



TECHNICAL REPORT	EIA-632™	REV. A
	Issued 1999-01 Reaffirmed 2003-09 Stabilized 2021-02 Superseding EIA-632	
Processes for Engineering a System		

RATIONALE

This document has been determined to contain basic and stable technology which is not dynamic in nature.

STABILIZED NOTICE

This document has been declared "Stabilized" by the SAE G-47 Systems Engineering Committee and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist.

NOTICE

This document has been taken directly from the original TechAmerica document and contains only minor editorial and format changes required to bring it into conformance with the publishing requirements of SAE Technical Standards. The release of this document is intended to replace the original with the SAE International document. Any numbers established by the original document remain unchanged.

The original document was adopted as an SAE publication under the provisions of the SAE Technical Standards Board (TSB) Rules and Regulations (TSB 001) pertaining to accelerated adoption of specifications and standards. TSB rules provide for (a) the publication of portions of unrevised specifications and standards without consensus voting at the SAE committee level, and (b) the use of the existing specification or standard format.

SAE Executive Standards Committee Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2021 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
http://www.sae.org

SAE WEB ADDRESS:

Full document details: SAE EIA632A

For more information on this standard, visit
<https://www.sae.org/standards/content/EIA632A>

Documents

Document Sharing Hub

TechAmerica Standard

Processes for Engineering a System

EIA-632

(Upgrade and Revision of EIA/IS-632)

January 1999



NOTICE

TechAmerica Engineering Standards and Publications are designed to serve the public interest by eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of TechAmerica from manufacturing or selling products not conforming to such Standards and Publications, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than TechAmerica members, whether the standard is to be used either domestically or internationally.

Standards and Publications are adopted by TechAmerica in accordance with the American National Standards Institute (ANSI) patent policy. By such action, TechAmerica does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the Standard or Publication.

This TechAmerica Standard is considered to have International Standardization implications, but the ISO/IEC activity has not progressed to the point where a valid comparison between the TechAmerica Standard and the ISO/IEC document can be made.

This Standard does not purport to address all safety problems associated with its use or all applicable regulatory requirements. It is the responsibility of the user of this Standard to establish appropriate safety and health practices and to determine the applicability of regulatory limitations before its use.

(From Standards Proposal No. 3527-A, formulated under the cognizance of the EIA 632 Working Group of the G-47 Systems Engineering Committee).

This document is maintained under the ANSI/TechAmerica continuous maintenance program. Changes may be submitted at any time on any part of the standard using the TechAmerica Document Improvement Proposal at the back of this document or a similar method containing the same information. These comments shall be acted on for revision of the standard at the first meeting following working group resolution of the comment.

Published by

© 2010 TechAmerica
Standards & Technology Department
1401 Wilson Boulevard, Suite 1100
Arlington, VA 22209
All rights reserved - Printed in U.S.A.

PLEASE!
DON'T VIOLATE
THE
LAW!

This document is copyrighted by TechAmerica and may not be reproduced without permission.

Organizations may obtain permission to reproduce a limited number of copies by entering into a license agreement with our distributors.

For distributor information please see our web site [www. techamerica.org/](http://www.techamerica.org/) or contact TechAmerica at 703-284-5355

ADOPTION NOTICE

EIA632, "ENGINEERING A SYSTEM, PROCESSES FOR", was adopted on 09-AUG-02 for use by the Department of Defense (DoD). Proposed changes by DoD activities must be submitted to the DoD Adopting Activity: OUSD(AT&L)/IO/SE (Systems Engineering), 3070 Defense Pentagon, Room 3D1075, Washington D. C. 20301-3070. Copies of this document may be purchased from the Electronic Industries Alliance, Engineering Department, 2500 Wilson Boulevard, Arlington, VA 22201. <http://www.eia.org>

Custodians:

Army - AM
Navy - AS
Air Force - 10
Other - SE

Adopting Activity:

Other - SE
(Project SESS-0036)

AREA SESS

DISTRIBUTION STATEMENT A: Approved for public release; distribution is unlimited.

Processes for Engineering a System

CONTENTS

FOREWORD	vii
INTRODUCTION	ix
ACKNOWLEDGMENTS.....	xi
1 SCOPE.....	1
1.1 PURPOSE.....	1
1.2 COVERAGE	1
1.3 INTENDED APPLICATIONS.....	2
1.4 LIMITATIONS	2
2 NORMATIVE REFERENCES	3
3 DEFINITIONS AND ACRONYMS.....	3
3.1 KEY TERMS.....	3
3.2 ACRONYMS.....	3
3.3 TERMINOLOGY	3
4 REQUIREMENTS	4
4.1 ACQUISITION AND SUPPLY	6
4.1.1 Supply Process	7
4.1.2 Acquisition Process.....	8
4.2 TECHNICAL MANAGEMENT	9
4.2.1 Planning Process.....	10
4.2.2 Assessment Process.....	14
4.2.3 Control Process.....	16
4.3 SYSTEM DESIGN	19
4.3.1 Requirements Definition Process	19
4.3.2 Solution Definition Process.....	23
4.4 PRODUCT REALIZATION	26
4.4.1 Implementation Process	27
4.4.2 Transition to Use Process	29
4.5 TECHNICAL EVALUATION.....	29
4.5.1 Systems Analysis Process	30
4.5.2 Requirements Validation Process.....	34
4.5.3 System Verification Process.....	37
4.5.4 End Products Validation Process.....	42
5 APPLICATION CONTEXT.....	43
5.1 ENTERPRISE FACTORS	44
5.2 PROJECT FACTORS	44
5.2.1 Enterprise support.....	44
5.2.2 Project support of the technical processes.....	45
5.3 EXTERNAL FACTORS	45
5.4 INFLUENCE OF OTHER ENTERPRISE PROJECTS	45
6 APPLICATION KEY CONCEPTS.....	46

6.1 SYSTEM CONCEPT	46
6.1.1 <i>Building block</i>	46
6.1.1.1 System element	47
6.1.1.2 End product elements	47
6.1.1.3 Subsystem elements	48
6.1.1.4 Enabling product elements	48
6.1.2 <i>Building block roles</i>	49
6.1.2.1 Specifications	50
6.1.2.2 Interface definition	52
6.1.2.3 Multidisciplinary teamwork	52
6.1.2.4 Risk management	53
6.1.2.5 Technical reviews.....	53
6.1.2.6 Cost collection and reporting.....	54
6.2 SYSTEM STRUCTURE CONCEPT.....	55
6.2.1 <i>Top-down development</i>	56
6.2.2 <i>Bottom-up realization</i>	58
6.3 ENGINEERING LIFE CYCLE CONCEPT	60
ANNEX A—GLOSSARY (NORMATIVE)	63
ANNEX B—ENTERPRISE-BASED LIFE CYCLE (INFORMATIVE)	69
B.1 RELATIONSHIP TO ENGINEERING LIFE CYCLE PHASES.....	69
B.2 PRODUCT EVOLUTION	70
B.3 LIFE CYCLE CONSIDERATIONS	70
ANNEX C—PROCESS TASK OUTCOMES (INFORMATIVE)	71
C.1 ACQUISITION AND SUPPLY TASK OUTCOMES	71
C.2 TECHNICAL MANAGEMENT TASK OUTCOMES	74
C.3 SYSTEM DESIGN TASK OUTCOMES	84
C.4 PRODUCT REALIZATION TASK OUTCOMES	92
C.5 TECHNICAL EVALUATION TASK OUTCOMES	94
ANNEX D—PLANNING DOCUMENTS (INFORMATIVE)	105
D.1 SOURCE DOCUMENTS	105
D.2 TECHNICAL DOCUMENTS	105
D.3 ENTERPRISE OR PROJECT DOCUMENTS	108
ANNEX E—SYSTEM TECHNICAL REVIEWS (INFORMATIVE)	110
ANNEX F—UNPRECEDENTED AND PRECEDENTED DEVELOPMENT (INFORMATIVE)	112
ANNEX G—REQUIREMENT RELATIONSHIPS (INFORMATIVE)	113
INDEX	117

LIST OF FIGURES

Figure 1.2—Fundamental processes for engineering a system	1
Figure 1.3—Application of this Standard	2
Figure 4a—Relationship of processes for engineering a system	4
Figure 4b—Requirements for engineering a system	5
Figure 4.1—Acquisition and Supply Processes	7
Figure 4.1.2—Acquisition Process requirements	8
Figure 4.2—Technical Management Processes	10
Figure 4.2.1—Planning Process requirements	10
Figure 4.2.2—Assessment Process requirements	14
Figure 4.2.3—Control Process requirements	17
Figure 4.3—System Design Processes	19
Figure 4.3.1—Requirements Definition Process requirements	20
Figure 4.3.2—Solution Definition Process requirements	23
Figure 4.4—Product Realization Processes	27
Figure 4.5—Technical Evaluation Processes	30
Figure 4.5.1—Systems Analysis Process requirements	30
Figure 4.5.2—Requirements Validation Process requirements	34
Figure 4.5.3—System Verification Process requirements	38
Figure 5.0—Context for application of this Standard	43
Figure 6.1—System concept	46
Figure 6.1.1—Building block	47
Figure 6.1.2.1—Building block role - specifications	50
Figure 6.1.2.3—Building block role - teamwork	52
Figure 6.1.2.5—Building block role - technical reviews	54
Figure 6.2—Forming a system structure	55
Figure 6.2.1a—Example system structure	57
Figure 6.2.1b—Top-down development	58
Figure 6.2.2—Bottom-up realization	59
Figure B.1—Enterprise-based life cycle phases	69
Figure F.1—Approaches for unprecedented and precededented end products	112
Figure G.1—Requirement relationships	113
Figure G.2—Role of specified requirements	114
Figure G.3—Development of enabling products	115
Figure G.4—Relationship between requirement types and elements of this Standard	116

