## Contents

# IEEE Recommended Practice for Software Design Descriptions

## 1. Scope

This is a recommended practice for describing software designs. It specifies the necessary information content, and recommended organization for a Software Design Description (SDD). An SDD is a representation of a software system that is used as a medium for communicating software design information.

The practice may be applied to commercial, scientific, or military software that runs on any digital computer. Applicability is not restricted by the size, complexity, or criticality of the software.

This practice is not limited to specific methodologies for design, configuration management, or quality assurance. It is assumed that the quality design information and changes to the design of description will be managed by other project activities. Finally, this document does not support nor is it limited to any particular descriptive technique. It may be applied to paper documents, automated databases, design description languages, or other means of description.

## 2. References

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

IEEE Std 610.12-1990, IEEE Standard Glossary of Software Engineering Terminology.[1]

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.

Freeman, P. and A. I. Wasserman, *Tutorial on Software Design Techniques.* 4th Edition, IEEE Computer Society Press, Annotated Bibliography, pp. 715–718, 1983.

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

## 3. Definitions

The definitions listed here establish meaning in the context of this recommended practice. Definitions of other terms used in this document can be found in IEEE Std 610.12-1990[2].

**3.1 design entity:** An element (component) of a design that is structurally and functionally distinct from other elements and that is separately named and referenced.

**3.2 design view:** A subset of design entity attribute information that is specifically suited to the needs of a software project activity.

**3.3 entity attribute:** A named characteristic or property of a design entity. It provides a statement of fact about the entity.

**3.4 software design description (SDD):** A representation of a software system created to facilitate analysis, planning, implementation, and decision making. A blueprint or model of the software system. The SDD is used as the primary medium for communicating software design information.

## 4. Considerations for producing an SDD

This clause provides information to be considered before producing an SDD. How the SDD fits into the software life cycle, where it fits, and why it is used are discussed.

### 4.1 Software life cycle

The life cycle of a software system is normally defined as the period of time that starts when a software product is conceived and ends when the product is no longer available for use. The life cycle approach is an effective engineering management tool and provides a model for a context within which to discuss the preparation and use of the SDD. While it is beyond the scope of this document to prescribe a particular standard life cycle, a typical cycle will be used to define such a context for the SDD. This cycle is based on IEEE Std 610.12-1990 and consists of a concept phase, requirements phase, design phase, implementation phase, test phase, installation and checkout phase, operation and maintenance phase, and retirement phase.

### 4.2 SDD within the life cycle

For both new software systems and existing systems under maintenance, it is important to ensure that the design and implementation used for a software system satisfy the requirements driving that system. The minimum documentation required to do this is defined in IEEE Std 730-1998. The SDD is one of these required products. It records the result of the design processes that are carried out during the design phase.

### 4.3 Purpose of an SDD

The SDD shows how the software system will be structured to satisfy the requirements identified in the software requirements specification IEEE Std 830-1998. It is a translation of requirements into a description of the software structure, software components, interfaces, and data necessary for the implementation phase. In essence, the SDD becomes a detailed blueprint for the implementation activity. In a complete SDD, each requirement must be traceable to one or more design entities.

[2]Information on references can be found in Clause 2.

# 5. Design description information content

## 5.1 Introduction

An SDD is a representation or model of the software system to be created. The model should provide the precise design information needed for planning, analysis, and implementation of the software system. It should represent a partitioning of the system into design entities and describe the important properties and relationships among those entities.

The design description model used to represent a software system can be expressed as a collection of design entities, each possessing properties and relationships.[3] To simplify the model, the properties and relationships of each design entity are described by a standard set of attributes. The design information needs of project members are satisfied through identification of the entities and their associated attributes. A design description is complete when the attributes have been specified for all the entities.

## 5.2 Design entities

A *design entity* is an element (component) of a design that is structurally and functionally distinct from other elements and that is separately named and referenced.

Design entities result from a decomposition of the software system requirements. The objective is to divide the system into separate components that can be considered, implemented, changed, and tested with minimal effect on other entities.

Entities can exist as a system, subsystems, data stores, modules, programs, and processes; see IEEE Std 610.12-1990. The number and type of entities required to partition a design are dependent on a number of factors, such as the complexity of the system, the design technique used, and the programming environment.

Although entities are different in nature, they possess common characteristics. Each design entity will have a name, purpose, and function. There are common relationships among entities such as interfaces or shared data. The common characteristics of entities are described by design entity attributes.

