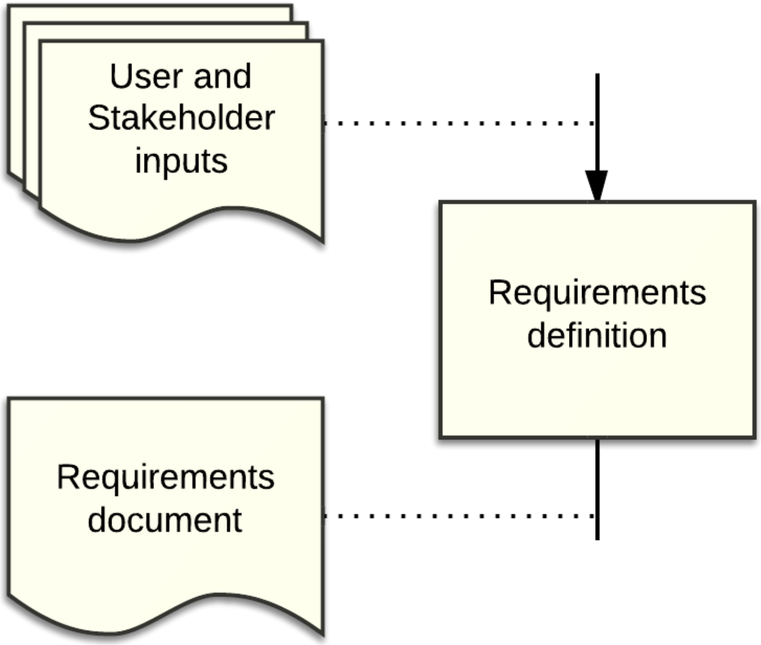
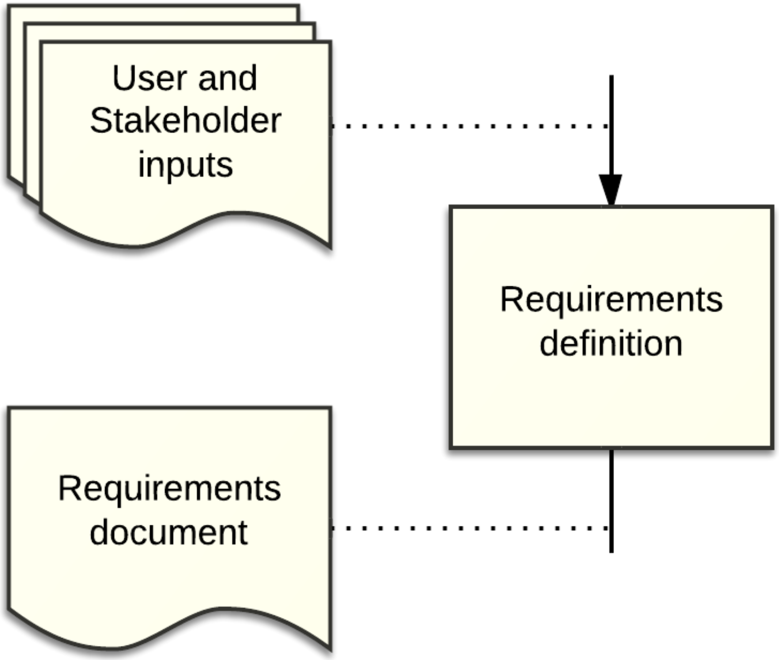


AmI Design Process

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

Good Requirements

- Correct
  - Every requirement stated is one that the software shall meet
  - Customer or users can determine if the requirement correctly reflects their actual needs
    - Traceability makes this easier
- Unambiguous
  - Every requirement has only one interpretation
  - Each characteristic of the final product must be described using a single unique term
  - Both to those who create it and to those who use it

Good Requirements

- Complete
  - Include all significant requirements
    - Address external requirements imposed by system specification
  - Define response to all realizable inputs
    - Both correct or incorrect
  - Define all terms and unit of measure
- Internally Consistent
  - No subset of requirements is in conflict
    - Characteristics of real-world objects (e.g. GUI)
    - Logical or temporal
    - Different terms for the same object

Good Requirements

- Ranked
  - Stability in the future
  - Necessity
    - Essential
    - Conditional
    - Optional
- Verifiable
  - there exists some finite cost-effective process with which a person or machine can check that the software product meets the requirement.
    - Ambiguous requirements are not verifiable

Good Requirements

- Modifiable
  - structure and style such that any changes can be made easily, completely, and consistently while retaining the structure and style
    - Well structured
    - Non redundant
    - Separate requirements
- Traceable
  - Backward
    - explicitly referencing source in earlier documents
  - Forward
    - unique name or reference number