LIST OF TABLES

Table 6.1.1.4—Examples of enabling products for each associated process	49
Table 6.1.2.5—Purposes of technical reviews.....	54
Table 6.3—Engineering life cycle phases	62
Table C.1—Requirement 1 (Supply Process - Product Supply)	71
Table C.2—Requirement 2 (Acquisition Process - Product Acquisition).....	72
Table C.3—Requirement 3 (Acquisition Process - Supplier Performance).....	73
Table C.4—Requirement 4 (Planning Process - Process Implementation Strategy).....	74
Table C.5—Requirement 5 (Planning Process - Technical Effort Definition).....	75
Table C.6—Requirement 6 (Planning Process - Schedule and Organization)	76
Table C.7—Requirement 7 (Planning Process - Technical Plans).....	77
Table C.8—Requirement 8 (Planning Process - Work Directives).....	78
Table C.9—Requirement 9 (Assessment Process - Progress Against Plans and Schedules)	78
Table C.10—Requirement 10 (Assessment Process - Progress Against Requirements)	79
Table C.11—Requirement 11 (Assessment Process - Technical Reviews)	79
Table C.12—Requirement 12 (Control Process - Outcomes Management)	80
Table C.13—Requirement 13 (Control Process - Information Dissemination)	83
Table C.14—Requirement 14 (Requirements Definition Process - Acquirer Requirements).....	84
Table C.15—Requirement 15 (Requirements Definition Process - Other Stakeholder Requirements).....	84
Table C.16—Requirement 16 (Requirements Definition Process - System Technical Requirements).....	85
Table C.17—Requirement 17 (Solution Definition Process - Logical Solution Representations).....	87
Table C.18—Requirement 18 (Solution Definition Process - Physical Solution Representations)	89
Table C.19—Requirement 19 (Solution Definition Process - Specified Requirements).....	91
Table C.20—Requirement 20 (Implementation Process)	92
Table C.21—Requirement 21 (Transition to Use Process).....	93
Table C.22—Requirement 22 (Systems Analysis Process - Effectiveness Analysis).....	94
Table C.23—Requirement 23 (Systems Analysis Process - Tradeoff Analysis)	95
Table C.24—Requirement 24 (Systems Analysis Process - Risk Analysis).....	96
Table C.25—Requirement 25 (Requirements Validation Process - Requirement Statements Validation)	97
Table C.26—Requirement 26 (Requirements Validation Process - Acquirer Requirements)	98
Table C.27—Requirement 27 (Requirements Validation Process - Other Stakeholder Requirements).....	98
Table C.28—Requirement 28 (Requirements Validation Process - System Technical Requirements)	99
Table C.29—Requirement 29 (Requirements Validation Process - Logical Solution Representations).....	100
Table C.30—Requirement 30 (System Verification Process - Design Solution Verification).....	101
Table C.31—Requirement 31 (System Verification Process - End Product Verification).....	102
Table C.32—Requirement 32 (System Verification Process - Enabling Product Readiness).....	102
Table C.33—Requirement 33 (End Products Validation Process)	104
Table E.1—System technical reviews	110

LIST OF REQUIREMENTS

Requirement 1—Product Supply	7
Requirement 2—Product Acquisition.....	8
Requirement 3—Supplier Performance	9
Requirement 4—Process Implementation Strategy	10
Requirement 5—Technical Effort Definition	11
Requirement 6—Schedule and Organization.....	12
Requirement 7—Technical Plans	13
Requirement 8—Work Directives	13
Requirement 9—Progress Against Plans and Schedules	14
Requirement 10—Progress Against Requirements.....	15
Requirement 11—Technical Reviews	16
Requirement 12—Outcomes Management.....	17
Requirement 13—Information Dissemination.....	17
Requirement 14—Acquirer Requirements	20
Requirement 15—Other Stakeholder Requirements.....	21
Requirement 16—System Technical Requirements	22
Requirement 17—Logical Solution Representations.....	23
Requirement 18—Physical Solution Representations	24
Requirement 19—Specified Requirements.....	26
Requirement 20—Implementation	28
Requirement 21—Transition to Use	29
Requirement 22—Effectiveness Analysis	31
Requirement 23—Tradeoff Analysis.....	32
Requirement 24—Risk Analysis	33
Requirement 25—Requirement Statements Validation	34
Requirement 26—Acquirer Requirements Validation.....	35
Requirement 27—Other Stakeholder Requirements Validation	35
Requirement 28—System Technical Requirements Validation.....	36
Requirement 29—Logical Solution Representations Validation	37
Requirement 30—Design Solution Verification.....	38
Requirement 31—End Product Verification.....	39
Requirement 32—Enabling Product Readiness.....	40
Requirement 33—End Products Validation.....	42

THIS PAGE LEFT BLANK

Foreword

This Standard is intended to enable an enterprise to strengthen its competitiveness in global markets by engineering and producing quality systems, and by delivering its products on time at an affordable price or cost. The focus, therefore, is on conceptualizing, creating, and realizing a system and the products that make up a system.

This Standard was developed as a joint project of the Electronic Industries Alliance (EIA) and the International Council on Systems Engineering (INCOSE). This effort was chartered by the G-47 Systems Engineering Committee of EIA and has been designated as Project PN-3537. This Standard has been approved by the EIA Engineering Department Executive Committee.

Intended uses of this Standard include

- a) benchmarking by an enterprise against the requirements of this Standard for engineering a system, or portion thereof;
- b) preparing enterprise standards, policies, and procedures for engineering a system;
- c) developing lower-tier industry- or domain-specific process standards;
- d) developing process capability and assessment models;
- e) establishing terminology and concepts for better communications;
- f) developing training and education curricula;
- g) preparing plans for actual development of a product.

Use is not limited to specific disciplines, industry sectors, or technology domains.

To provide each enterprise with the greatest degree of flexibility for adapting to changing environments while maintaining the integrity of adopted processes, this Standard

- a) limits the set of required processes to those directly related to the technical aspects of engineering systems;
- b) defines representative tasks associated with each process;
- c) includes the relevant information flows and interactions with enterprise and project entities.

This Standard is intended to define “what to do” with respect to the processes for engineering a system. ANSI/EIA-731, *Systems Engineering Capability*, provides a capability model and assessment method as a basis and means for determining “how well” the processes in ANSI/EIA-632 are defined and implemented.

This Standard is consistent with ISO 9000 in that it provides processes that can be adopted by enterprises for engineering systems.

Annex A is normative. Annexes B through G are informative.

THIS PAGE LEFT BLANK

Introduction

Background

In June 1994, a working group of industry associations, the International Council on Systems Engineering (INCOSE), and the Department of Defense developed an interim standard for the engineering of systems. This effort was led by the G-47 Committee on Systems Engineering of the Electronic Industries Alliance (EIA). EIA/IS 632 was intended to provide a standard for use by commercial enterprises, as well as government agencies and their development contractors.

In April 1995, a formal working group was established under Project PN-3537 and with EIA and INCOSE sponsorship to generate and release this full Standard. The joint working group decided that it would best serve U. S. industry to develop a “top-tier” standard applicable across all industry sectors and technology domains. As a result, the contents of this Standard are an abstraction of the essential features of the engineering practices described in the interim version of this Standard.

Contents of this Standard

This Standard defines a systematic approach to engineering or reengineering a system, incorporating best practices that have evolved during the second half of the twentieth century. The defined approach has three premises:

- a) A system is one or more end products and sets of related enabling products that allow end products, over their life cycle of use, to meet stakeholder needs and expectations;
- b) Products are an integrated composite of hierarchical elements so integrated as to meet the defined stakeholder requirements;
- c) The engineering of a system and its related products is accomplished by applying a set of processes to each element of the system hierarchy by a multidisciplinary team of people who have the requisite knowledge and skills.

The systematic approach of this Standard is applicable for: (1) completing corrective actions, (2) making refinements, (3) developing derivatives, (4) producing modifications, and (5) updating existing products, (6) creating and realizing new systems, and (7) allowing for the safe and cost-effective disposal (retirement) of a system. This approach is incrementally applied in an engineering life cycle framework that can be implemented during any one or more phases of an enterprise-based life cycle (for example, during production, operations, support, or disposal).

Voluntary Compliance

Adoption of this Standard is intended to be entirely voluntary, within the discretion of individual enterprises or other individual organizations.