## 5.3 Design entity attributes

A *design entity attribute* is a named characteristic or property of a design entity. It provides a statement of fact about the entity.

Design entity attributes can be thought of as questions about design entities. The answers to those questions are the values of the attributes. All the questions can be answered, but the content of the answer will depend upon the nature of the entity. The collection of answers provides a complete description of an entity.

The list of design entity attributes presented in this subclause is the minimum set required for all SDDs. The selection of these attributes is based on three criteria:

a) The attribute is necessary for all software projects;
b) An incorrect specification of the attribute value could result in a fault in the software system to be developed;
c) The attribute describes intrinsic design information and not information related to the design process. Examples of attributes that do not meet the second and third criteria are designer names, design status, and revision history. This important process information is maintained by other software project activities as described in IEEE Std 730-1998 and IEEE Std 828-1998.

[3]The design description model is similar to an entity-relationship model, a common approach to information modeling.

All attributes shall be specified for each entity. Attribute descriptions should include references and design considerations such as tradeoffs and assumptions when appropriate. In some cases, attribute descriptions may have the value *none*. When additional attributes are identified for a specific software project, they should be included in the design description. The attributes and associated information items are defined in 5.3.1 through 5.3.10.

### 5.3.1 Identification

*The name of the entity.* Two entities shall not have the same name. The names for the entities may be selected to characterize their nature. This will simplify referencing and tracking in addition to providing identification.

### 5.3.2 Type

*A description of the kind of entity.* The type attribute shall describe the nature of the entity. It may simply name the kind of entity, such as subprogram, module, procedure, process, or data store. Alternatively, design entities may be grouped into major classes to assist in locating an entity dealing with a particular type of information. For a given design description, the chosen entity types shall be applied consistently.

### 5.3.3 Purpose

*A description of why the entity exists.* The purpose attribute shall provide the rationale for the creation of the entity. Therefore, it shall designate the specific functional and performance requirements for which this entity was created; see IEEE Std 830-1998. The purpose attribute shall also describe special requirements that must be met by the entity that are not included in the software requirements specification.

### 5.3.4 Function

*A statement of what the entity does.* The function attribute shall state the transformation applied by the entity to inputs to produce the desired output. In the case of a data entity, this attribute shall state the type of information stored or transmitted by the entity.

### 5.3.5 Subordinates

*The identification of all entities composing this entity.* The subordinates attribute shall identify the *composed of* relationship for an entity. This information is used to trace requirements to design entities and to identify parent/child structural relationships through a software system decomposition.

### 5.3.6 Dependencies

*A description of the relationships of this entity with other entities.* The dependencies attribute shall identify the *uses* or *requires the presence of* relationship for an entity. These relationships are often graphically depicted by structure charts, data flow diagrams, and transaction diagrams.

This attribute shall describe the nature of each interaction including such characteristics as timing and conditions for interaction. The interactions may involve the initiation, order of execution, data sharing, creation, duplicating, usage, storage, or destruction of entities.

### 5.3.7 Interface

*A description of how other entities interact with this entity.* The interface attribute shall describe the *methods* of interaction and the *rules* governing those interactions. The methods of interaction include the mechanisms for invoking or interrupting the entity, for communicating through parameters, common data areas or messages, and for direct access to internal data. The rules governing the interaction include the communications protocol, data format, acceptable values, and the meaning of each value.

This attribute shall provide a description of the input ranges, the meaning of inputs and outputs, the type and format of each input or output, and output error codes. For information systems, it should include inputs, screen formats, and a complete description of the interactive language.

### 5.3.8 Resources

*A description of the elements used by the entity that are external to the design.* The resources attribute shall identify and describe all of the resources *external* to the design that are needed by this entity to perform its function. The interaction rules and methods for using the resource shall be specified by this attribute.

This attribute provides information about items such as physical devices (printers, disc-partitions, memory banks), software services (math libraries, operating system services), and processing resources (CPU cycles, memory allocation, buffers).

The resources attribute shall describe usage characteristics such as the process time at which resources are to be acquired and sizing to include quantity, and physical sizes of buffer usage. It should also include the identification of potential race and deadlock conditions as well as resource management facilities.

### 5.3.9 Processing

*A description of the rules used by the entity to achieve its function.* The processing attribute shall describe the algorithm used by the entity to perform a specific task and shall include contingencies. This description is a refinement of the function attribute. It is the most detailed level of refinement for this entity.

