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Foreword

This document describes a telecommunications product development and support capability model named ***Trillium.***

Trillium is used by Bell Canada to assess the product development and support capability of prospective and existing suppliers of telecommunications or information technology-based products. Trillium can also be used as a reference benchmark in an internal capability improvement program.

Trillium is the result of a partnering project between Bell Canada, Northern Telecom and Bell-Northern Research.

How this document is organized

This document is organized into five major components:

- The Model Overview introduces the model and provides an overview of the objectives and benefits.
- The Implementation Guidelines provide guidelines for the various contexts in which the ***Trillium*** model is intended to be used. While references are made to implementation methods, method details are beyond the scope of this document (i.e., covered via appropriate training).
- The Model Description defines the structure of the model and illustrates its relationships to industry standards.
- The ***Trillium*** Capability Areas, Roadmaps and Practices detail the core of the model.
- The appendices include a list of abbreviations, a glossary, a cross reference between external source documents and ***Trillium*** practices, and a bibliography.

Future Versions

The next release of the ***Trillium*** model is expected to include the following extensions to address management information systems (MIS):

- A *Re-engineering* roadmap added to the Development Practices Capability Area.
- A *Management Information Systems* Capability Area that includes the following roadmaps: Business Process Engineering, Architectures, Data Management, Data Centre Management, and Maintenance.

Future releases may include some of the following: hardware development, manufacturing and service capability.

The quality of Bell Canada's products and services depends on the quality of the products and services that Bell acquires from its suppliers. It is hoped that this product development and support capability model will help the telecommunications software supplier community improve the quality of its products.

Ordering Information

The ***Trillium*** model is in the public domain. Copies (as a series of uuencoded Postcript files) are distributed free of charge through the Internet.

Bound hard copies are available from the Bell Canada Acquisitions department. Pricing and shipping information are available on request.

Comments and Suggestions

Comments and suggestions regarding this document or the strategy for future versions are welcome. They should be addressed to:

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Acknowledgments and Document History

Document History

Version 1.0 Draft (91/08)

- Limited distribution
- Used for Telecommunications Software Product Development Capability Assessment trial
- Based on SEI CMM Version 0 with limited additions from version 1.0.
- Original concept from François Coallier [Bell Canada] with contributions from Al Graydon [NTL] and Mehmet Ficcici [NTL].

Version 1.1 Draft (91/09)

- Limited distribution
- Included minor corrections to version 1.0.

Version 1.2 Draft (91/10)

- Wide distribution
- Included minor corrections to version 1.1.

Version 1.3 Draft (91/11)

- Limited distribution
- Included changes to the scoring scheme previously used.

Version 2.0 Draft (92/02)

- Limited distribution
- First to be issued under the ***Trillium*** name
- Major changes to incorporate feedback from trial and input from suppliers
- Practices reorganized into 9 Capability Areas
- Roadmap concept introduced
- Based on CMM version 1.0.

Version 2.1 Draft (92/04)

- Not distributed
- Included minor corrections to version 2.0.

Version 2.2 Draft (92/07)

- Wide distribution
- Included minor corrections to version 2.1
- Submitted to the ISO/IEC JTC1/SC7 working group (WG) 10 responsible for the development of a *Software Process Assessment Standard.*
- Major contributors to this version were François Coallier [Bell Canada], Neil Gammage [BNR] and Al Graydon [NTL].

Version 2.3 Draft (93/10)

- Distribution to 30 reviewers and on request
- Capability Area 9 (Performance Metrics) removed
- Added more than 50 new practices taken from the SEI CMM 1.1.
- Major corrections to version 2.2.
- Addition of traceability tables.
- Major contributors to this version were John F. Wilson [Bell Canada], Jean-Normand Drouin [Bell Canada], Bruno Potvin [Bell Canada], and Jean Mayrand [Bell Canada].

Version 3.0 (94/12)

- Wide distribution.
- The introductory chapters explaining the model and its usage have been extensively rewritten.
- Practices are updated to provide 100% coverage of CMM version 1.1, ISO 9001:1994 and ISO 9000-3, and Bellcore TR-NWT-000179.
- Traceability tables to external source documents are generated automatically. The verification of all references is thorough.
- The Glossary has been updated.

Acknowledgments

Major contributors to this document were:

- François Coallier [Bell Canada] (model owner)
- Richard McKenzie [NTL]
- John F. Wilson [Bell Canada]
- Joe Hatz [BNR] (editor)

This work was performed under the mandate of the ***Trillium*** Technical Committee whose membership was:

- Allan Graydon [BNR]
- Joe Hatz [BNR] (Team Leader)
- Kevin Jones [NT]
- Harry Lawrence [NT]
- Richard McKenzie [NT]
- Jeff Perry [BNR]
- John F. Wilson [Bell Canada]

Thanks are also expressed to the people mentioned below, and to all the individuals who gave their time and energy to review and provide valuable feedback on this document and the continuous improvement of ***Trillium.***

We thank all of you for your contribution.