Document Organization

The Standard is organized as follows:

Clause 1	<i>Scope</i>	states the purpose of the Standard and defines the particular processes to which it is intended to apply.
Clause 2	<i>Normative references</i>	lists other standards that are so referred to in the text as to make them indispensable in applying this Standard.
Clause 3	<i>Definitions and acronyms</i>	defines special use terms and acronyms.
Clause 4	<i>Requirements</i>	contains the requirements for the processes that are central to engineering a system. Representative tasks associated with each process are defined.
Clause 5	<i>Application context</i>	describes the context in which the processes of this Standard are applied.
Clause 6	<i>Application key concepts</i>	describes key concepts related to applying the processes of Clause 4 to generate and integrate the layers of end products and enabling products needed for engineering a system.
Annex A	<i>Glossary</i>	gives definitions for words that are used in a specific technical way in the body of the Standard. Only those terms for which the normal dictionary definition does not suffice are included.
Annex B	<i>Enterprise-based life cycle</i>	describes the management-life cycle phases in which a system, or portion thereof, is incrementally engineered.
Annex C	<i>Process task outcomes</i>	provides expected outcomes for the representative tasks identified in Clause 4.
Annex D	<i>Planning documents</i>	lists typical source, technical, and other documents related to engineering a system and their contents.
Annex E	<i>System technical reviews</i>	describes the necessary technical reviews for assessing progress against technical plans and requirements, and for assessing planned tasks.
Annex F	<i>Unprecedented and precededented development</i>	describes the application of the requirements of System Design processes for cases when system development is either unprecedented or precededented.
Annex G	<i>Requirement relationships</i>	defines different types of requirements and the relationship between these types and the logical and physical solution representations.

Acknowledgments

This document was developed by a team of subject matter experts (SME), including representatives from the following organizations:

- Electronic Industries Alliance (EIA)
- International Council on Systems Engineering (INCOSE).

Members of the Technical Committee are listed below:

James Martin, Raytheon Systems Co.
Chairman, Working Group and Technical Committee

Richard Harwell	Lockheed Martin Aeronautical Systems	INCOSE
Jerome (Jerry) Lake	Systems Management international	SME
John Velman	Hughes Space and Communications Co.	EIA

The Technical Committee was established to integrate and validate inputs from the Working Group and to disposition comments from Working Group members and from key reviewers. Other members of the Working Group are listed below:

Karl Arunski	Raytheon Systems Co.	EIA
Jim Johnson	Northrop Grumman, ESSD, Oceanic Systems	EIA
Ken LaSala	National Oceanic & Atmospheric Admin.	EIA
Ken Peterson	Boeing Defense and Space Co.	EIA
Cho Shimizu	Boeing Defense and Space Co.	EIA
Barbara Armistead	PRC, Inc.	INCOSE
Bruce Pittman	Profit Engineering Technologies	INCOSE
Richard Rountree	The Aerospace Corporation	INCOSE
Robert Shishko	CalTech/NASA Jet Propulsion Laboratory	INCOSE
John Snoderly	Defense Systems Management College	INCOSE
Randy Zittel	Defense Systems Management College	INCOSE
James Armstrong	Software Productivity Consortium	SME
Steve Tavan	Draper Laboratory	SME

Two liaison members involved with ISO standardization activities related to this Standard participated in working group activities:

Stuart Arnold	Defence Evaluation Research Agency	ISO Liaison
Raghu Singh	Federal Aviation Administration	ISO Liaison

THIS PAGE LEFT BLANK

1 Scope

1.1 Purpose

The purpose of this Standard is to provide an integrated set of fundamental processes to aid a developer in the engineering or reengineering of a system.

Use of this Standard is intended to help developers

- a) establish and evolve a complete and consistent set of requirements that will enable delivery of feasible and cost-effective system solutions;
- b) satisfy requirements within cost, schedule, and risk constraints;
- c) provide a system, or any portion of a system, that satisfies stakeholders over the life of the products that make up the system.

NOTE—The term *product* is used in this standard to mean: a *physical item*, such as a satellite (*end product*), or any of its component parts (*end products*); a software item such as a stand-alone application to run within an existing system (*end product*); or a *document* such as a plan, or a *service* such as test, training, or maintenance support, or *equipment* such as a simulator (enabling products).

- d) provide for the safe and/or cost-effective disposal or retirement of a system.

1.2 Coverage

This Standard defines processes for engineering a system, as shown in Figure 1.2. These have been organized into five groups.

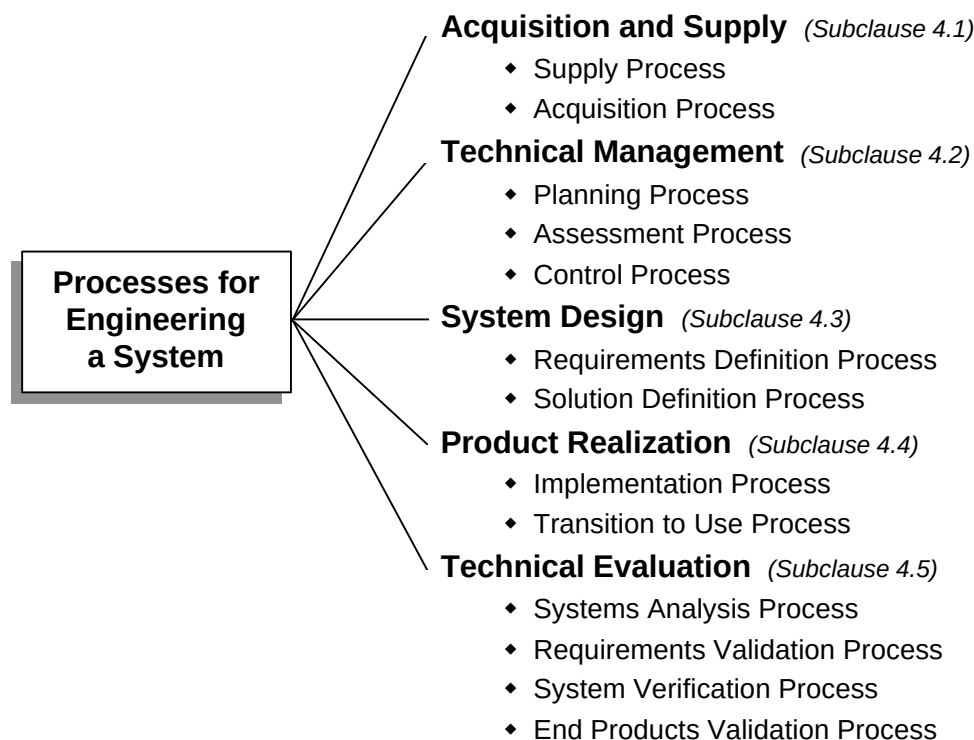


Figure 1.2—Fundamental processes for engineering a system

1.3 Intended applications

This Standard is intended to be applicable to the engineering or the reengineering of

- a) commercial or non-commercial systems, or portions thereof;
- b) any system, small or large, simple or complex, software-intensive or not, preceded or unprecedented;
- c) systems containing products made up of hardware, software, firmware, personnel, facilities, data, materials, services, techniques, or processes (or combinations thereof);
- d) a new system or a legacy system, or portions thereof.

NOTE—The specific tasks and implementation methods for applying the processes required by this Standard can vary, for example, between commercial and government projects, or between customer-involved and internally developed projects. The fundamental processes, however, are the same in all cases.

The requirements of this Standard, or a designated subset, are intended to be applied by establishing enterprise policies and procedures that define the requirements for project implementation of the adopted processes of this Standard. The application of this Standard with respect to enterprises and projects is shown in Figure 1.3.



Figure 1.3—Application of this Standard

1.4 Limitations

This Standard does not specify the details of “how to” implement process requirements for engineering a system. Nor does it specify the methods or tools a developer would use to implement the process requirements. It is intended that the developer select or define methods and tools that are applicable to the development, and that are consistent with enterprise policies and procedures.

This Standard does not prescribe the name, format, content, structure, or medium of documentation.

2 Normative references

The following standards contain provisions that, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

ANSI/EIA-649-1998, *National Consensus Standard for Configuration Management, August 1998*

IEEE/EIA 12207.0-1996 (An American National Standard), Industry Implementation of International Standard ISO/IEC : 1995, *Software life cycle processes*

IEEE/EIA 12207.1-1997 (An American National Standard), Industry Implementation of International Standard ISO/IEC : 1995, *Software life cycle processes-Life cycle data*

IEEE/EIA 12207.2-1997 (An American National Standard), Industry Implementation of International Standard ISO/IEC : 1995, *Software life cycle processes-Implementation considerations*

3 Definitions and acronyms

3.1 Key terms

Definitions for special use of terms are contained in Annex A, Glossary.

3.2 Acronyms

Acronyms used in this Standard are shown below.

EIA	Electronic Industries Alliance
IEEE	Institute of Electrical and Electronics Engineers
INCOSE	International Council on Systems Engineering
IS	Interim Standard

NOTE—Acronyms that are spelled out in the text and not used elsewhere in the document are not listed above.

3.3 Terminology

The word **shall** identifies mandatory provisions of this Standard. The word **should** identifies recommended provisions of this Standard. The word **may** identifies permissive provisions of this Standard.

4 Requirements

This Clause provides requirements for processes used in engineering a system and is applicable to any product development regardless of its place in the hierarchy of the system structure (see Clause 6) or the enterprise-based life cycle phase (see Annex B). The processes are applicable for the engineering or reengineering of the end products that make up a system, as well as the development of enabling products required to provide life-cycle support to system end products. Figure 4a shows the relationships between the processes of this Standard.