This description should include timing, sequencing of events or processes, prerequisites for process initiation, priority of events, processing level, actual process steps, path conditions, and loop back or loop termination criteria. The handling of contingencies should describe the action to be taken in the case of overflow conditions or in the case of a validation check failure.

### 5.3.10 Data

*A description of data elements internal to the entity.* The data attribute shall describe the method of representation, initial values, use, semantics, format, and acceptable values of internal data.

The description of data may be in the form of a data dictionary that describes the content, structure, and use of all data elements. Data information shall describe everything pertaining to the use of data or internal data structures by this entity. It shall include data specifications such as formats, number of elements, and initial values. It shall also include the structures to be used for representing data such as file structures, arrays, stacks, queues, and memory partitions.

The meaning and use of data elements shall be specified. This description includes such things as static versus dynamic, whether it is to be shared by transactions, used as a control parameter, or used as a value, loop iteration count, pointer, or link field. In addition, data information shall include a description of data validation needed for the process.

# 6. Design description organization

## 6.1 Introduction

Each design description user may have a different view of what are considered the essential aspects of a software design. All other information is extraneous to that user. The proportion of useful information for a specific user will decrease with the size and complexity of a software project. The needed information then becomes difficult or impractical to extract from the description and impossible to assimilate. Hence, a practical organization of the necessary design information is essential to its use.

This clause introduces the notion of *design views* to aid in organizing the design attribute information defined in Clause 5. It does not supplement Clause 5 by providing additional design information nor does it prescribe the format or documentation practice for design views.

A recommended organization of design entities and their associated attributes are presented in this clause to facilitate the access of design information from various technical viewpoints. This recommended organization is flexible and can be implemented through different media such as paper documentation, design languages, or database management systems with automated report generation, and query language access. A sample table of contents is given in Annex A to illustrate how an access structure to a design description may be prepared.

## 6.2 Design views

Entity attribute information can be organized in several ways to reveal all of the essential aspects of a design. In so doing, the user is able to focus on design details from a different perspective or viewpoint. A *design view* is a subset of design entity attribute information that is specifically suited to the needs of a software project activity.

Each design view represents a separate concern about a software system. Together, these views provide a comprehensive description of the design in a concise and usable form that simplifies information access and assimilation.

A recommended organization of the SDD into separate design views to facilitate information access and assimilation is given in Table 1. Each of these views, their use, and representation are discussed in detail.

**Table 1—Recommended design views**

| Design view | Scope | Entity attributes | Example representations |
|---|---|---|---|
| Decomposition description | Partition of the system into design entities | Identification, type, purpose, function, subordinates | Hierarchical decomposition diagram, natural language |
| Dependency description | Description of the relationships among entities and system resources | Identification, type, purpose, dependencies, resources | Structure charts, data flow diagrams, transaction diagrams |
| Interface description | List of everything a designer, programmer, or tester needs to know to use the design entitites that make up the system | Identification, function, interfaces | Interface files, parameter tables |
| Detail description | Description of the internal design details of an entity | Identification, processing, data | Flowcharts, N-S charts, PDL |

### 6.2.1 Decomposition description

#### 6.2.1.1 Scope

The decomposition description records the division of the software system into design entities. It describes the way the system has been structured and the purpose and function of each entity. For each entity, it provides a reference to the detailed description via the identification attribute.

The attribute descriptions for identification, type, purpose, function, and subordinates should be included in this design view. This attribute information should be provided for all design entities.

#### 6.2.1.2 Use

The decomposition description can be used by designers and maintainers to identify the major design entities of the system for purposes such as determining which entity is responsible for performing specific functions and tracing requirements to design entities. Design entities can be grouped into major classes to assist in locating a particular type of information and to assist in reviewing the decomposition for completeness. For example, a module decomposition may exist separately from a data decomposition.

The information in the decomposition description can be used by project management for planning, monitoring, and control of a software project. They can identify each software component, its purpose, and basic functionality. This design information together with other project information can be used in estimating cost, staff, and schedule for the development effort.

Configuration management may use the information to establish the organization, tracking, and change management of emerging work products; see IEEE Std 828-1998. Metrics developers may also use this information for initial complexity, sizing, staffing, and development time parameters. The software quality assurance staff can use the decomposition description to construct a requirements traceability matrix.