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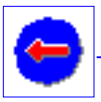 Back one chapter.


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Model Overview

This document describes the ***Trillium*** Model. The goal of the Model is to provide a means to initiate and guide a continuous improvement program. The Model is used in a variety of ways:

- to benchmark an organization's product development and support process capability against best practices in the industry,
- in self-assessment mode, to help identify opportunities for improvement within a product development organization, and
- in pre-contractual negotiations, to assist in selecting a supplier.

This Model and its accompanying tools are not in themselves a product development process or life-cycle model. Rather, the ***Trillium*** Model provides key industry practices which can be used to improve an existing process or life-cycle.

The practices in the ***Trillium*** model are derived from a benchmarking exercise which focused on all practices that would contribute to an organization's product development and support capability.

Trillium:

- has a telecommunications orientation
- provides a customer focus
- provides a product perspective
- covers ISO, Bellcore, Malcolm Baldrige, IEEE and IEC standards
- includes technological maturity
- includes additional ***Trillium***-specific practices
- provides a *roadmap* approach which sequences improvements by maturity.

Objectives

The ***Trillium*** Model has been developed from a customer perspective, as perceived in a competitive, commercial environment. In this context, *Capability* is defined as:
The ability of a development organization to consistently deliver a product or an enhancement to an existing product:

- *that meets customer expectations,*
- *with minimal defects(1)*
- *for the lowest life-cycle cost, and*
- *in the shortest time.*

A telecommunications product typically includes hardware, software, documentation, training and support services.

Benefits

For customer organizations, a higher capability means that:

- the development organization is more responsive to customer and market demands,
- the life-cycle cost of the product(s) is minimized, and
- end-user satisfaction is maximized.

For the development organization, achieving a higher capability can result in:

- lower development and maintenance costs,
- shorter cycle time and development intervals,
- an increased ability to achieve content and schedule commitments due to effective project risk analysis and effort estimation, and
- an increasing ability to meet quantifiable design and quality objectives at all stages of the development process.

Implementation

This model should be used as part of the organization's program for the continuous improvement of the product development and support process capability.

Such a program would typically include organization-wide self-assessments on a regular basis (12-18 months).

The ***Trillium*** model is based on the Carnegie Mellon University Software Engineering Institute's (SEI) Capability Maturity Model (CMM) v1.1 initially developed by W. Humphrey and collaborators for the United States Department of Defense.

Additional sources are:

- ISO 9001 and ISO 9000-3
- Bellcore's TR-NWT-000179 and TA-NWT-001315,
- Malcom Baldrige National Quality Award criteria,
- IEEE Software Engineering standards and IEC 300,
- professional and technical references.

To fully understand the ***Trillium*** model, it is desirable to have a background in product engineering and quality management, and a solid understanding of the source documents listed above.

Footnotes

(1)

In telecommunications and other industries (e.g., transportation, medical) defects resulting in system failure or service outages are unacceptable. However, certain defects may be tolerable provided they have no impact on service levels and operations.

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Implementation Guidelines

Overview

This part of the document presents four different ways in which the ***Trillium*** Model is typically applied.

The Capability Evaluation and Capability Joint-Assessment are two methods of evaluating an organization's product development and support process capability. A Capability Evaluation is the evaluation of a supplier by a second party, typically the customer. A Capability Joint Evaluation assumes an effective partnership relationship exists between the customer and supplier.

The Capability Self-Assessment and the Continuous Improvement (CI) program are linked, in that often the first will initiate the latter. Both are conducted internal to the organization (i.e., first party). The goal is to:

- identify opportunities for improvement, and
- deploy a robust management mechanism to continuously identify and act on improvement opportunities.

Scope

The application of ***Trillium*** is most effective if it is used uniformly across the organization, involving all departments or personnel affecting product development and support. This means all functions that contribute to the customer's perception of the product are treated as a single entity, including engineering, marketing, customer support, and quality assurance, according to the products and services provided.

Application Guidelines

The ultimate objective of the improvement programs initiated as a result of a ***Trillium*** assessment is increased customer and shareholder satisfaction, rather than rigid conformance to the standards referenced by this document.

A successful ***Trillium*** program will be context sensitive, i.e., considerate of the nature of the product and its usage, the current customer perceptions of the product and its evolution, and the organization structures for development and support.

Key to a successful ***Trillium*** program are the qualifications and training of the staff conducting the evaluation or assessment activities.

It is desirable to select members of the evaluation or assessment team from the senior staff and the opinion leaders within the organization. The team requires a combination of knowledge and experience in the SEI CMM, and must be trained in the skills needed to effectively conduct an assessment or evaluation.