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

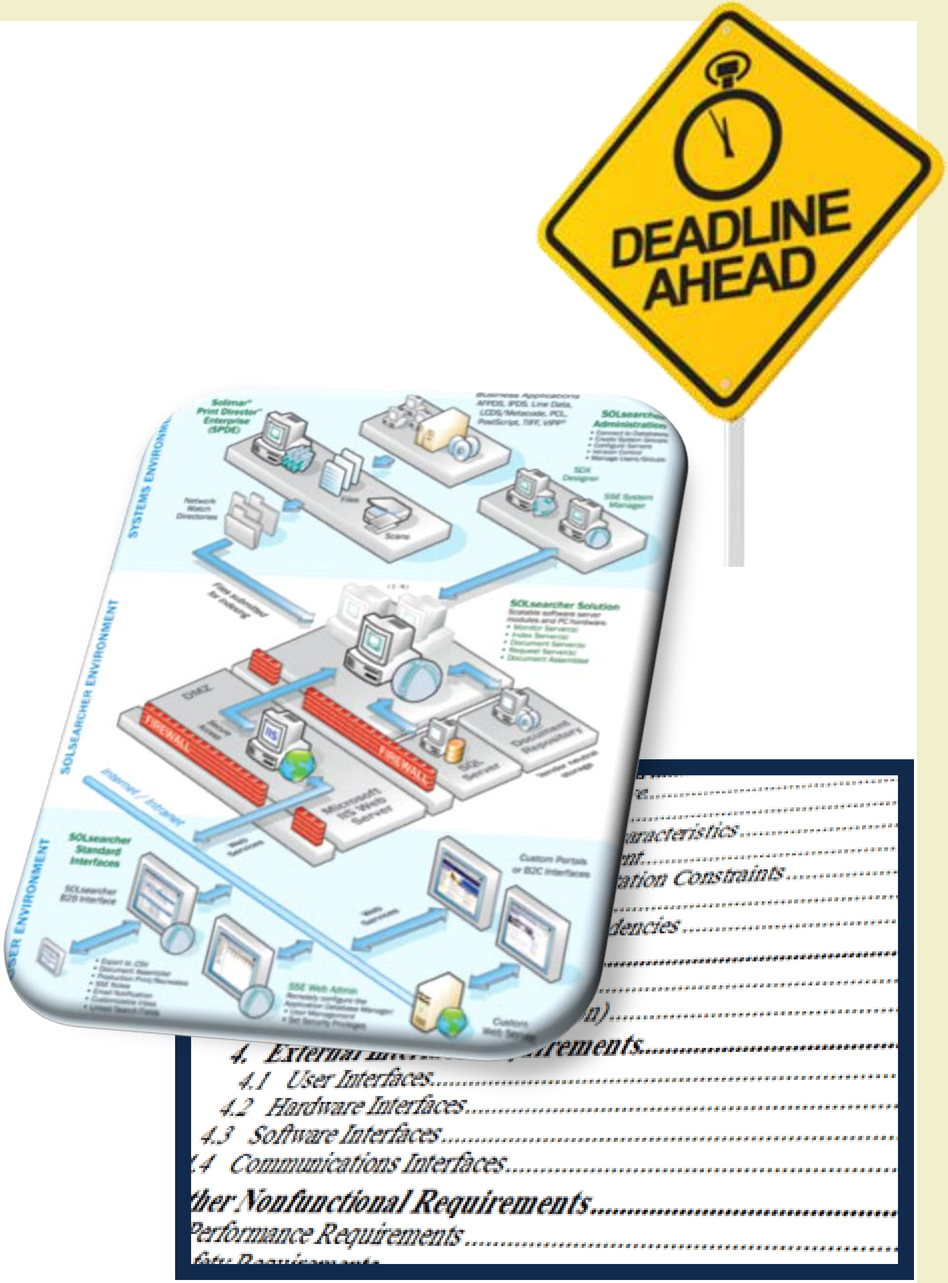
- Features may be illustrated by describing how a user is exploiting them, to reach some user goal
- A user X wants to achieve result Y so that he may get the benefit Z
  - Example: as an avid restaurant visitor I want to see unbiased reviews of a restaurant near a specific location so that I can decide 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 04/05
- **Features**
- **Architecture**
- We'll provide a checklist
- Upload on the website
  - Integrate, no separate download
- You'll receive feedback on 07/05



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...ation Constraints........

...dencies........

...n)........