#### 6.2.1.3 Representation

The literature on software engineering describes a number of methods that provide consistent criteria for entity decomposition (see Freeman and Wasserman, *Tutorial on Software Design Techniques*). These methods provide for designing simple, independent entities and are based on such principles as structured design and information hiding. The primary graphical technique used to describe system decomposition is a hierarchical decomposition diagram. This diagram can be used together with natural language descriptions of purpose and function for each entity.

### 6.2.2 Dependency description

#### 6.2.2.1 Scope

The dependency description specifies the relationships among entities. It identifies the dependent entities, describes their coupling, and identifies the required resources.

This design view defines the strategies for interactions among design entities and provides the information needed to easily perceive how, why, where, and at what level system actions occur. It specifies the type of relationships that exist among the entities such as shared information, prescribed order of execution, or well-defined parameter interfaces.

The attribute descriptions for identification, type, purpose, dependencies, and resources should be included in this design view. This attribute information should be provided for all design entities.

#### 6.2.2.2 Use

The dependency description provides an overall picture of how the system works in order to assess the impact of requirements and design changes. It can help maintainers to isolate entities causing system failures or resource bottlenecks. It can aid in producing the system integration plan by identifying the entities that are needed by other entities and that must be developed first. This description can also be used by integration testing to aid in the production of integration test cases.

#### 6.2.2.3 Representation

There are a number of methods that help minimize the relationships among entities by maximizing the relationship among elements in the same entity. These methods emphasize low module coupling and high module cohesion (see Freeman and Wasserman, *Tutorial on Software Design Techniques*).

Formal specification languages provide for the specification of system functions and data, their interrelationships, the inputs and outputs, and other system aspects in a well-defined language. The relationship among design entities is also represented by data flow diagrams, structure charts, or transaction diagrams.

### 6.2.3 Interface description

#### 6.2.3.1 Scope

The entity interface description provides everything designers, programmers, and testers need to know to correctly use the functions provided by an entity. This description includes the details of external and internal interfaces not provided in the software requirements specification.

This design view consists of a set of interface specifications for each entity. The attribute descriptions for identification, function, and interfaces should be included in this design view. This attribute information should be provided for all design entities.

#### 6.2.3.2 Use

The interface description serves as a binding contract among designers, programmers, customers, and testers. It provides them with an agreement needed before proceeding with the detailed design of entities. In addition, the interface description may be used by technical writers to produce customer documentation or may be used directly by customers. In the latter case, the interface description could result in the production of a human interface view.

Designers, programmers, and testers may need to use design entities that they did not develop. These entities may be reused from earlier projects, contracted from an external source, or produced by other developers. The interface description settles the agreement among designers, programmers, and testers about how cooperating entities will interact. Each entity interface description should contain everything another designer or programmer needs to know to develop software that interacts with that entity. A clear description of entity interfaces is essential on a multiperson development for smooth integration and ease of maintenance.

#### 6.2.3.3 Representation

The interface description should provide the language for communicating with each entity to include screen formats, valid inputs, and resulting outputs. For those entities that are data driven, a data dictionary should be used to describe the data characteristics. Those entities that are highly visible to a user and involve the details of how the customer should perceive the system should include a functional model, scenarios for use, detailed feature sets, and the interaction language.

### 6.2.4 Detailed design description

#### 6.2.4.1 Scope

The detailed design description contains the internal details of each design entity. These details include the attribute descriptions for identification, processing, and data. This attribute information should be provided for all design entities.