Formal training in the ***Trillium*** method, the SEI assessment method and the CMM are advised.

It would be an asset to the team to have members with additional qualifications and knowledge (content and evaluation method), such as,

- Quality Assurance Institute's CQA (Certified Quality Analyst) certification,
- TickIT Lead Auditor certification,
- Malcolm Baldrige National Quality Award Criteria, or
- IEEE Software Engineering standards.

Using *Trillium* in a Capability Evaluation

The objective is to evaluate the product development and support capability (of a supplier) by using the ***Trillium*** model as the reference benchmark.

A capability evaluation is performed according to recognized auditing practices such as ISO 10011-2, consistent with the Application Guidelines described above.

A capability evaluation is performed to:

- assess the risks associated with the procurement of a given product, and/or
- monitor a quality/capability improvement program.

To be successful, such an evaluation needs:

- an assessor or team of assessors with adequate qualifications, experience and skills,
- the cooperation of the supplier, and
- adequate preparation.

Using *Trillium* in a Capability Joint-Assessment

A capability joint-assessment is a capability evaluation performed by a combined customer-supplier team. The conclusions and recommendations of this program represent a team consensus.

To be successful, a joint-assessment needs:

- a team of assessors with adequate qualifications, experience and skills,
- adequate partnering maturity between the organizations, and
- clear buy-in from senior management in both organizations.

Using *Trillium* in a Capability Self-Assessment

A ***Trillium*** capability self-assessment is more than an assessment of the processes, tools, techniques, etc. of the organization, because of the emphasis on their effectiveness in achieving business objectives.

A ***Trillium*** capability self-assessment follows SEI-89-TR-7, with the following differences:

- at least one qualified customer representative is on the assessment team as a regular team member,
- customer issues are systematically considered by the assessment team through all phases of the assessment, and
- the ***Trillium*** model is used as the reference benchmark.

A ***Trillium*** capability self-assessment requires an organizational sponsor who is willing to make a serious commitment of resources to the assessment project (the resource commitment is similar to an SEI assessment). The assessment outputs are an effective initiator of a capability improvement program because findings and recommendations are generated using a process that also achieves organization buy-in.

Using *Trillium* in a Continuous Improvement Program

A ***Trillium*** continuous improvement program is based on the Deming PDCA (Plan, Do, Check, Act) cycle.

In a ***Trillium*** continuous improvement program:

- at least one qualified customer representative is on the CI program steering and management teams,
- customer issues are systematically considered by the CI teams through all phases of the CI cycle, and
- the ***Trillium*** model is used as the reference benchmark.

In order to achieve the highest possible capability, development and support organizations must strive to:

- make the continuous improvement philosophy part of the organization culture,
- ensure that the proper mechanisms and processes are in place to support and encourage this culture, and
- engineer and optimize their processes to meet customer or market requirements and objectives for the specific product and/or service.

From the customer's perspective, it is a reassuring sign of organizational maturity when a supplier has an effective improvement program in place.

From a supplier quality management perspective, being invited to participate in such a program is a sign of a mature customer-supplier partnership.

The effectiveness of a continuous improvement program should be measurable in terms of:

- improvement in customer and shareholder satisfaction, and
- increased confidence in the organization's ability to meet business challenges and commitments, i.e., improvements in capability maturity.

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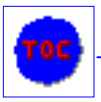

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Model Description

Scope

The ***Trillium*** Model covers all aspects of the software development life-cycle, most system and product development and support activities, and a significant number of related marketing activities.

Although ***Trillium*** has been designed to be applied to embedded software systems such as telecommunications systems, much of the model can be applied to other segments of the software industry such as Management Information Systems (MIS).

Many of the practices described in the model can be applied directly to hardware development.

Model Foundation

The ***Trillium*** Model is based on the Software Engineering Institute (SEI) Capability Maturity Model (CMM) version 1.1.

The architecture of the ***Trillium*** Model differs from the CMM version 1.1. The most significant differences are:

- a model architecture based on roadmaps, rather than key process areas,
- a product perspective, rather than software,
- wider coverage of capability impacting issues, and
- a customer focus, technological maturity, and a telecommunications orientation.

This version of the ***Trillium*** Model covers all SEI CMM v1.1 activities and abilities and some of the commitments, measurements and verifications (see Appendices for details of coverage).

In addition to the above, this version of the Model incorporates the intent of:

- ISO 9001: 1994 International Standard,
- ISO 9000-3: 1991 Guideline,
- Bellcore TR-NWT-000179 Issue 2, June, 1993,
- Bellcore TA-NWT-001315 Issue 1, December, 1993,
- relevant parts of the Malcolm Baldrige National Quality Award, 1995 Award Criteria,
- IEEE Software Engineering Standards Collection, 1993 Edition, and
- the IEC Standard Publication 300: 1984.

