Design Specification for IEEE Std 1471
Recommended Practice for Architectural Description
IEEE Architecture Working Group

0 Motivation

Despite significant efforts to improve engineering practices and technologies, software-intensive systems continue to present formidable risks and difficulties in their design, construction, and evolution. Recent attempts to address these difficulties have focused on the earliest period of design decision-making and evaluation, increasingly referred to as the "architectural level of system development." Many innovations are resulting from this attention, among them architecture description languages and environments, architectural frameworks, models and patterns, and techniques for architectural analysis and assessment.

These innovations are occurring, and maturing, rapidly within many research and application communities, and they reflect differing interests, influences, insights, and intentions. There has not yet emerged any reliable consensus on what "architecture" is, what purposes descriptions of it serve, in what forms, for what users, and in what situations. The boundaries and relationships between architectural practices and other practices, and between architectural technology and other technology, are not yet widely recognized.

In such situations, progress often depends on mediating influences. Potential adopters of architectural practices and technology need some frame of reference for addressing implementation and adoption decisions. Technology developers need some frame of reference to communicate the motivating concepts of their technology, and to appreciate feedback from early adoption. To this end, the Architecture Working Group (AWG) is undertaking to codify the best trends in practices for architectural description available today, and to provide a technical framework for further evolution in this area, by providing a recommended practice and a companion guide to its use.

1 Customers of the Standard

1.1 Definition and prioritization of customers

The principal class of users envisioned for the proposed standard comprises stakeholders in system development, including:

- those that use, own and acquire the system (clients, users, operators, acquirers, and maintainers), and
- those that develop and deliver the system (architects, designers, developers, testers, domain engineers, quality assurance staff, configuration management staff, suppliers and project managers).

A secondary class of users who will benefit indirectly from this proposed standard are those involved in the enterprise-wide, infrastructure activities that span multiple system developments, including:

- methodologists
- process and process improvement engineers
- researchers

- standards preparers
- tool builders
- trainers

1.2 Customer Needs

As producers and consumers of architectural information, the principal class of users identified above (i.e., stakeholders in system development) have the following needs for the proposed standard:

- a common set of concepts for addressing architectural concerns;
- a common vocabulary for articulating architectural concepts and principles;
- guidance for recording and communicating architectural descriptions;
- evaluation criteria for recognizing and promoting applicable, desirable architectural qualities of systems;
- an appropriate form for expressing architectural elements; and
- a basis for applying and maturing architectural practices.

The secondary class of users identified above (i.e., those involved in enterprise-wide, infrastructure activities) shares this set of needs.

Both the principal and secondary classes of users need this information in a form such that it may be:

- Referenced in Requests for Proposals: The acquirer would reference the standard to specify the delivery requirements for descriptions of proposed architectures from suppliers. The standard would also be used as the basis for developing evaluation criteria for responses (i.e., in terms of rating the completeness and consistency of the responses and identifying desired features, etc.)
- Used in Requests for Proposals and in Proposals: The standard would be used by the acquirer to document an architecture and request that potential suppliers respond with estimates for the development or maintenance of the specified system.
- Referenced in internal organizational process and policy documents: The standard would provide a common basis for the communication and documentation of architectures among all organizations involved in the production, fielding, operation and maintenance of a system. It would also serve as the basis for organization- or enterprise-specific handbooks of architectural practices particular to a product line or business area.
- Used in development and maintenance documentation: The standard would be used to produce the architectural descriptions for system and software documentation, such as material for reuse repositories and training materials.
- Referenced in techniques for architectural review, analysis, and evaluation: Common techniques for review, analysis, and evaluation of architectures would use the proposed standard to provide a common framework for terms,

concepts, views and notations. These evaluation techniques would then be consistently applicable in the review, analysis, and evaluation of architectures for specific systems or in enterprise-wide technology planning, business process improvement, and technology insertion activities.

- Used to produce architectural specifications for review, analysis, and evaluation; and subsequent system design and development.

