

IEEE Guide for Developing System Requirements Specifications

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Abstract: Guidance for the development of the set of requirements, System Requirements Specification (SyRS), that will satisfy an expressed need is provided. Developing an SyRS includes the identification, organization, presentation, and modification of the requirements. Also addressed are the conditions for incorporating operational concepts, design constraints, and design configuration requirements into the specification. This guide also covers the necessary characteristics and qualities of individual requirements and the set of all requirements.

Keywords: requirement, SyRS, system, system requirements specification

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Introduction

(This introduction is not a part of IEEE Std 1233, 1998 Edition, IEEE Guide for Developing System Requirements Specifications.)

The purpose of this guide is to provide guidance for capturing system requirements. This guide serves the analyst by providing a clear definition for identifying well-formed requirements and ways of organizing them.

This guide should be used to help the analyst capture requirements at the beginning of the system requirements phase. It should be used to clarify what constitutes a good requirement and provide an understanding of where to look to identify different requirement sources.

The readers of this guide are referred to Annex C for guidelines for using this guide to meet the requirements of IEEE/EIA 12207.1-1997, IEEE/EIA Guide for Information Technology—Software life cycle processes—Life cycle data.

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IEEE Guide for Developing System Requirements Specifications

1. Overview

1.1 Scope

This guide provides guidance for the development of a set of requirements that, when realized, will satisfy an expressed need. In this guide that set of requirements will be called the System Requirements Specification (SyRS). Developing an SyRS includes the identification, organization, presentation, and modification of the requirements. This guide addresses conditions for incorporating operational concepts, design constraints, and design configuration requirements into the specification. This guide also addresses the necessary characteristics and qualities of individual requirements and the set of all requirements.

This guide does not specify industry-wide system specification standards nor state a mandatory System Requirements Specification. This guide is written under the premise that the current state of the art of system development does not warrant or support a formal standards document.

2. References

This guide shall be used in conjunction with the following publications:

IEEE Std 100-1996, IEEE Standard Dictionary of Electrical and Electronics Terms.¹

IEEE Std 610.12-1990, IEEE Standard Glossary of Software Engineering Terminology.

IEEE Std 730-1998, IEEE Standard for Software Quality Assurance Plans.

IEEE Std 828-1998, IEEE Standard for Software Configuration Management Plans.

IEEE Std 830-1998, IEEE Recommended Practice for Software Requirements Specifications.

IEEE Std 1074-1997, IEEE Standard for Developing Software Life Cycle Processes.

¹IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA (<http://www.standards.ieee.org/>).

IEEE Std 1220-1998, IEEE Standard for Application and Management of the Systems Engineering Process.

ISO 9000-1: 1994, Quality management and quality assurance standards—Part 1: Guidelines for selection and use.²

ISO 9126: 1991, Information technology—Software product evaluation—Quality characteristics and guidelines for their use.

MIL-STD-490A, Specification Practices.³

MIL-STD-498, Software Development and Documentation.

3. Definitions

The definitions listed below establish meaning in the context of this guide. Terms not defined in this guide are included in IEEE Std 610.12-1990.⁴

3.1 analyst: A member of the technical community (such as a systems engineer or business analyst, developing the system requirements) who is skilled and trained to define problems and to analyze, develop, and express algorithms.

3.2 annotation: Further documentation accompanying a requirement such as background information and/or descriptive material.

3.3 baseline: A specification or system that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development and can be changed only through formal change control procedures. (IEEE Std 610.12-1990)

3.4 constraint: A statement that expresses measurable bounds for an element or function of the system. That is, a constraint is a factor that is imposed on the solution by force or compulsion and may limit or modify the design changes.

3.5 customer(s): The entity or entities for whom the requirements are to be satisfied in the system being defined and developed. This can be an end-user of the completed system, an organization within the same company as the developing organization (e.g., System Management), a company or entity external to the developing company, or some combination of all of these. This is the entity to whom the system developer must provide proof that the system developed satisfies the system requirements specified.

3.6 derived requirement: A requirement deduced or inferred from the collection and organization of requirements into a particular system configuration and solution.

3.7 element: A component of a system; may include equipment, a computer program, or a human.

3.8 end user: The person or persons who will ultimately be using the system for its intended purpose.

²ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

³MIL publications are available from Customer Service, Defense Printing Service, 700 Robbins Ave., Bldg. 4D, Philadelphia, PA 19111-5094, USA.

⁴Information on references can be found in Clause 2.

3.9 environment: The circumstances, objects, and conditions that will influence the completed system; they include political, market, cultural, organizational, and physical influences as well as standards and policies that govern what the system must do or how it must do it.

3.10 function: A task, action, or activity that must be accomplished to achieve a desired outcome.

3.11 model: A representation of a real world process, device, or concept.

3.12 prototype: An experimental model, either functional or nonfunctional, of the system or part of the system. A prototype is used to get feedback from users for improving and specifying a complex human interface, for feasibility studies, or for identifying requirements.

3.13 raw requirement: An environmental or customer requirement that has not been analyzed and formulated as a well-formed requirement.

3.14 representation: A likeness, picture, drawing, block diagram, description, or symbol that logically portrays a physical, operational, or conceptual image or situation.

3.15 requirement: (A) A condition or capability needed by a user to solve a problem or achieve an objective. (B) A condition or capability that must be met or possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document. (C) A documented representation of a condition or capability as in definition (A) or (B). (IEEE Std 610.12-1990)

3.16 system: An interdependent group of people, objects, and procedures constituted to achieve defined objectives or some operational role by performing specified functions. A complete system includes all of the associated equipment, facilities, material, computer programs, firmware, technical documentation, services, and personnel required for operations and support to the degree necessary for self-sufficient use in its intended environment.