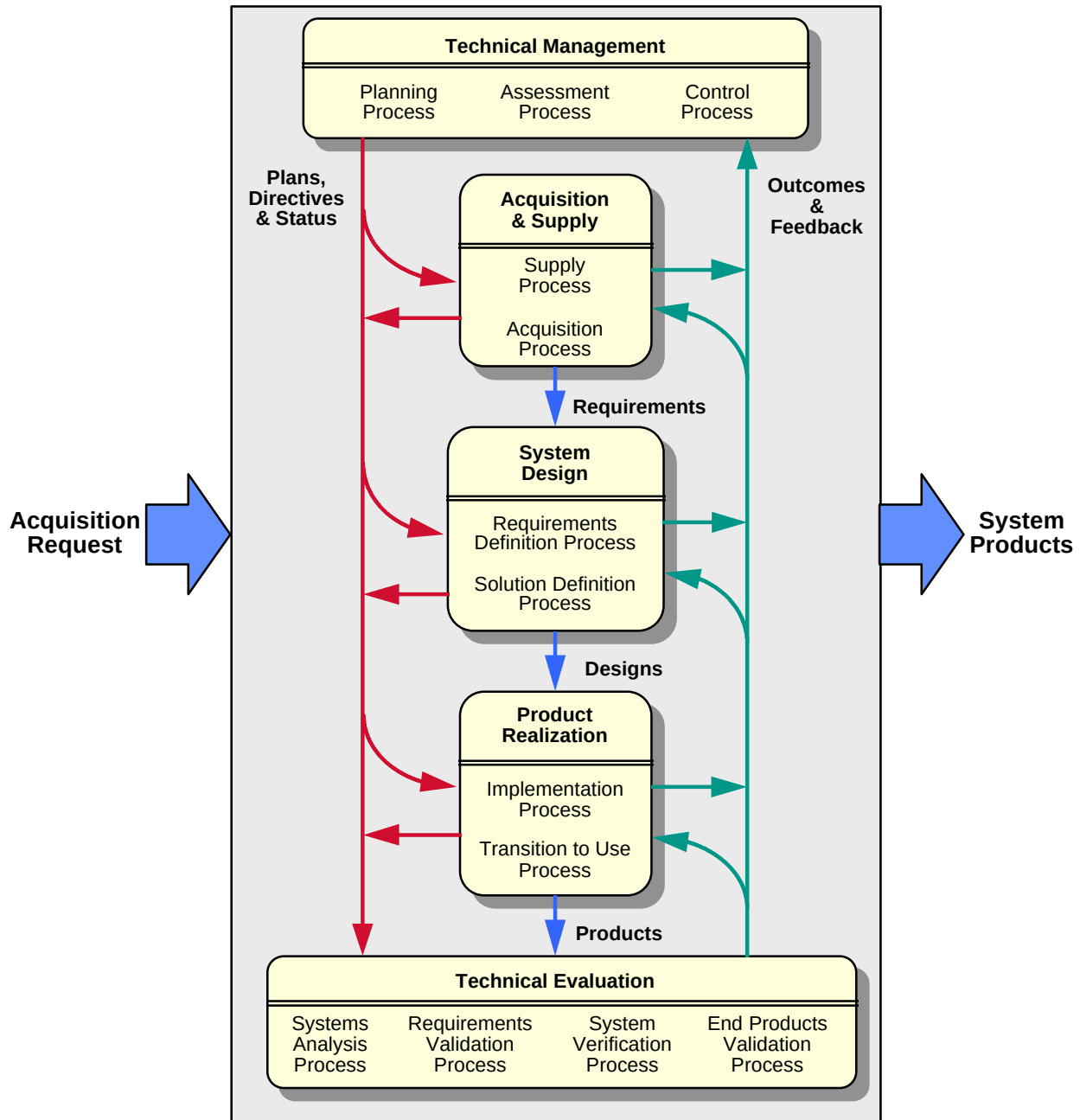


Figure 4a—Relationship of processes for engineering a system

NOTES

- 1 The application of the processes shown in Figure 4a is discussed in Clause 6 and Annex F. Appropriate processes of Figure 4a are applied recursively and iteratively to define the system products of the system hierarchy from the top down, and then, to implement and transition the system products from the bottom up to the user or customer.
- 2 Although the requirements in this Standard are presented sequentially, in practice many associated tasks are concurrent and highly iterative, and have interactive dependencies that lead to alteration of previously established technical requirements.

This Standard specifies the 33 requirements as shown in Figure 4b.

SUPPLY PROCESS REQUIREMENTS	REQUIREMENTS DEFINITION PROCESS REQUIREMENTS	SYSTEMS ANALYSIS PROCESS REQUIREMENTS
1—Product Supply		
ACQUISITION PROCESS REQUIREMENTS	14—Acquirer Requirements	22—Effectiveness Analysis
2—Product Acquisition	15—Other Stakeholder Requirements	23—Tradeoff Analysis
3—Supplier Performance	16—System Technical Requirements	24—Risk Analysis
PLANNING PROCESS REQUIREMENTS	SOLUTION DEFINITION PROCESS REQUIREMENTS	REQUIREMENTS VALIDATION PROCESS REQUIREMENTS
4—Process Implementation Strategy	17—Logical Solution Representations	25—Requirement Statements Validation
5—Technical Effort Definition	18—Physical Solution Representations	26—Acquirer Requirements Validation
6—Schedule and Organization	19—Specified Requirements	27—Other Stakeholder Requirements Validation
7—Technical Plans		28—System Technical Requirements Validation
8—Work Directives		29—Logical Solution Representations Validation
ASSESSMENT PROCESS REQUIREMENTS	IMPLEMENTATION PROCESS REQUIREMENTS	SYSTEM VERIFICATION PROCESS REQUIREMENTS
9—Progress Against Plans and Schedules	20—Implementation	30—Design Solution Verification
10—Progress Against Requirements		31—End Product Verification
11—Technical Reviews		32—Enabling Product Readiness
CONTROL PROCESS REQUIREMENTS	TRANSITION TO USE PROCESS REQUIREMENTS	END PRODUCTS VALIDATION PROCESS REQUIREMENTS
12—Outcomes Management	21—Transition to Use	33—End Products Validation
13—Information Dissemination		

Figure 4b—Requirements for engineering a system

The developer **should**: (1) decide which of the processes in Figure 4a apply to their enterprise; (2) decide which requirements from this Standard apply for the processes selected; (3) establish appropriate policies and procedures that govern project implementation; (4) define appropriate tasks for each of the selected requirements; and (5) establish the methods and tools to support task implementation. Representative tasks, along with their expected outcomes, are provided in Annex C for each requirement of this Standard.

NOTES

- 1 The developer can be an enterprise, a group of enterprises, an organization, or a project.
- 2 A developer can be either an acquirer or a supplier of systems, subsystems, or end products.
- 3 A developer can act in both roles (acquirer and supplier) simultaneously on the same project, e.g., supplying an end product to another organization, while acquiring subsystems from a third organization.

For a system that contains product elements for which lower-tier development standards exist, or where standards or guides exist for safety, security, or other system aspects, these **should** be used in conjunction with this Standard—for example: (1) IEEE/EIA 12207 for a system that contains software, or for a stand-alone software product; and (2) ANSI/EIA-649 for configuration management.

4.1 Acquisition and Supply

The Acquisition and Supply Processes are used by a developer to arrive at an agreement with another party to accomplish specific work and to deliver required products, or with another party or parties to have work done and to obtain desired products. The parties can either be inside the developer's own enterprise (another project, functional organization, or project team), or can be in a different enterprise. The Acquisition and Supply Processes can be initiated as a result of a project go-ahead or approval decision, or by the receipt of an acquisition request, offer or directive. A project go-ahead can be given within an enterprise as a result of a market-needs analysis, technology breakthrough, a perceived market opportunity, a customer requirement, an internal project directive, or a similar stimulus.

NOTE—Although a project or development effort can be initiated by casual means, an agreement is nevertheless useful to ensure that all parties involved understand the purpose, goals, and expectations of the work.

An agreement can be between enterprises and between organizational elements within an enterprise, to include between projects, between projects and functional units, and between units within a project. The agreement within an enterprise can take the form of a work directive, work package, work authorization, or project memorandum of agreement. Agreements between enterprises can take the form of a formal contract for the delivery of a product, or a memorandum of agreement that establishes the working relationship between two or more enterprises on a common project.

Regardless of the form or purpose of the agreement, certain information **should** be included, for example:

- a) Work to be performed;
- b) Cost and schedule constraints;
- c) Concept of operations;
- d) Requirements to be satisfied, including known functional, performance, and interface requirements, attributes, and characteristics;
- e) Product and data to be delivered;
- f) Information pertaining to cost, schedule, planning, delivery information, product structure, packaging and handling instructions, or installation instructions;
- g) Appropriate technical plans;
- h) Applicable financial structure, management and authority provisions;
- i) Exit criteria for relevant enterprise-based life cycle phases;
- j) Identification of applicable engineering life cycle phases;
- k) Required technical reviews.

NOTE—A developer can be developing a product without any contractual relationship to the user or customer (e.g., commercial product development). However, much of the information above must be available to the developing organization in order to proceed.

The role of the developer with respect to the two processes of Acquisition and Supply is shown in Figure 4.1.