#### 6.2.4.2 Use

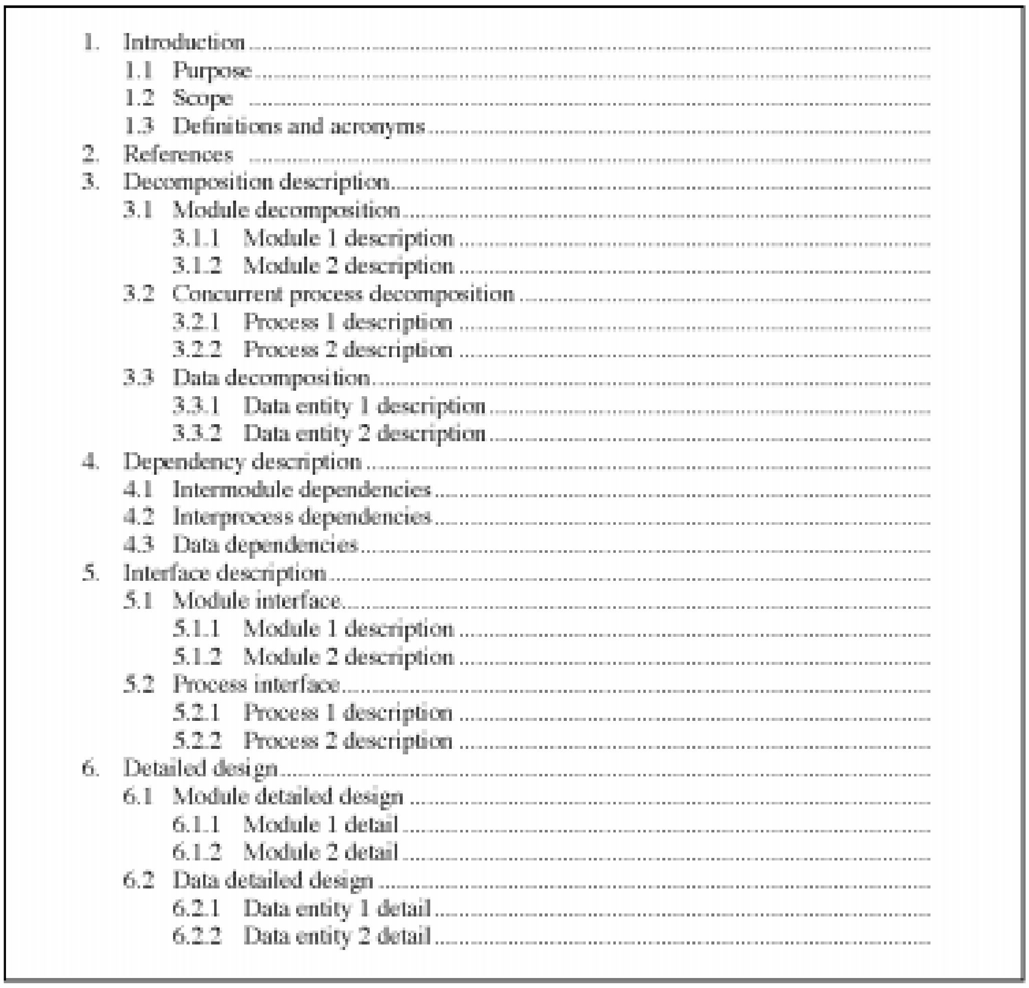
This description contains the details needed by programmers prior to implementation. The detailed design description can also be used to aid in producing unit test plans.

### 6.2.4.3 Representation

There are many tools used to describe the details of design entities. Program design languages can be used to describe inputs, outputs, local data and the algorithm for an entity. Other common techniques for describing design entity logic include using metacode or structured English, or graphical methods such as Nassi-Schneidermann charts or flowcharts.

## Annex A
## Sample table of contents for an SDD
## (Informative)

The following example of a table of contents shows only one of many possible ways to organize and format the design views and associated information presented in Clause 6 of this standard.



1. Introduction ........
   1.1 Purpose ........
   1.2 Scope ........
   1.3 Definitions and acronyms ........
2. References ........
3. Decomposition description ........
   3.1 Module decomposition ........
      3.1.1 Module 1 description ........
      3.1.2 Module 2 description ........
   3.2 Concurrent process decomposition ........
      3.2.1 Process 1 description ........
      3.2.2 Process 2 description ........
   3.3 Data decomposition ........
      3.3.1 Data entity 1 description ........
      3.3.2 Data entity 2 description ........
4. Dependency description ........
   4.1 Intermodule dependencies ........
   4.2 Interprocess dependencies ........
   4.3 Data dependencies ........
5. Interface description ........
   5.1 Module interface ........
      5.1.1 Module 1 description ........
      5.1.2 Module 2 description ........
   5.2 Process interface ........
      5.2.1 Process 1 description ........
      5.2.2 Process 2 description ........
6. Detailed design ........
   6.1 Module detailed design ........
      6.1.1 Module 1 detail ........
      6.1.2 Module 2 detail ........
   6.2 Data detailed design ........
      6.2.1 Data entity 1 detail ........
      6.2.2 Data entity 2 detail ........

**Figure A.1—Table of contents for an SDD**