Lecture 5: Requirements Specifications

- Why we need to write specifications
  - Purpose and audience
  - Choosing an appropriate size and formality
- Desiderata for Specifications
  - Properties of good specifications
  - Typical problems
  - What not to include
- Structure of a requirements document
  - IEEE standard

Software Requirements Specification

- How do we communicate the Requirements to others?
  - It is common practice to capture them in an SRS
    - But an SRS doesn't need to be a single paper document...

- Purpose
  - Communicates an understanding of the requirements
    - explains both the application domain and the system to be developed
  - Contractual
    - May be legally binding!
    - Expresses agreement and a commitment
  - Baseline for evaluating subsequent products
    - supports system testing, verification and validation
    - enough information to verify whether delivered system meets requirements
  - Baseline for change control
    - requirements change, software evolves

- Audience
  - Users, Purchasers
    - Most interested in system requirements
    - Not generally interested in detailed software requirements
  - Systems Analysts, Requirements Analysts
    - Write various specifications that inter-relate
  - Developers, Programmers
    - Have to implement the requirements
  - Testers
    - Determine that the requirements have been met
  - Project Managers
    - Measure and control the analysis and development processes

Appropriate Specification

- Consider two different projects:
  - A) Tiny project, 1 programmer, 2 months work
    - programmer talks to customer, then writes up a 5-page memo
  - B) Large project, 50 programmers, 2 years work
    - team of analysts model the requirements, then document them in a 500-page SRS

	Project A	*Project B*
Purpose of spec?	Crystalizes programmer's understanding; feedback to customer	Build-to document; must contain enough detail for all the programmers
Management view?	Spec is irrelevant; have already allocated resources	Will use the spec to estimate resource needs and plan the development
Readers?	**Primary**: Spec author; **Secondary**: Customer	**Primary**: programmers, testers, managers; **Secondary**: customers

A complication: Procurement

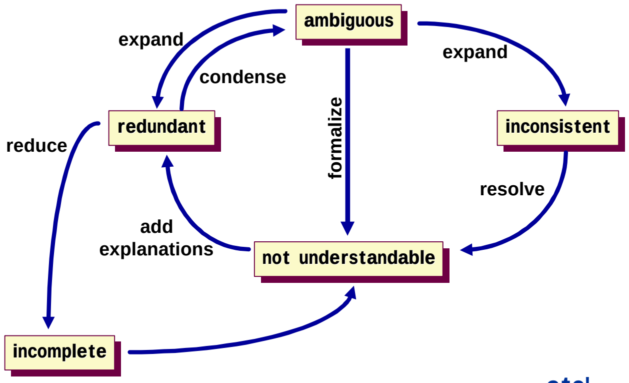
- An 'SRS' may be written by…
  - …the procurer:
    - SRS is really a call for proposals
    - Must be general enough to yield a good selection of bids…
    - …and specific enough to exclude unreasonable bids
  - …the bidders:
    - SRS is a proposal to implement a system to meet the CfP
    - must be specific enough to demonstrate feasibility and technical competence
    - …and general enough to avoid over-commitment
  - …the selected developer:
    - reflects the developer's understanding of the customers needs
    - forms the basis for evaluation of contractual performance
  - …or by an independent RE contractor!
- Choice over what point to compete the contract
  - Early (conceptual stage)
    - can only evaluate bids on apparent competence & ability
  - Late (detailed specification stage)
    - more work for procurer; appropriate RE expertise may not be available in-house
  - IEEE Standard recommends SRS jointly developed by procurer & developer