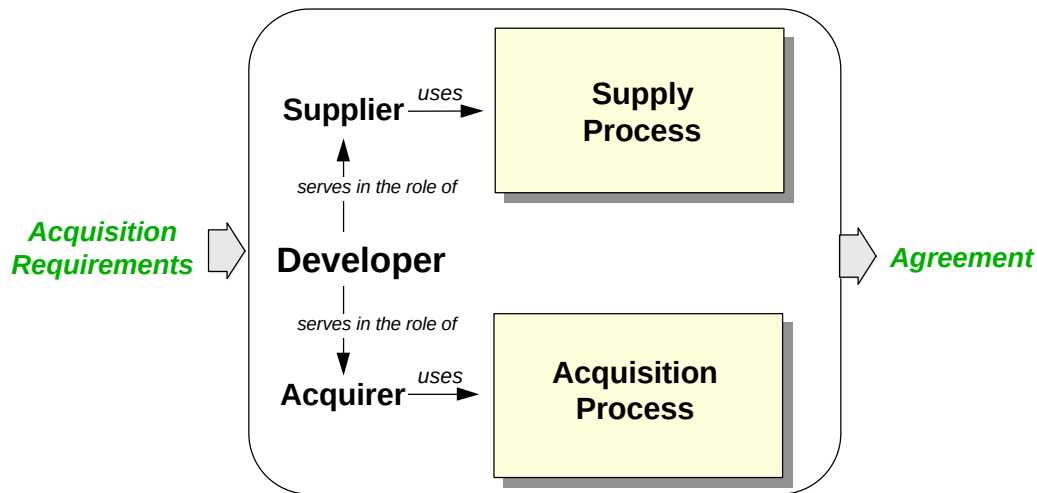


Figure 4.1—Acquisition and Supply Processes

NOTES

- 1 The acquirer can be either one of the following:
 - a) Internal to enterprise—for example, another project, marketing organization, parent project of a product team, the project team itself, executive manager, supervisor.
 - b) External to enterprise—for example, procurement agency, prime contractor, another developer, buyer, customer, end user, owner, purchaser.
- 2 The supplier can be either one of the following:
 - a) Internal to enterprise—for example, another project, functional organization, product team.
 - b) External to enterprise—for example, another developer, prime contractor, producer, seller, subcontractor, vendor.
- 3 The requirements of this Standard apply to the developer in its role as acquirer, supplier, or both.

4.1.1 Supply Process

This process is used by the developer when acting as a supplier to establish and satisfy an agreement with the acquirer.

Requirement 1—Product Supply

For a system, or portion thereof, supplied to an acquirer, the developer (when acting as the supplier) **shall** establish and satisfy an agreement with the acquirer.

The developer (as supplier) **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Assess the acquisition request, offer, or directive to determine the capability to meet the acquisition document requirements.

- b) Establish a satisfactory agreement within legal, regulatory, enterprise, and project bounds.
- c) Record the established agreement in the form appropriate to the effort.
- d) Implement the processes of this Standard, as applicable, to meet the requirements of the agreement.
- e) Deliver the products and other deliverables as specified in the established agreement.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement influence the Acquisition, Planning, and Control Processes.

4.1.2 Acquisition Process

This process is used by the developer when acting as an acquirer to establish an agreement with a supplier and to manage supplier performance.

The Acquisition Process includes the two requirements shown in Figure 4.1.2.

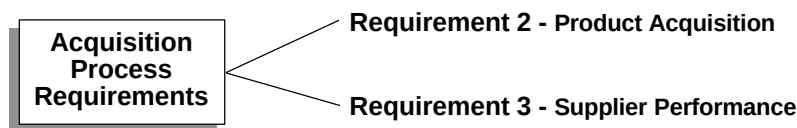


Figure 4.1.2—Acquisition Process requirements

Requirement 2—Product Acquisition

For a system, or portion thereof, acquired from a supplier, the developer (when acting as the acquirer) **shall** establish an agreement with that supplier.

The developer (as acquirer) **should** plan and do the appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Prepare the applicable acquisition request, offer, or directive to obtain supply of work or delivery of desired system products.
- b) Evaluate supplier response to acquisition request, offer, or directive.
- c) Make offer or provide directive to desired supplier.
- d) Negotiate agreement to establish a satisfactory agreement within legal, regulatory, enterprise, and project bounds.
- e) Record the established agreement in the form appropriate to the effort.
- f) Accept delivered products.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement influence the Supply, Planning, and Control Processes.

Requirement 3—Supplier Performance

The developer (when acting as the acquirer) **shall** manage supplier performance to ensure that the technical effort to be accomplished by the supplier provides end products that satisfy the assigned requirements.

The developer (as acquirer) **should** plan and do the appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Define the required developer-supplier relationships.
- b) Participate on appropriate supplier product teams.
- c) Monitor supplier performance against key product metrics.
- d) Flow-down changes in requirements or operational concept that might affect the supplier's project.
- e) Control changes to requirements made by the supplier that would affect the developer's project or other related projects or products.
- f) Assess supplier performance against assigned requirements, including conduct of, or participation in, appropriate technical reviews.
- g) Validate products delivered from the supplier, or ensure that products have been validated before delivery and prior to integration with other products that form a composite end product intended to meet the developer's specified requirements.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement influence the Planning, Assessment, Control, and Implementation Processes.

4.2 Technical Management

The Technical Management Processes are to be used to plan, assess, and control the technical work efforts required to satisfy the established agreement. The relationship of the three Technical Management Processes for planning, assessing progress, and controlling the technical effort is shown in Figure 4.2

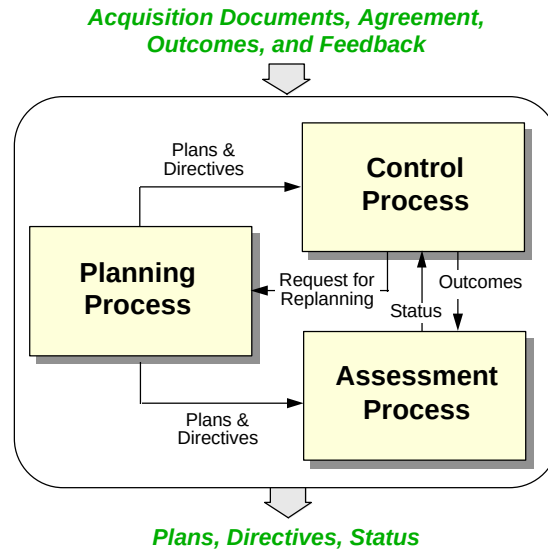


Figure 4.2—Technical Management Processes

4.2.1 Planning Process

This process is used to support enterprise and project decision making and to prepare necessary technical plans that support and complement project plans to: (1) arrive at a decision to supply services according to an external solicitation; (2) determine whether to proceed with an internal enterprise project for a new product or a product improvement; (3) guide the work efforts that will meet the requirements of an established agreement; or (4) replan applicable processes for engineering a system. Replanning is normally initiated (1) when required by an agreement; (2) when significant variations or anomalies are identified from other Technical Management process outcomes, or (3) before implementation of the next enterprise-based life cycle phase.

The five requirements associated with the Planning Process are shown in Figure 4.2.1.

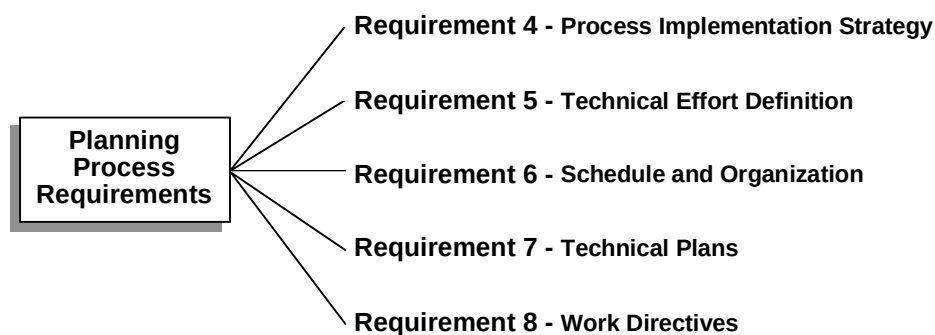


Figure 4.2.1—Planning Process requirements

Requirement 4—Process Implementation Strategy

The developer **shall** define a strategy for implementing the adopted processes of this Standard as a basis for project technical planning and that is in accordance with the agreement.

The developer **should** plan and do the appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify stakeholders who will have an interest or stake in the outcome of the project.
- b) Identify and acquire applicable documents, and the requirements therein, that could affect the project.
- c) Identify associated process approaches for development, production, test, deployment/installation, training, support, and disposal that will require enabling products to be developed or procured.
- d) Identify applicable enterprise-based life cycle phases (see Annex B), expected work product outputs, applicable management reviews, and life-cycle-phase exit criteria.
- e) Identify and define how the applicable processes of this Standard will be integrated, how internal and external projects will be involved, and how they will be integrated.
- f) Identify and define progress assessment metrics and reporting requirements.
- g) Prepare, document, and make available the process implementation strategy.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement: (1) provide a roadmap for the technical implementation of the project, including engineering life-cycle activities within specified enterprise-based life cycle phases; (2) are to be implementable by each product team or product manager; (3) are used in preparing and negotiating an agreement; and (4) influence the developer's ability to fulfill the other requirements of the Planning Process. The process implementation strategy includes requirements for the processes to be undertaken, applicable constraints, completion criteria, and feasibility of each process, considering resources (personnel, materials, technology) and project execution environment. This strategy can be a part of the project plan or a stand-alone document.

