All deliverable should be submitted through GitHub
  - GitHub project(s) for source code
  - Public project website for deliverable contents
- We provide “templates” for the required contents of the deliverables
- Deliverables will be checked, and we will provide feedback.
  - If you have questions or doubts, you are responsible for asking
- Deliverables will be evaluated during the exam.

Resources

- http://en.wikipedia.org/wiki/Verification_and_validation
- IEEE Std 830-1998, IEEE Recommended Practice for Software Requirements Specifications

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