Desiderata for Specifications

Source: *Adapted from IEEE-STD-830-1998*

- Valid (or "correct")
  - Expresses only the real needs of the stakeholders (customers, users,…)
  - Doesn't contain anything that isn't "required"
- Unambiguous
  - Every statement can be read in exactly one way
- Complete
  - Specifies all the things the system must do…
    - …and all the things it must not do!
  - Conceptual Completeness
    - E.g. responses to all classes of input
  - Structural Completeness
    - E.g. no TBDs!!!
- Understandable (Clear)
  - E.g. by non-computer specialists
- Consistent
  - Doesn't contradict itself
    - I.e. is satisfiable
  - Uses all terms consistently
- Ranked
  - Must indicate the importance and/or stability of each requirement
- Verifiable
  - A process exists to test satisfaction of each requirement
    - *"every requirement is specified behaviorally"*
- Modifiable
  - Can be changed without difficulty
    - Good structure and cross-referencing
- Traceable
  - Origin of each requirement is clear
  - Facilitates referencing of requirements in future documentation

There is no Perfect SRS!



…etc!

SRS Contents

- Software Requirements Specification should address:
  - Functionality.
    - What is the software supposed to do?
  - External interfaces.
    - How does the software interact with people, the system's hardware, other hardware, and other software?
  - Performance.
    - What is the speed, availability, response time, recovery time of various software functions, and so on?
  - Attributes.
    - What are the portability, correctness, maintainability, security, and other considerations?
  - Design constraints imposed on an implementation.
    - Are there any required standards in effect, implementation language, policies for database integrity, resource limits, operating environment(s) and so on?

SRS should not include…

- Project development plans
    - cost, staffing, schedules, methods, tools, etc
  - Lifetime of SRS is until the software is made obsolete
  - Lifetime of development plans is much shorter
- Product assurance plans
    - CM, V&V, test, QA, etc
  - Different audiences
  - Different lifetimes
- Designs
  - Requirements and designs have different audiences
  - Analysis and design are different areas of expertise
    - I.e. requirements analysts shouldn't do design!
  - *Except where application domain constrains the design*
    - e.g. limited communication between different subsystems for security reasons.

Source: *Adapted fromDavis, 1990, p183*

Typical mistakes

- Noise
  - text that carries no relevant information to any feature of the problem.
- Silence
  - a feature that is not covered by any text.
- Over-specification
  - text that describes a feature of the solution, rather than the problem.
- Contradiction
  - text that defines a single feature in a number of incompatible ways.
- Ambiguity
  - text that can be interpreted in at least two different ways.
- Forward reference
  - text that refers to a terms or features yet to be defined.
- Wishful thinking
  - text that defines a feature that cannot possibly be validated.
- Jigsaw puzzles
  - distributing key information across a document and then cross-referencing
- Duckspeak requirements
  - Requirements that are only there to conform to standards
- Unnecessary invention of terminology
  - E.g. 'user input presentation function'
  - E.g. 'airplane reservation data validation function'
- Inconsistent terminology
  - Inventing and then changing terminology
- Putting the onus on the development staff
  - i.e. making the reader work hard to decipher the intent
- Writing for the hostile reader
  - There are fewer of these than friendly readers

Source: *Adapted from Kovitz, 1999*

Use Appropriate Notations

- **Natural Language?**
  - "The system shall report to the operator all faults that originate in critical functions or that occur during execution of a critical sequence and for which there is no fault recovery response."
    (this is adapted from a real NASA spec for the international space station)
- **Or a decision table?**

Originate in critical functions	F	T	F	T	F	T	F	T
Occur during critical seqeunce	F	F	T	T	F	F	T	T
No fault recovery response	F	F	F	F	T	T	T	T
Report to operator?								

Source: *Adapted from Easterbrook & Callahan, 1997.*

Requirements Traceability

- **Definition (DOD-STD-2167A):**
  "(1) The document in question contains or implements all applicable stipulations in the predecessor document
  (2) a given term, acronym, or abbreviation means the same thing in all documents
  (3) a given item or concept is referred to by the same name or description in the documents
  (4) all material in the successor document has its basis in the predecessor document, that is, no untraceable material has been introduced
  (5) the two documents do not contradict one another"
- **In short:**
  - A demonstration of completeness, necessity and consistency
  - a clear allocation/flowdown path (down through the document hierarchy)
  - a clear derivation path (up through the document hierarchy)