Requirement 5—Technical Effort Definition

The developer **shall** define a technical effort that is in accordance with the process implementation strategy.

The developer **should** plan and do the appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify project requirements to include: agreement requirements; other stakeholder requirements; and enterprise, project, and associated process constraints.
- b) Establish an information database that will allow capture of project data and be able to securely retain and make information available, as required.
- c) Determine the risk management strategy to identify technical risks to the appropriate level and properly avert those risks that could adversely affect the project.

- d) Define product metrics by which the quality of the products will be evaluated and process metrics by which the efficiency and effectiveness of the technical effort will be measured.
- e) Establish cost objectives (e.g., ownership, acquisition, operating, support, and disposal) to be used in tradeoff analyses.
- f) Identify technical performance measures that will be used to determine the success of the system, or portion thereof, and that will receive management focus and be tracked using Technical Performance Measurement (TPM) procedures.

NOTE—A TPM program provides an early warning of the adequacy of a design in terms of satisfying selected critical performance parameter requirements of a system end product. TPM also examines marginal cost benefit of performance in excess of requirements. A *critical performance parameter* is one that characterizes a significant total system qualifier. In addition, it must be possible to project the evolution of the parameter as a function of time toward the desired value at the completion of development. The projection can be based on verification, validation, planning, or historical data.

- g) Identify applicable tasks based on analysis of the key events of the project and entry and exit criteria for each event.
- h) Identify the appropriate methods and tools, required facilities and equipment, and training required to be able to complete defined tasks and meet event exit criteria.
- i) Identify applicable or potential technology constraints and develop an approach for overcoming each constraint by using an appropriate mitigation approach and by technology insertion at the appropriate time in the enterprise-based life cycle.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement will provide guidance for preparing schedules and applicable technical plans and for identifying resource requirements, and will influence the developer's ability to complete the other applicable processes for engineering a system.

Requirement 6—Schedule and Organization

The developer **shall** schedule and organize the defined technical effort.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Develop event-based schedules based on key events, related tasks, and relevant completion criteria for the applicable enterprise-based life cycle phase.
- b) Develop the calendar-based schedule, showing the dates of expected task and event completion and the dependency relationships among tasks.
- c) Identify resources required to complete the scheduled tasks.
- d) Define the staffing and discipline needs to complete the scheduled tasks, training needs, and risks if required staff are not available.

- e) Define the team and organizational structure to complete the scheduled tasks within resource constraints.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement provide guidance for preparing applicable technical plans used to guide completion of the technical efforts for each applicable process to meet agreement requirements.

Requirement 7—Technical Plans

The developer **shall** create technical plans to ensure an integrated and cost effective technical effort in accordance with the defined schedule and organization.

The developer **should** prepare appropriate plans to complete this requirement. Plans to consider include the following:

- a) Engineering Plan;
- b) Risk Management Plan;
- c) Technical Review Plan;
- d) Verification Plans;
- e) Validation Plans;
- f) Other applicable plans as called for in the agreement or by enterprise policies and procedures.

The expected outcomes for the tasks related to developing these plans are provided in Annex C. The outcomes associated with completing this requirement provide guidance for preparing work directives and completing other applicable project processes for engineering a system.

Any plan created **should** include the scope, tasks, methods, tools, metrics, risks, and resources as applicable to fulfill the purpose of the plan.

NOTE—Annex D of this Standard contains a listing of typical planning documents. Some projects require either more or significantly less documentation. These planning documents can be tailored as to the level and formality of planning to suit project complexity and uncertainty.

Requirement 8—Work Directives

The developer **shall** create work directives that implement the planned technical effort.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Develop individual project team or organization work packages that describe the work to be done, resource sources, schedules, budget, and reporting requirements.

- b) Generate work authorizations for the team or organization that provide approval for applicable teams or organizations to complete their work package requirements and to release applicable resources.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement provide the means to implement the planned technical effort.

4.2.2 Assessment Process

The Assessment Process is used to: (1) determine progress of the technical effort against both plans and requirements; (2) review progress during technical reviews; and (3) support control of the engineering of a system. The product and process metrics selected for assessing progress **should** provide information for risk aversion, meaningful financial and non-financial performance, and support of project management.

NOTE—When variations are sufficiently significant or cannot be corrected by re-accomplishment of the process tasks that generated the outcome data, the Planning Process is re-initiated in order to implement appropriate corrective actions.

The three requirements associated with the Assessment Process are shown in Figure 4.2.2.

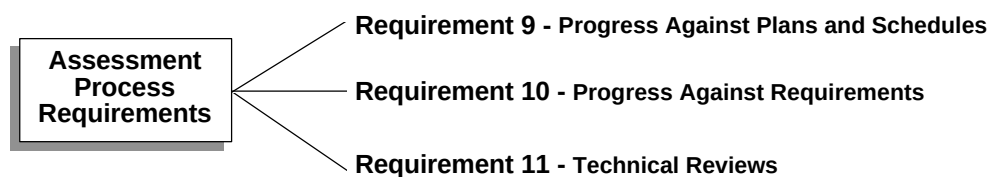


Figure 4.2.2—Assessment Process requirements

Inputs to the Assessment Process are in the form of technical plans, stakeholder requirements, and engineering outcomes from other processes.

Requirement 9—Progress Against Plans and Schedules

The developer **shall** assess the progress of the technical effort against applicable technical plans and schedules.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify events, tasks, and process metrics for monitoring progress against plans and schedules.
- b) Collect and analyze identified process metrics data and results from completion of planned and scheduled tasks and events.
- c) Compare process metrics data against plans and schedule to determine technical areas requiring management or team attention.
- d) Determine and implement required changes to correct variances, make changes to plan and schedule, and redirect work.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement provide status information to enable efficient use of resources, evaluation of progress against plan, identification of variances of cost and schedule from planned project management baselines, and early identification and resolution of productivity problems.

NOTE—*Process metrics* are identified and used to assess the means of attaining stakeholder satisfaction. Process metrics include earned value (cost/schedule measure), amount of waste, number of engineering changes, percentage of drawings completed, number of drawing errors, percentage of lines of code completed, rework percentage, idle time (e.g., work in progress), change rate, and turnover in personnel. The criteria for process metric selection are based on how well enhancement in project performance correlates with improvement in potential customer satisfaction.

Requirement 10—Progress Against Requirements

The developer **shall** assess the progress of system development by comparing currently defined system characteristics against requirements.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify product metrics, and their expected values, that will affect the quality of the product and provide information of the progress toward satisfying acquirer and other stakeholder requirements, as well as derived requirements.
- b) Collect and analyze product metrics data.
- c) Record rationale for decisions and assumptions made with respect to collected data.
- d) Compare results against requirements to determine degree of technical requirement satisfaction, progress toward maturity of the system (or portion thereof) being engineered, and variations and variances from requirements.
- e) Identify required changes and implement approved revisions to specifications and configuration baselines.

The expected outcomes for these representative tasks are provided in Annex C. Representative outcomes associated with completing this requirement provide: (1) an evaluation of the progress toward meeting requirements pertaining to the system being engineered or reengineered; (2) status information to enable efficient use of resources, (3) evaluation and tracking of system quality and technology, (4) faster response time to inquiries from acquirer or other stakeholders, (5) identification of variances from planned improvements in critical technical parameters as the design evolves, (6) early identification and resolution of system related problems, and (7) tracking of tradeoff analysis recommendations, effectiveness analysis results, verification outcomes, and validation results.

NOTE—*Product metrics* are used to measure stakeholder satisfaction, deliver an ever-improving value to the acquirers of system end products, and be indicative that the design process is continuing toward an acceptable solution. An example of an input product metric is the quality of materials and skills of assigned project personnel. An example of an output metric is a technical performance measure (TPM).

Requirement 11—Technical Reviews

The developer **shall** conduct technical reviews of progress and accomplishments in accordance with appropriate technical plans.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify the review objectives and requirements cited in the Technical Review Plan, enterprise policies and procedures, and agreement, as applicable.
- b) Determine progress toward satisfying the technical review entry requirements.
- c) Establish the technical review board, agenda, and speakers.
- d) Prepare the appropriate materials to include the read-ahead technical review package and presentation package.
- e) Facilitate and support identification and resolution of emerging issues prior to the review.
- f) Conduct the technical review according to the Technical Review Plan, identifying and documenting action items required to meet the review objectives.
- g) Close out the review after (1) minutes have been prepared, approved, and distributed, (2) action items have been resolved, and (3) the review has been signed off by the chairperson.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completion of this requirement (1) help ensure that all event-based plan criteria have been met, (2) provide ongoing status of design maturity and how well the concepts satisfy requirements, (3) provide traceability of requirements and validity of assumptions and decision rationale, (4) provide identification of issues to be resolved and those issues not determined during the development effort, and (5) highlight related risks, needed resources, and preparation for conducting the next engineering life cycle phase development effort.

Representative technical reviews, used for assessing progress against the requirements and technical plans and for assessing planned tasks, are described in Annex E.