4. External Inte... ...rements........

4.1 User Interfaces........

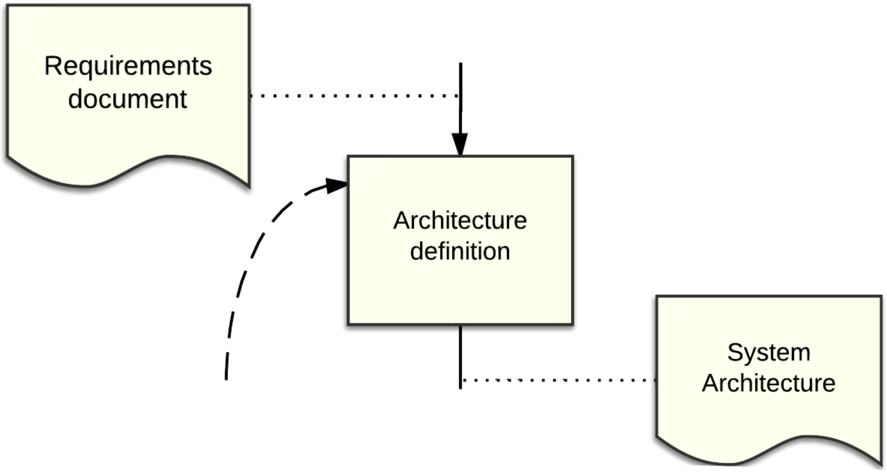
4.2 Hardware Interfaces........

4.3 Software Interfaces........

4.4 Communications Interfaces........

Other Nonfunctional Requirements........

Performance Requirements........



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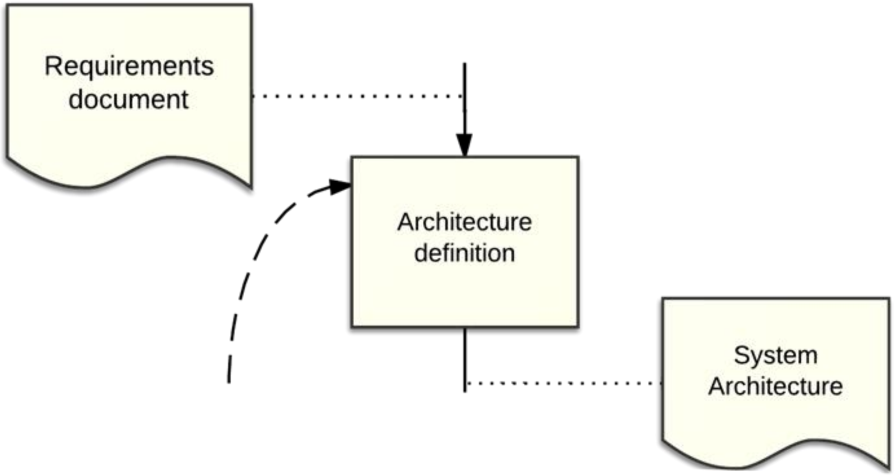
STEP 4: ARCHITECTURE DEFINITION

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?