3.17 System Requirements Specification (SyRS): A structured collection of information that embodies the requirements of the system.

3.18 testability: The degree to which a requirement is stated in terms that permit establishment of test criteria and performance of tests to determine whether those criteria have been met. (IEEE Std 610.12-1990)

3.19 traceability: The degree to which a relationship can be established between two or more products of the development process, especially products having a predecessor-successor or master-subordinate relationship to one another; e.g., the degree to which the requirements and design of a given system element match. (IEEE Std 610.12-1990)

3.20 validation: The process of evaluating a system or component during or at the end of the development process to determine whether a system or component satisfies specified requirements. (IEEE Std 610.12-1990)

3.21 verification: The process of evaluating a system or component to determine whether the system of a given development phase satisfies the conditions imposed at the start of that phase. (IEEE Std 610.12-1990)

3.22 well-formed requirement: A statement of system functionality (a capability) that can be validated, and that must be met or possessed by a system to solve a customer problem or to achieve a customer objective, and is qualified by measurable conditions and bounded by constraints.

4. System requirements specification

A System Requirements Specification (SyRS) has traditionally been viewed as a document that communicates the requirements of the customer to the technical community who will specify and build the system. The collection of requirements that constitutes the specification and its representation acts as the bridge between the two groups and must be understandable by both the customer and the technical community. One of the most difficult tasks in the creation of a system is that of communicating to all of the subgroups within both groups, especially in one document. This type of communication generally requires different formalisms and languages.

4.1 Definition

The SyRS presents the results of the definition of need, the operational concept, and the system analysis tasks. As such, it is a description of what the system's customers expect it to do for them, the system's expected environment, the system's usage profile, its performance parameters, and its expected quality and effectiveness. Thus it presents the conclusions of the SyRS development process described in Clause 5.

This guide suggests a distinction between this structured collection of information and the way in which it is presented to its various audiences. The presentation of the SyRS should take a form that is appropriate for its intended use. This can be a paper document, models, prototypes, other non-paper document representations, or any combination. All of these representations can be derived from this one SyRS to meet the needs of a specific audience. However, care should be taken to ensure that each of these presentations is traceable to a common source of system requirements information. The audience should be made aware that this structured collection of information remains the one definitive source for resolving ambiguities in the particular presentation chosen.

This guide makes a clear distinction between the system requirements (what the system must do) contained in the SyRS and process requirements (how to construct the system) that should be contained in contract documents such as a Statement of Work.

4.2 Properties

The collection of requirements should have the following properties:

- a) *Unique set.* Each requirement should be stated only once.
- b) *Normalized.* Requirements should not overlap (i.e., they shall not refer to other requirements or the capabilities of other requirements).
- c) *Linked set.* Explicit relationships should be defined among individual requirements to show how the requirements are related to form a complete system.
- d) *Complete.* An SyRS should include all the requirements identified by the customer, as well as those needed for the definition of the system.
- e) *Consistent.* SyRS content should be consistent and noncontradictory in the level of detail, style of requirement statements, and in the presentation of material.
- f) *Bounded.* The boundaries, scope, and context for the set of requirements should be identified.
- g) *Modifiable.* The SyRS should be modifiable. Clarity and nonoverlapping requirements contribute to this.
- h) *Configurable.* Versions should be maintained across time and across instances of the SyRS.
- i) *Granular.* This should be the level of abstraction for the system being defined.

4.3 Purpose

The purpose of the SyRS is to provide a “black-box” description of what the system should do, in terms of the system’s interactions or interfaces with its external environment. The SyRS should completely describe all inputs, outputs, and required relationships between inputs and outputs. The SyRS organizes and communicates requirements to the customer and the technical community.

4.3.1 Organizing requirements

The purpose of the SyRS can best be achieved by organizing the system requirements into conceptual categories. In practice, it is difficult to identify and separate requirements from other aspects of the customer’s perception of the system that are often included in documents that define “requirements.” Often, traditional user procedures or user or technical community assumptions about the implementation cloud the fundamental statement of need. The analyst should capture and state the fundamental needs of the customer and the technical community, properly form requirements, and organize or group these needs and requirements into meaningful categories.

While organizing the unstructured users’ statements into a structured set of requirements, the analyst should identify technical requirements without being diverted into stating an implementation approach. To be distracted into implementation issues before a clear understanding of the requirements is achieved may lead to both an inadequate statement of requirements and a faulty implementation. Discerning between technical requirements and technical implementations is a constant challenge to the analyst.

The description of the system should be stated in operational and logistical terms. Issues addressed include the system’s desired operational capabilities; physical characteristics; performance parameters and expected values; interfaces and interactions with its environment; documentation requirements; reliability requirements; logistical requirements; and personnel requirements.

These requirements should be communicated in a structured manner to ensure that the customer and technical community are able to do the following:

- a) Identify requirements that are derived from other requirements;
- b) Organize requirements of different levels of detail into their appropriate levels;
- c) Verify the completeness of the set of requirements;
- d) Identify inconsistencies among requirements;
- e) Clearly identify the capabilities, conditions, and constraints for each requirement;
- f) Develop a common understanding with the customer of the purpose and objectives of the set of requirements;
- g) Identify requirements that will complete the SyRS.

It is important that structure be added to the set of requirements by the analysts, and that representations of the SyRS communicate the requirements in a structured manner. Clause 6 provides guidelines for explicitly defining the requirements.

4.3.2 Communicating to two audiences

The SyRS has two primary audiences and essentially serves to document an agreement between the customer and the technical community.