2 Scope

2.1 Purpose

The intended value of the proposed standard is to facilitate the communication of architectures and lay a foundation for quality and cost gains by establishing a basis for architecture description.

2.2 Field of Application

The proposed standard will address architectural description of software-intensive systems. *Software-intensive systems* are those complex systems where software contributes essential influences to the design, construction, deployment and evolution of the system as a whole. In addressing architectural description, the field of application for the proposed standard are those products and other artifacts of system development which capture architectural information. Therefore, the field of application includes:

- Products to be used to express the system
- Artifacts to be used for communication among the system stakeholders
- Techniques to assist in the evaluation of system architectures in a consistent manner
- Activities by which interdisciplinary teams will consider the elements of system designs (persistent characteristics)
- Artifacts to be used to record lessons learned

The proposed standard is intended as a Recommended Practice.

3 Interaction with other standards

3.1 Vocabulary standard

The primary source of key vocabulary for this standard will be IEEE Std 610.12–1990, *Glossary of Software Engineering Terminology*. As noted in the APG's Action Plan, necessary changes to 610.12 relating to architecture will be identified and forwarded to current IEEE terminology efforts such as P729.

Other terminology sources for this standard include (but are not limited to):

- ISO 8402, Quality management and quality assurance; vocabulary
- ISO/IEC 2382–1, Data Processing – Vocabulary Section 01: Fundamental Terms

- ISO/IEC 2382–20: Information Technology – Vocabulary; Part 20: System Development.

3.2 Road Map standard

The proposed standard is intended as a program element standard within the resource program element (cf. *Vision 2000 Strategy Statement*, SESC/BPG–002).

3.3 Quality system standards

The proposed standard is intended to fulfill the requirements of ISO 9001, as delineated in ISO 9000–3, for architecture-related development activities such that: those activities are carried out in a disciplined manner, rules and standards are observed, methods and tools used are "appropriate" to satisfying acquirer requirements and the products (i.e., architectural descriptions) are subject to review against the standards.

3.4 Software life cycle process standards

The proposed standard will supply the architectural activities and activity descriptions underlying the creation and use of architectural descriptions. These architectural activities should be considered for incorporation into the IEEE/EIA 12207 implementation of the ISO system standard and software life cycle standard, the IEEE 1074 systems software life cycle standards and the ISO/IEC [Working Draft] 15288 Systems Engineering Process standard. The recommended practice will then serve as a guide in the fulfillment of these activities related to architectural description within the context of the life cycle processes above, and therefore in meeting the requirements of those life cycle process standards.

3.5 Supporting standards

The proposed standard extends the IEEE set of standards to address the architecture of software-intensive systems. The recommended practice will fill a gap in the IEEE family of standards since no comprehensive standards exist for developing and describing a software-intensive system's architecture. The proposed standard will provide input for global architectural standardization efforts.

The recommended practice will supply the appropriate architectural frame of reference, vocabulary, concepts and principles for the IEEE/EIA 12207 implementation of the ISO system standard and software life cycle standard. In addition, the following standards efforts address issues related to the proposed standard and therefore are points of coordination with the recommended practice: IEEE P1362, Concept of Operations Document; IEEE 1233, System Requirements Specification; IEEE 1220, Systems Engineering; and, IEEE 1016, 1016.1, Recommended Practice for Software Design Descriptions and Guide.

4 Consistency among the ISO/IEC SC7 standards

4.1 Style and presentation

This standard will use the style and format prescribed by the *IEEE Style Manual*.