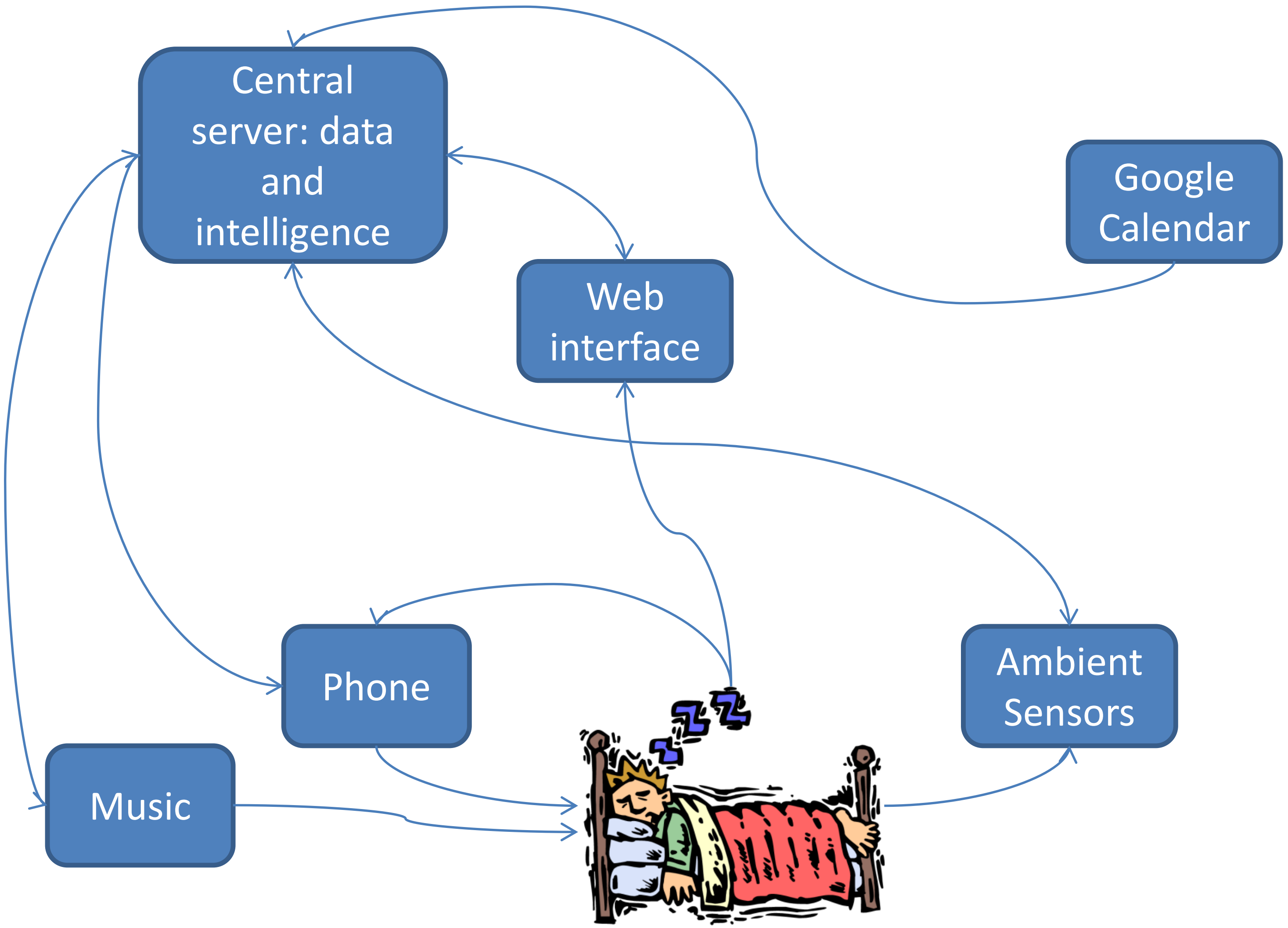
Hardware Architecture

- 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

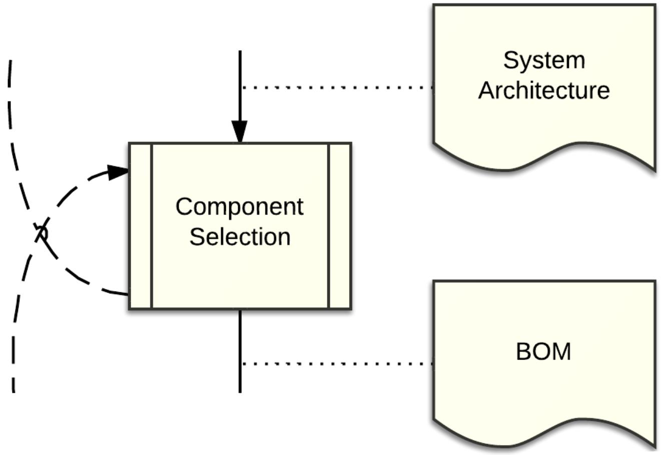
- Ambient sensors
  - Movement sensors in the room
  - Weight/movement sensors under the bed
  - Local gateway (raspberry?) for integrating sensor data
- Mobile Phone (any, Android 4+)
- Server (data storage, interaction with cloud services, web interface generation, intelligence)
  - Anywhere in the 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



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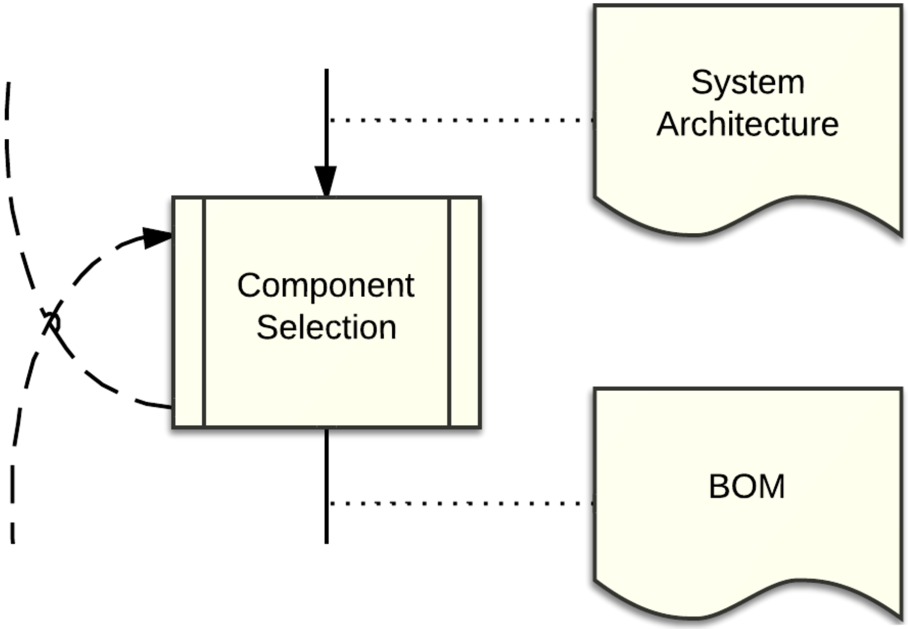
STEP 5: COMPONENT SELECTION