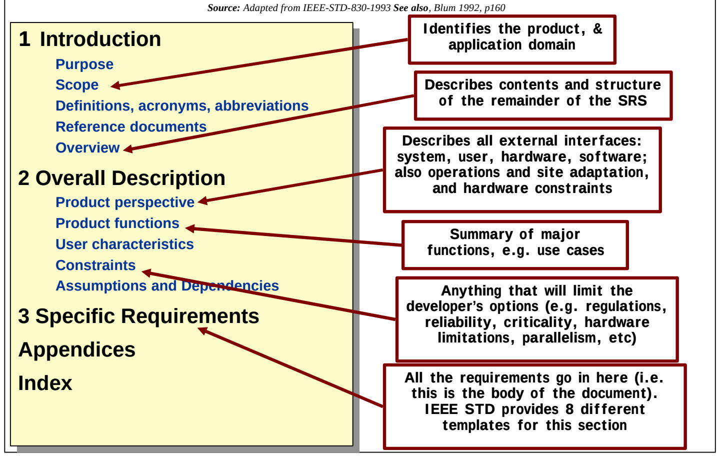
Source: *Adapted from Palmer, 1996, p 367*

Organizing the Requirements

- **Need a logical organization for the document**
  - IEEE standard offers different templates
- **Example Structures - organize by…**
  - …External stimulus or external situation
    - e.g., for an aircraft landing system, each different type of landing situation: wind gusts, no fuel, short runway, etc
  - …System feature
    - e.g., for a telephone system: call forwarding, call blocking, conference call, etc
  - …System response
    - e.g., for a payroll system: generate pay-cheques, report costs, print tax info;
  - …External object
    - e.g. for a library information system, organize by book type
  - …User type
    - e.g. for a project support system: manager, technical staff, administrator, etc.
  - …Mode
    - e.g. for word processor: page layout mode, outline mode, text editing mode, etc
  - …Subsystem
    - e.g. for spacecraft: command&control, data handling, comms, instruments, etc.

IEEE Standard for SRS

Source: *Adapted from IEEE-STD-830-1993* **See also**, *Blum 1992, p160*



1 Introduction
- Purpose
- Scope
- Definitions, acronyms, abbreviations
- Reference documents
- Overview

2 Overall Description
- Product perspective
- Product functions
- User characteristics
- Constraints
- Assumptions and Dependencies

3 Specific Requirements

Appendices

Index

Identifies the product, & application domain

Describes contents and structure of the remainder of the SRS

Describes all external interfaces: system, user, hardware, software; also operations and site adaptation, and hardware constraints

Summary of major functions, e.g. use cases

Anything that will limit the developer's options (e.g. regulations, reliability, criticality, hardware limitations, parallelism, etc)

All the requirements go in here (i.e. this is the body of the document). IEEE STD provides 8 different templates for this section

IEEE STD Section 3 (example)

Source: *Adapted from IEEE-STD-830-1993.* **See also**, *Blum 1992, p160*

3.1 External Interface Requirements

- 3.1.1 User Interfaces
- 3.1.2 Hardware Interfaces
- 3.1.3 Software Interfaces
- 3.1.4 Communication Interfaces

3.2 Functional Requirements

this section organized by mode, user class, feature, etc. For example:

- 3.2.1 Mode 1
  - *3.2.1.1 Functional Requirement 1.1*
  - …
- 3.2.2 Mode 2
  - *3.2.1.1 Functional Requirement 1.1*
  - …
- ...
- 3.2.2 Mode n
  - ...

3.3 Performance Requirements

Remember to state this in measurable terms!

3.4 Design Constraints

- *3.4.1 Standards compliance*
- *3.4.2 Hardware limitations*
- *etc.*

3.5 Software System Attributes

- 3.5.1 Reliability
- 3.5.2 Availability
- 3.5.3 Security
- 3.5.4 Maintainability
- 3.5.5 Portability

3.6 Other Requirements