4.2.3 Control Process

The Control Process is used to: (1) manage the conduct and outcomes of the Acquisition and Supply Processes, System Design Processes, Planning and Assessment Processes, Product Realization Processes, and Technical Evaluation Processes; (2) monitor variations from the plan and anomalies relative to requirements; (3) distribute required and requested information; and (4) ensure necessary communications. This process supports satisfaction of the agreement and assurance that variations and anomalies are corrected by repeating appropriate tasks.

The two requirements associated with the Control Process are shown in Figure 4.2.3.

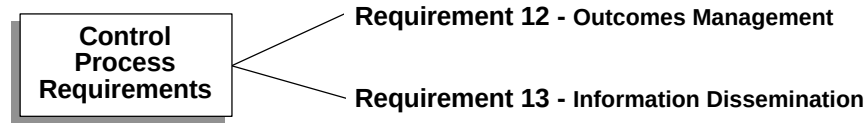


Figure 4.2.3—Control Process requirements

Inputs to the Control Process are in the form of outcomes from other processes plus project and enterprise information affecting the engineering of a system.

Requirement 12—Outcomes Management

The developer **shall** manage the outcomes of the technical effort.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Capture the outcomes, descriptions of methods and tools used, decisions and assumptions, lessons learned, and other data that allow for tracking requirements.
- b) Perform configuration management in accordance with the Configuration Management Plan.
- c) Perform change management in accordance with the Change Management Plan.
- d) Perform interface management in accordance with the Interface Management Plan.
- e) Perform risk management in accordance with the Risk Management Plan.
- f) Perform data and document management in accordance with the Data and Document Management Plan.
- g) Manage the information database to ensure that captured data is properly retained, is secure, and is available to those with authority to have access.
- h) Manage and track stakeholder requirements, system technical requirements, logical solution representations, physical solution representations, derived technical requirements, specified requirements, approved changes, and validation results.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement help to ensure that the outcomes of the applicable processes for engineering a system are properly recorded and managed according to the applicable plan, the agreement, or enterprise policies and procedures.

Requirement 13—Information Dissemination

The developer **shall** ensure that required and requested information is disseminated in accordance with the agreement, project plans, enterprise policies, and enterprise procedures.

The developer **should** plan and do appropriate tasks to complete this requirement. Information to consider for dissemination includes, as appropriate, the following materials captured and controlled in the information database:

- a) Progress status;
- b) Planning information;
- c) Requirements;
- d) Technical data package and other materials for technical reviews;
- e) Design data and schema;
- f) Lessons learned;
- g) Variances and anomalies from validations and verifications and other progress assessments;
- h) Data deliverables;
- i) Approved changes;
- j) Work directives resulting from management decisions, planning, or approved changes.

The expected outcomes for the representative tasks associated with this distribution are provided in Annex C. The outcomes associated with completing this requirement help to ensure that required and requested information is appropriately distributed to satisfy the needs of the acquirer and requesters, and in accordance with an agreement, project directives and plans, and enterprise policies and procedures.

4.3 System Design

The System Design Processes are used to convert agreed-upon requirements of the acquirer into a set of realizable products that satisfy acquirer and other stakeholder requirements.

Two processes are involved—Requirements Definition and Solution Definition. The relationship of these processes is shown in Figure 4.3.

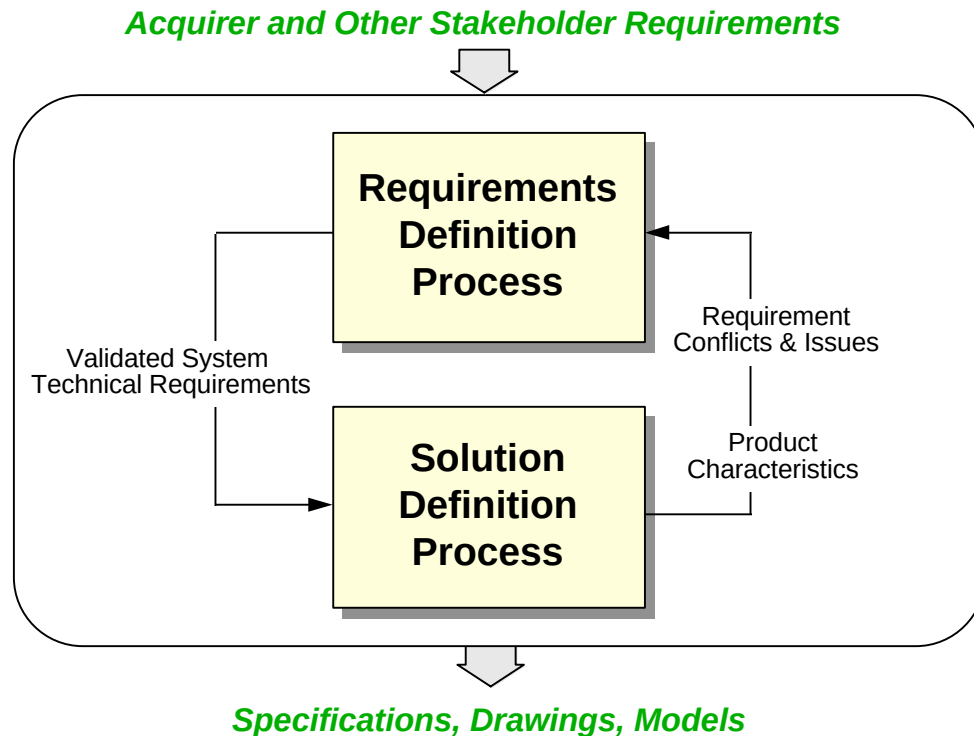


Figure 4.3—System Design Processes

This technical effort begins with the identifying, collecting, and defining *acquirer and other stakeholder requirements*. These requirements are transformed into a set of *validated system technical requirements*. The validated system technical requirements are then transformed into a design solution described by a set of *specified requirements*. The specified requirements take the form of specifications, drawings, models, or other design documents, depending on design maturity. These are used to: 1) build, code, assemble and integrate end products; 2) verify end products against; 3) obtain off-the-shelf products; or 4) assign to a supplier for development of subsystem products. The relationship between the requirements involved with the System Design Processes is shown in Annex G.

NOTE—Requirements traceability is instituted for tracking requirements from the identification of acquirer and other stakeholder requirements to the system technical requirements, logical solution representations, physical solution representations, derived technical requirements, and specified requirements. (See Requirement 12, task h.)

4.3.1 Requirements Definition Process

The three requirements associated with the Requirements Definition Process are shown in Figure 4.3.1.

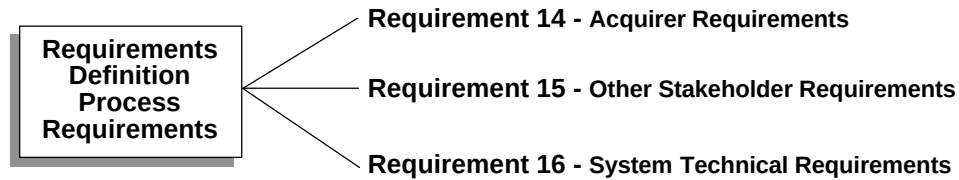


Figure 4.3.1—Requirements Definition Process requirements

Inputs to the Requirements Definition Process are of three types: (1) requirements from the agreement, other documents, and individuals or groups that have a stake in the outcome of the engineering or reengineering of the system, (2) requirements in the form of outcomes from other processes such as technical plans and decisions from technical reviews, and (3) requested or approved changes to requirements of the first type.

NOTES

- 1 The requirements defined by this process come from stakeholders who have an interest in the system being engineered. Stakeholders are of two kinds: the acquirer of the system products (see the definition of acquirer in the Glossary, Annex A) and all other stakeholders (see the definition of other stakeholder in Annex A).
- 2 The Requirements Definition Process is used to transform stakeholder requirements into a set of system technical requirements. These requirements are stated in acceptable technical terms and represent a reasonably complete description of the problem that must be solved to provide a set of end products and enabling products that meet the acquirer's and other stakeholders' needs and expectations.
- 3 The Requirements Definition Process is re-accomplished, as necessary, whenever requirements in an agreement change or when other stakeholder requirements are identified that affect the product design or otherwise constrain the technical effort required to engineer a new system, develop a derivative system, or reengineer a legacy system. Such changes could be caused by technology limitations, project schedule and cost anomalies, or new requirements.
- 4 Sometimes it is important to preserve competition when defining requirements to ensure that there will be more than one supplier that can meet the requirements. Otherwise, the cost of a single supplier can be too high since there can sometimes be little incentive to give a low-cost bid.

Requirement 14—Acquirer Requirements

The developer **shall** define a validated set of acquirer requirements for the system, or portion thereof.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify, collect, and prioritize assigned, customer, user, or operator requirements for the system, or portion thereof, including any requirements for development, production, test, deployment/installation, training, operations, support/maintenance, and disposal of the system's products.
- b) Ensure that the resulting set of requirements agrees with the acquirer needs and expectations (see Requirement 26).

- c) Record the resulting set of acquirer requirements in the established information database.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement are used, when combined with other stakeholder requirements, to define the system technical requirements and to identify requirements for enabling products.