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

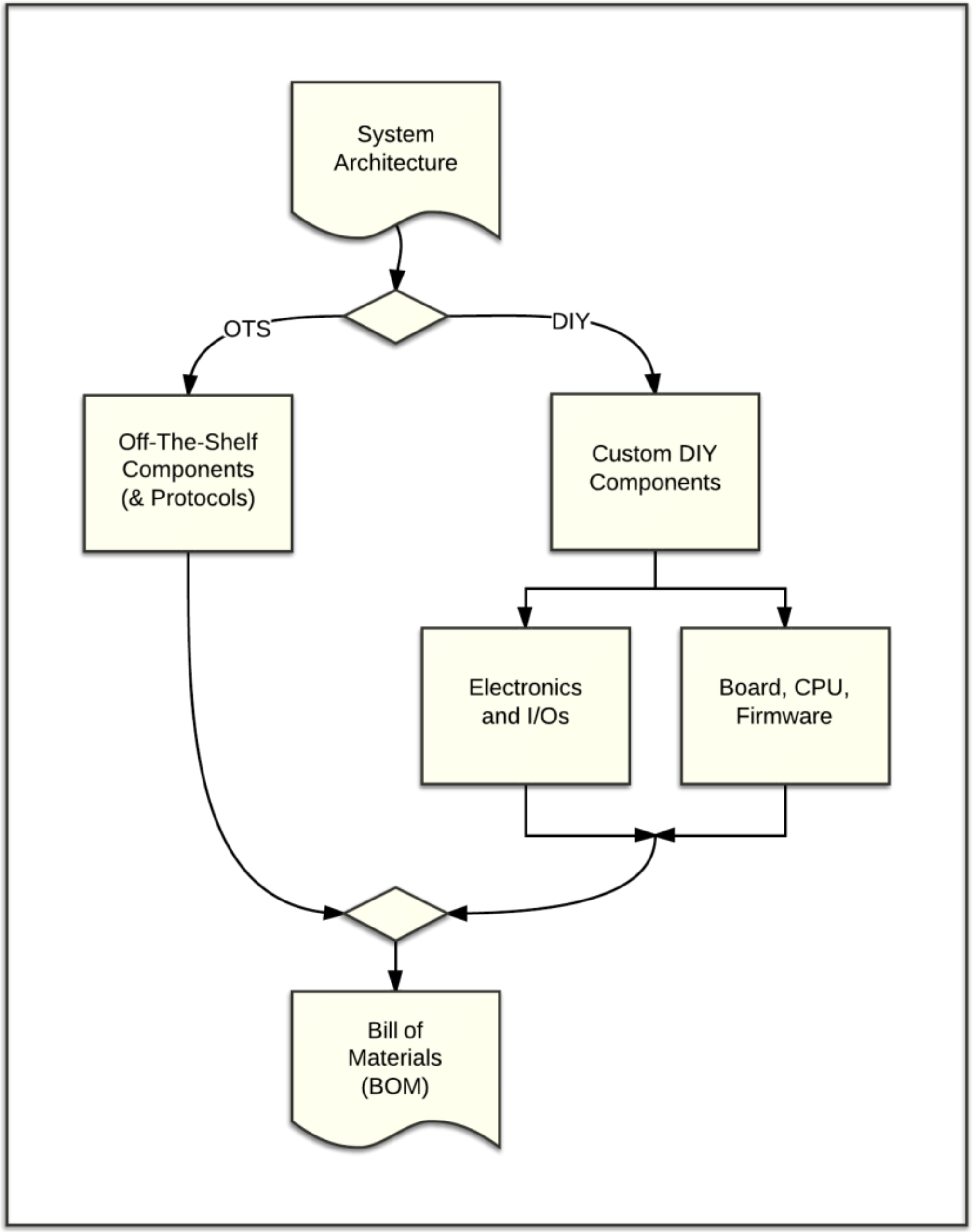
Off-the-shelf

- 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



System Architecture

OTS

DIY

Off-The-Shelf Components (& Protocols)

Custom DIY Components

Electronics and I/Os

Board, CPU, Firmware

Bill of Materials (BOM)