4.2 Terminology

The terms listed below are fundamental to the proposed standard. When appropriate, common usages will be employed following *Webster's New Collegiate Dictionary*. Those terms which are useful to the proposed standard and which have already been defined by

other standards will be defined by reference. Whenever possible, this standard will use ISO terminology to promote global standardization. For terms not defined by ISO, the proposed standard will employ IEEE 610.12 as a primary source. In addition, the AWG will track IEEE P729 for emerging common definitions.

architect
architectural pattern
architecture
architecture description
component
connection
constraint
domain
domain model
framework
instance
instantiation
metamodel
product line
reference model
style
system
system stakeholder
view

4.3 Referencing

The Architecture Working Group will coordinate with other IEEE working groups contributing to the US implementation of ISO/IEC 12207 to promote a consistent use of architectural concepts, vocabulary and references in accordance with this standard.

5 Structure of the Recommended Practice for Architectural Description

The outline for the proposed standard appears below:

1. Overview (informative)
1.1 Scope
1.2 Purpose
1.3 Intended Users
1.4 Relationship to other standards
1.5 Compliance to this Standard (normative)
2. References (normative)
3. Definitions (normative)
3.X Acronyms and Abbreviations
4. Conceptual Framework (informative)
4.1 Life Cycle Context
4.2 Stakeholders and their Roles
4.3 Uses of Architecture
4.4 Architectural Description Metamodel (normative)
5. Architectural Practices (normative)
5.1 Architectural Documentation Practices

5.2 Architectural Description Techniques
5.3 Selection of Views
5.4 Architectural Analysis Techniques
5.5 Architectural Reviews and Audits
6. Evaluating Architectures (normative)
6.1 Principles of Evaluation
6.2 Uses of Evaluation
6.3 Evaluation Techniques
6.4 Evaluation Criteria
7. Implementation of this Standard (normative)
A. Bibliography (informative)

Proposed Outline for the Recommend Practice

6 Content of the Recommended Practice

The proposed standard will define a conceptual framework for the construction and use of software-intensive systems architectures throughout the system life cycle. The framework will include standard terminology, concepts and principles of architectural description. These key concepts will be presented as a metamodel.

The framework will be used to articulate a notional architectural concept of operations, describing the roles of architecture in the life cycle, with regard to key users (stakeholders). This concept of operations will describe the ways in which the standard may be put to use.

The proposed standard will address documentation practices, techniques for architectural description, and techniques for architectural analysis.

The draft recommended practice will be assessed by mapping to this *Design Specification*, once it is approved. To ensure further the utility of the recommended practice, the project plan will provide for review of the proposed standard by selected organizations representing the related standards activities identified above, and by organizations representing the primary and secondary users of the proposed standard.

Appendix

This section contains information for the companion *Guide* to the recommended practice. This is the tentative outline for the *Guide.*

I. Overview
  A. Scope
  B. Purpose
II. References
  A. Books
  B. Articles
  C. Related Work
  D. Conventions, Definitions, and Acronyms and Abbreviations
    1. Conventions
    2. Definitions
    3. Acronyms and Abbreviations
III. Architecture, Architect, Architectural Practice, Architectural Descriptions
  A. Architecture
    1. When is an Architecture complete
    2. Who are the owners (and other stakeholders) of the Architecture
    3. Who are the audiences for the Architecture
    4. How is the relationship of the Architecture determined for
      a) Systems
      b) Software
      c) Hardware
      d) Operational aspects
  B. Architect
    1. Selecting of an architect
      a) Knowledge
      b) Skills
      c) Experience
    2. Duties
      a) Technical
      b) Management
  C. Application of Architectural Practice
    1. When is it performed
    2. What is the environment for performing the work
    3. What are the functional interfaces with other disciplines
      a) Where are the inputs derived from
    4. What are the non functional interfaces (users, customers, buyer)
      a) Where are the inputs derived from
    5. Who manages the artifacts containing architectural descriptions
    6. How do we maintain control of the artifacts
    7. Effective use of the standard as a method of communication
    8. How to select and use Tools
    9. How to select and use Methodologies
      a) Heuristics
      b) Formal Methods
    10. Relationship to Design Practices
  D. Architectural Descriptions
    1. How are needed artifacts determined
    2. How to select a descriptive or diagrammatic communication media