Requirement 15—Other Stakeholder Requirements

The developer **shall** define a validated set of other stakeholder requirements for the system, or portion thereof.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Identify and collect other stakeholder requirements that can constrain the system's end products.
- b) Identify and collect other stakeholder requirements that can constrain development, production, test, deployment/installation, training, support/maintenance, and disposal of system end products.
- c) Identify and collect other stakeholder constraints such as applicable laws and regulations, technology base, standards and specifications, competitor's product capabilities and trends, and interfaces with other evolving systems or platforms.
- d) Ensure that the resulting set of requirements agrees with other stakeholder needs and expectations (see Requirement 27).
- e) Record the resulting set of other stakeholder requirements in the established information database.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completion of this requirement help to ensure that the other stakeholder requirements reflect the interests of those who have a stake in the outcome of the project, and when combined with acquirer requirements, can be used to define system technical requirements and requirements for enabling products.

NOTES

- 1 In general, other stakeholder requirements place constraints on the system development, both on the resulting system products and the processes for developing the system products.
- 2 Some sources of other stakeholder requirements include the agreement, owners of associated processes, external system interfaces, market research, government and industry regulations, international conventions and agreements, project and enterprise directives, project and enterprise process constraints, lessons learned, and interviews.
- 3 It is usually not possible to meet all other stakeholder requirements for a particular system since various stakeholders (including the acquirer) have conflicting requirements relative to one another. Some of these requirements can be addressed in later versions of the system.

- | | |
|---|--|
| 4 | Constraints can result, for example, from treaties, laws, regulations, standards, culture, natural laws, or firm customer or user needs. |
| 5 | Constraints also apply to those characteristics necessary to interface with other existing systems. |

Requirement 16—System Technical Requirements

The developer **shall** define a validated set of system technical requirements.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Establish required transformation rules, priorities, inputs, outputs, states, modes, and configurations, as appropriate to each system product.
- b) Define operational requirements to include operational profiles, and for each operational profile the utilization environment, events to which system end products must respond, frequency of use, physical and functional interfaces, and system functional requirements (what system end products must accomplish).
- c) Define the performance requirement (how well each functional requirement must be accomplished), including identification of critical performance parameters.
- d) Analyze acquirer and other stakeholder requirements to define human factor effects and concerns, establish capacities and timing, define technology and product design constraints, define enabling product requirements, identify conflicts, and determine criteria for tradeoff analyses to resolve conflicts.
- e) Identify and resolve requirements that have questionable utility or have unacceptable risk of not being satisfied.
- f) Resolve identified conflicts between the sets of acquirer requirements and other stakeholder requirements, and among these sets (see Requirement 23).
- g) Prepare a set of system technical requirement statements that are well formulated in accordance with Requirement 25.
- h) Ensure that the set of system technical requirements is correct in accordance with Requirement 28.
- i) Record the resulting set of system technical requirements in the established information database.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement provide a set of system technical requirements that are unambiguous, complete, consistent, achievable, verifiable, and necessary and sufficient for a system design.

4.3.2 Solution Definition Process

The Solution Definition Process is used to generate an acceptable design solution. This solution satisfies: 1) the system technical requirements resulting from completing the Requirements Definition Process described in Subclause 4.3.1; and 2) the derived technical requirements from the Solution Definition Process described in this subclause.

The three requirements associated with the Solution Definition Process are shown Figure 4.3.2.

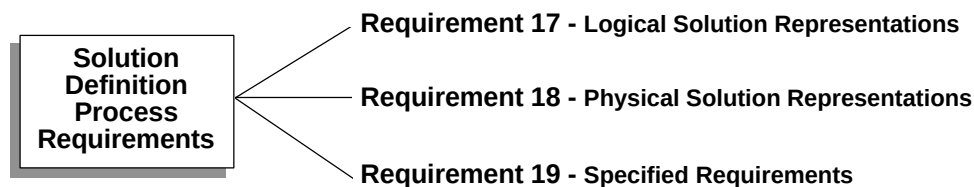


Figure 4.3.2—Solution Definition Process requirements

NOTE—The purpose of the requirements related to the Solution Definition Process is to solve the technical problem. This involves identifying alternative end products for the system, selecting and defining an optimal set of end products, defining the feasible subsystems related to the end products, identifying requirements for enabling products, and identifying needed high-risk technology developments.

Requirement 17—Logical Solution Representations

The developer **shall** define one or more validated sets of logical solution representations that conform with the technical requirements of the system.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Select and implement one or more appropriate approaches to providing an abstract definition of the solution to the system technical requirements. For the approaches selected, complete the appropriate tasks from (b) through (d) below that aid in defining logical solution representations.

NOTE—Functional analysis, object-oriented analysis, structured analysis, and information engineering analysis are recognized approaches found in text books and other literature to develop logical solution representations in terms of, for example, functional flows, behavioral responses, state and mode transitions, timelines, control flows, data flows, information models, object services and attributes, context diagrams, threads, data structures, and functional failure modes and effects.

- b) Establish sets of logical solution representations by (1) doing tradeoff analyses (see Requirement 23), (2) identifying and defining interfaces, states and modes, timelines, and data and control flows, (3) analyzing behaviors, and (4) analyzing failure modes and defining failure effects.
- c) Assign system technical requirements (especially performance requirements and constraints from the system technical requirements) to elements of the logical solution representations, e.g., subfunctions, groups of subfunctions, objects, and data structures.

NOTES

- 1 There can also be *system technical requirements* that are neither appropriate to assign to the sets of *logical solution representations* nor modifiable into *derived technical requirements*. An example is a characteristic or constraint applicable only to the system, not to the products of the system. These *system technical requirement* statements must be analyzed and assigned during Requirement 18 tasks a), b), and c).
- 2 There will be additional derived technical requirements prepared to reflect systems analysis results from Requirement 18 task c).

- d) Identify and define derived technical requirement statements resulting from tasks a) and b). Ensure that the derived technical requirements are stated acceptably in accordance with Requirement 25.
- e) Ensure that each set of logical solution representations is correct in accordance with Requirement 29.
- f) Record the resulting sets of logical solution representations, the set of derived technical requirement statements, and any unassigned system technical requirements [see the note under task c) above], along with source rationale and assumptions in the established information database.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement, when combined with the system technical requirements, provide the basis for developing alternative physical solution representations.

NOTES

- 1 Conditions for logical groupings are determined by many factors, and vary from one project to another. One common driver for logical groupings is to enable the use of existing products, and thus lessen development time and cost. Another common reason is to gain some advantage by introducing a particular new technology. In either of these cases, the grouping can result in interfaces that did not previously exist. New requirements have to be derived to accommodate these.
- 2 Accomplishment of the tasks associated with this requirement is often iterative because outcomes raise questions that require certain tasks of the Requirements Definition Process to be reaccomplished. In turn, certain tasks associated with defining logical solution representations and derived technical requirements are reaccomplished. Such iteration is important in order to lessen the possibility of more costly iterations of System Design Processes during a later engineering life cycle phase.

Derived technical requirements and requirements associated with logical solution representations **should** be incorporated into traceability procedures. This will enable ensuring that system technical requirements are properly supported by the derived technical requirements and logical solution representations.

Requirement 18—Physical Solution Representations

The developer **shall** define a preferred set of physical solution representations that agrees with the assigned logical solution representations, derived technical requirements, and system technical requirements.

The developer **should** plan and do appropriate tasks to complete this requirement. Tasks to consider include the following:

- a) Analyze logical solution representations, derived technical requirements, and any unassigned system technical requirements [see the note under Requirement 17, task c)] to determine which ones (1) provide requirements for enabling products, (2) can be done best manually or by facilities, materials, data, services, or techniques, and (3) can be done best by hardware, software, or firmware products (new or existing).
- b) Assign representations from Requirement 17, unassigned system technical requirements, and derived technical requirements to physical entities that will make up a physical solution.

NOTE—The assignment to physical entities and the generation of alternative solutions composed of these entities are tightly coupled and iterative.

- c) Generate alternative physical solutions by:
 - 1) Identification and definition of physical interfaces
 - 2) Identification and analysis of critical parameters
 - 3) Identification and assessment of physical solution options:
 - (a) Technology requirements
 - (b) Off-the-shelf availability
 - (c) Competitive considerations
 - (d) Failure modes, effects, and criticality
 - (e) Performance assessment
 - (f) Life cycle considerations
 - (g) Capacity to evolve
 - (h) Make versus buy
 - (i) Standardization considerations
 - (j) Integration concerns
 - 4) Performance of systems analysis (see Requirements 22, 23, and 24)
- d) Identify and define derived technical requirement statements resulting from tasks a), b), and c) that are stated acceptably in accordance with Requirement 25.
- e) Select the preferred physical solution representation for further characterization into a design solution from the evaluation of each physical solution representation results (Requirements 22, 23, and 24.
- f) Ensure that the selected physical solution representation is consistent with the assigned logical solution representations, derived technical requirements, and any unassigned system technical requirements [see the note under Requirement 17, Task c)].
- g) Record the selected physical solution representation, and the outcomes of Task d) above, along with selection rationale and assumptions, in the established information database.

The expected outcomes for these representative tasks are provided in Annex C. The outcomes associated with completing this requirement provide the preferred physical solution representation that will be fully characterized during Requirement 19. Additionally, the outcomes show that