Deliverable 2

- Before 04/05
- **Features**
- **Architecture**
- We'll provide a checklist
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SYSTEMS ENVIRONMENT
SOLSEARCHER ENVIRONMENT
USER ENVIRONMENT
SOLsearcher Solution
DMZ
FIREWALL
FIREWALL
Internet / Intranet
Microsoft IIS Web Server
SQL Server
Document Repository
SOLsearcher Standard Interfaces
Custom Portals or B2C Interfaces
SSE Web Admin

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4.1 User Interfaces
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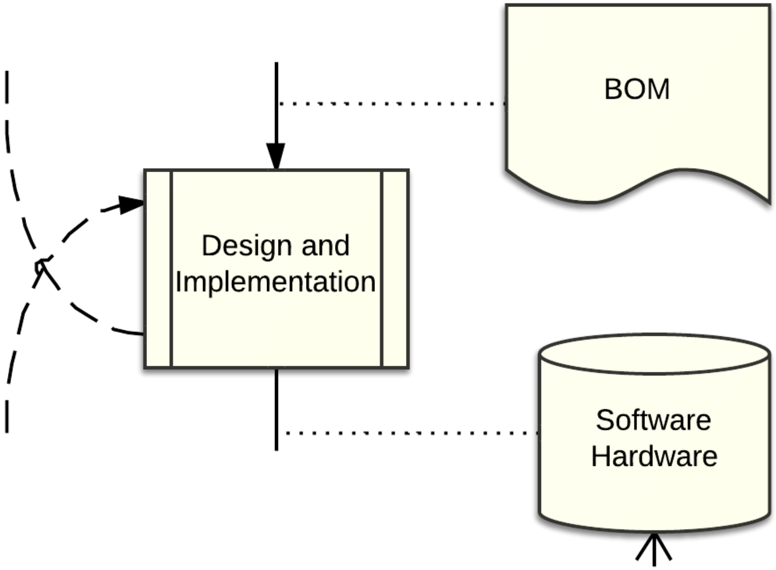
Performance Requirements



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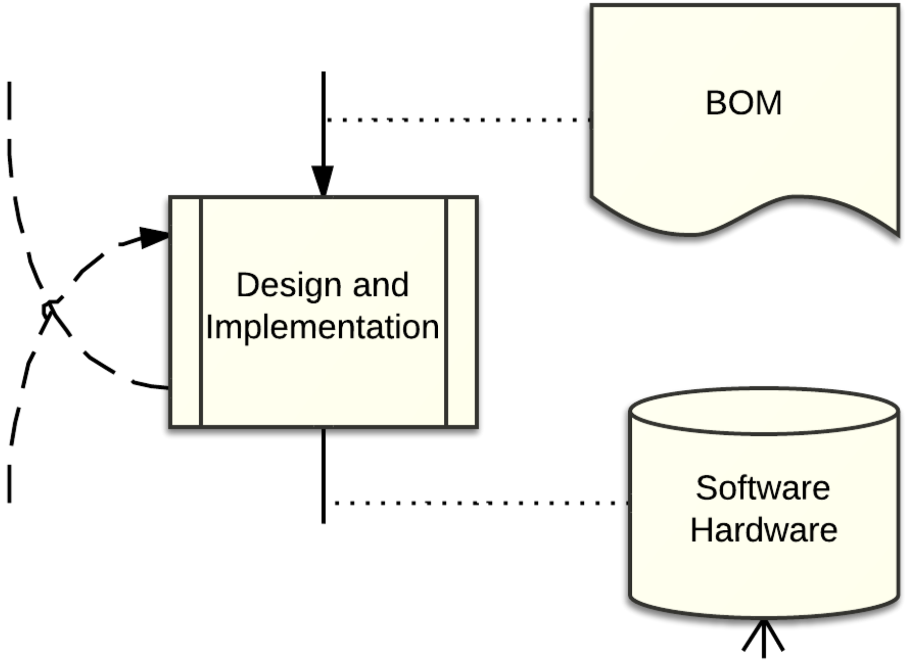
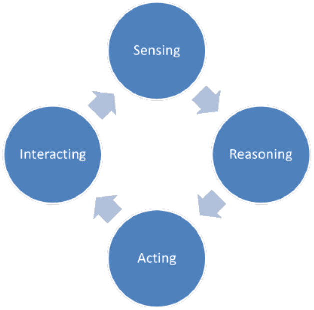
STEP 6: DESIGN & IMPLEMENTATION

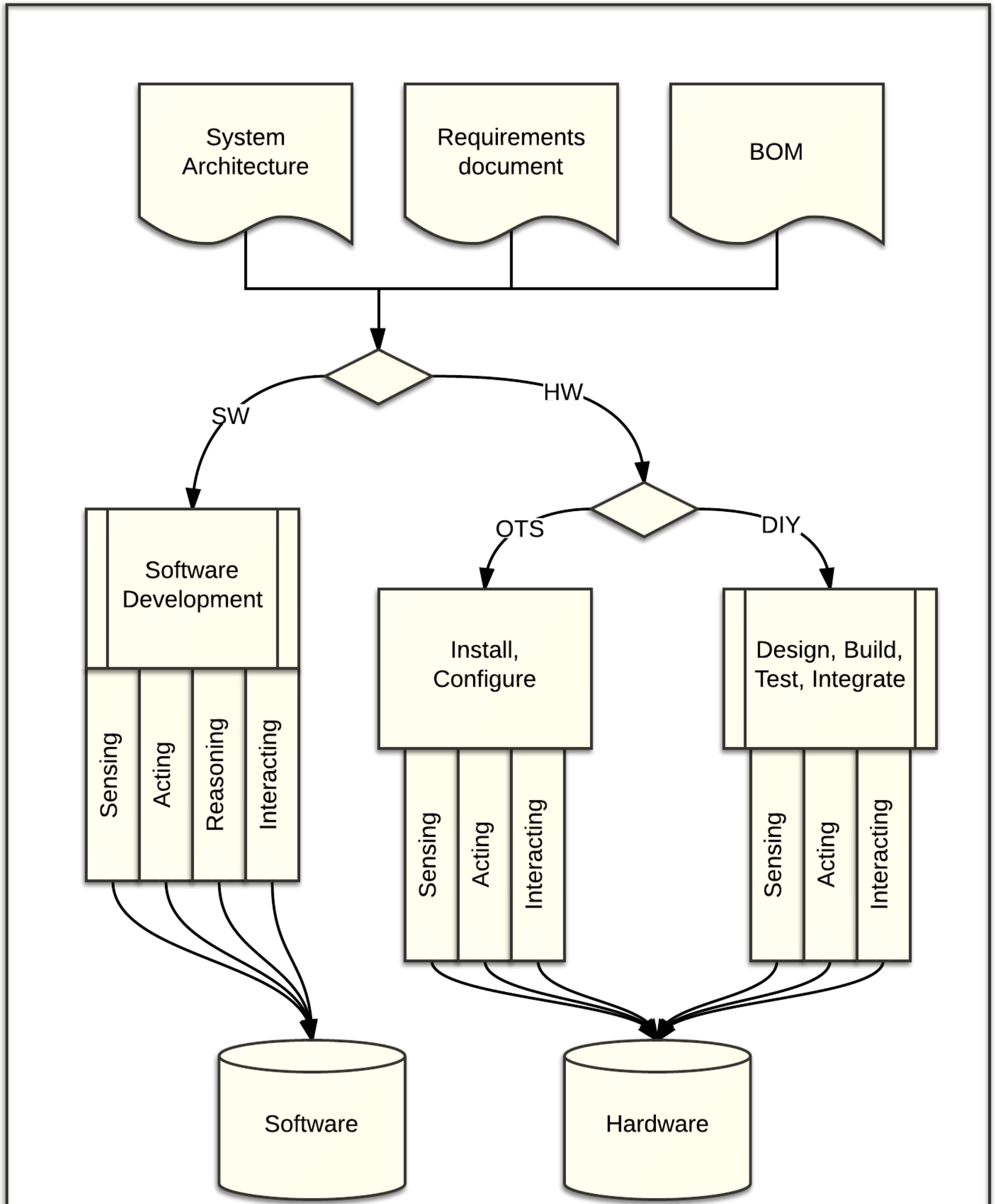
Implementation

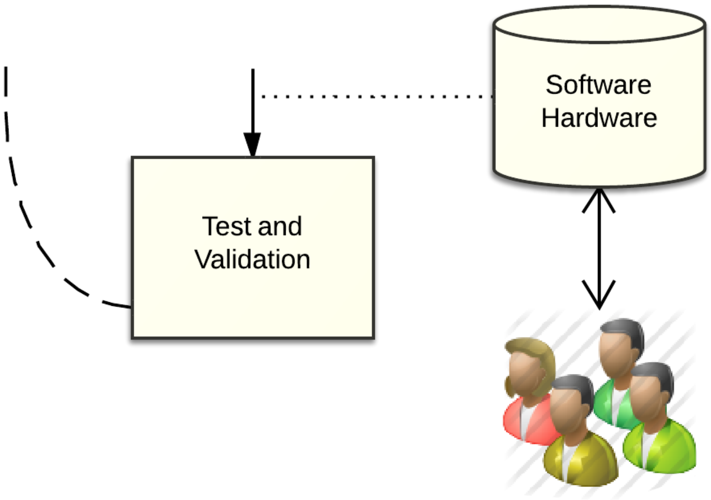
- Realize the HW and SW components defined in the previous steps
  - Implement DIY Hardware
  - Install and/or configure OTS Hardware
  - Develop Software
  - Integrate the SW architecture
- Parallel activities for different disciplines



Design and Implementation







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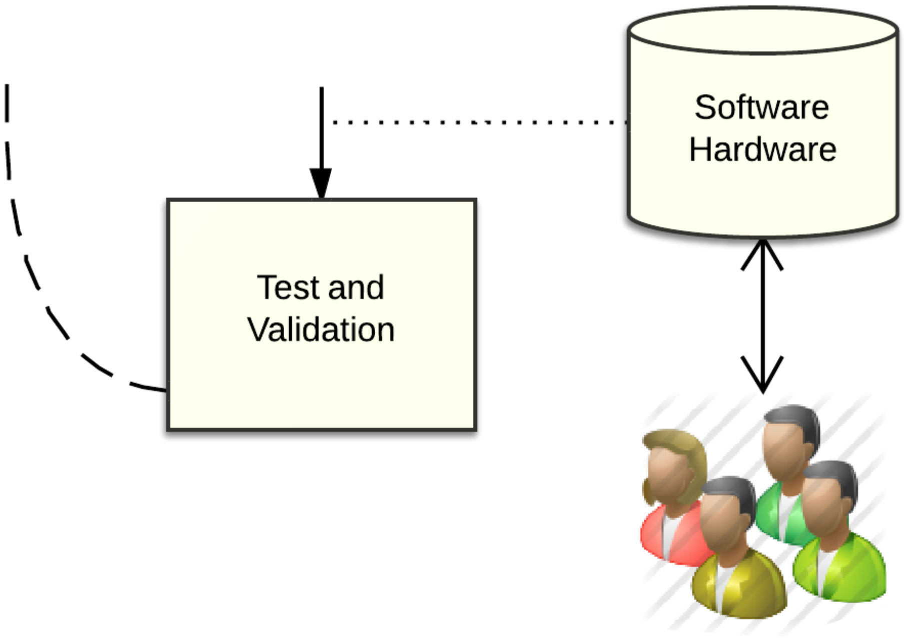
STEP 7: TEST AND VALIDATION

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



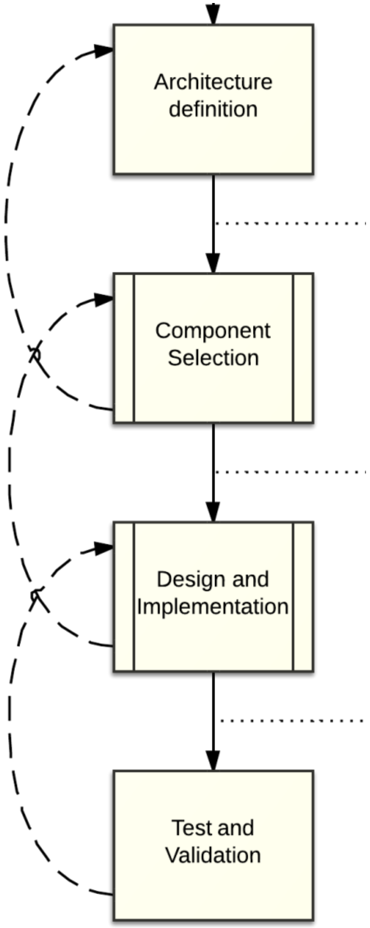
What are we testing?
(aka Verification and Validation)

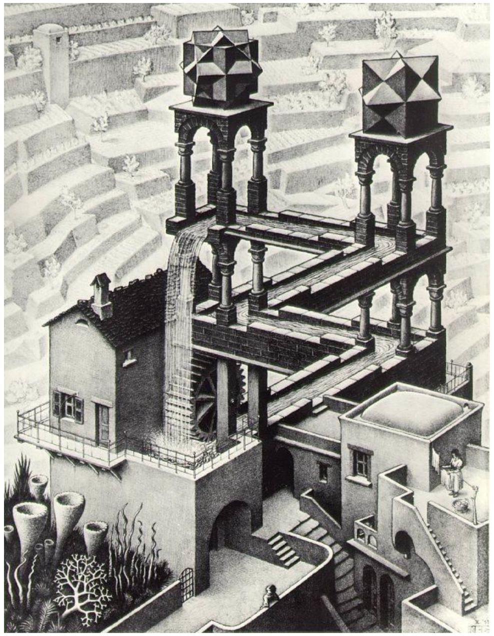
- **Verification** is intended to check that a product, service, or system meets a set of design specifications.
- Test with respect to the Requirements document
- «Am I building the system right?»

- **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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