The ***Trillium*** Model incorporates additional practices from the following topics:

- Quality Management
- Business Process Engineering
- Technological Maturity
- Development Environment
- Systems Engineering
- Co-Engineering
- Concurrent Engineering
- Reliability Engineering
- Customer Support/Partnership
- Usability Engineering

The *Trillium* Scale

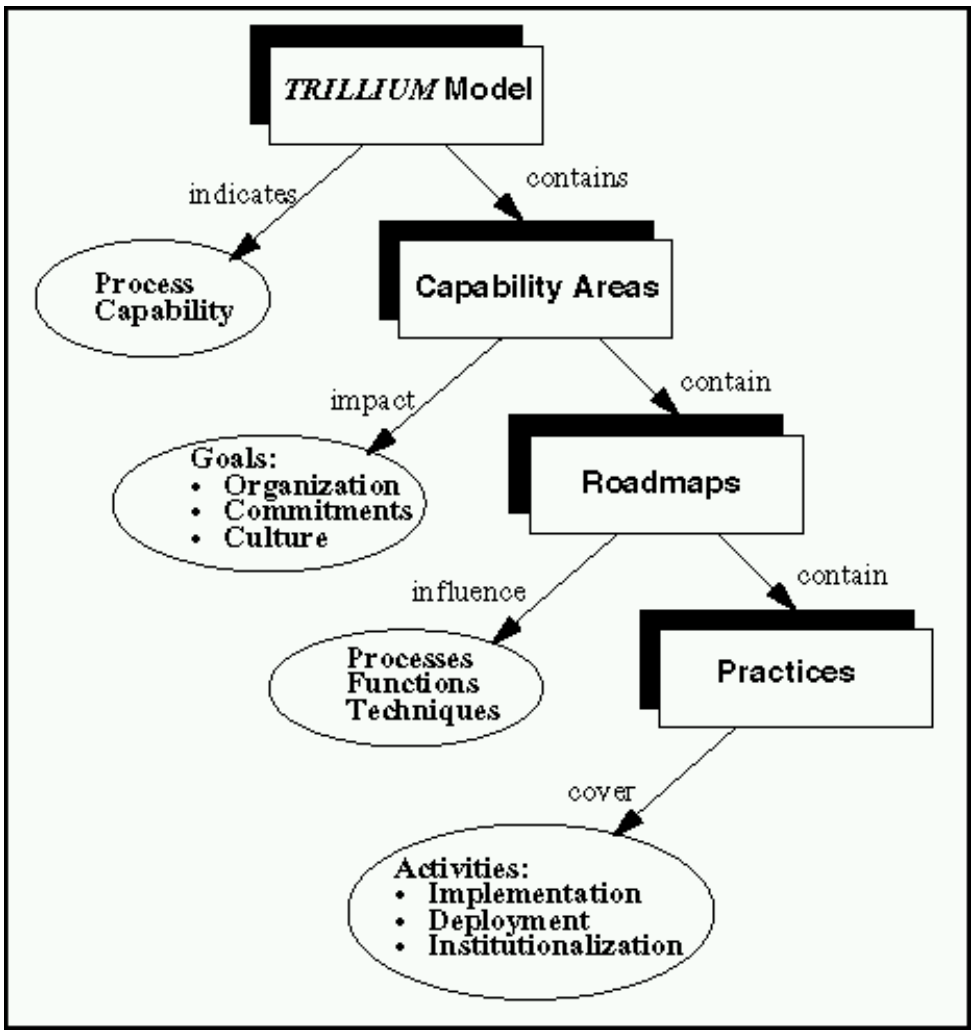
The ***Trillium*** scale spans levels 1 through 5. The levels can be characterized in the following way:

1. **Unstructured:** The development process is adhoc. Projects frequently cannot meet quality or schedule targets. Success, while possible, is based on individuals rather than on organizational infrastructure. (Risk - High)
2. **Repeatable and Project Oriented:** Individual project success is achieved through strong project management planning and control, with emphasis on requirements management, estimation techniques, and configuration management. (Risk - Medium)

3. **Defined and Process Oriented:** Processes are defined and utilized at the organizational level, although project customization is still permitted. Processes are controlled and improved. ISO 9001 requirements such as training and internal process auditing are incorporated. (Risk - Low)
4. **Managed and Integrated:** Process instrumentation and analysis is used as a key mechanism for process improvement. Process change management and defect prevention programs are integrated into processes. CASE tools are integrated into processes. (Risk - Lower)
5. **Fully Integrated:** Formal methodologies are extensively used. Organizational repositories for development history and process are utilized and effective. (Risk - Lowest)

Architecture of the *Trillium* Model

The ***Trillium*** Model consists of Capability Areas, Roadmaps and Practices.



Capability Areas

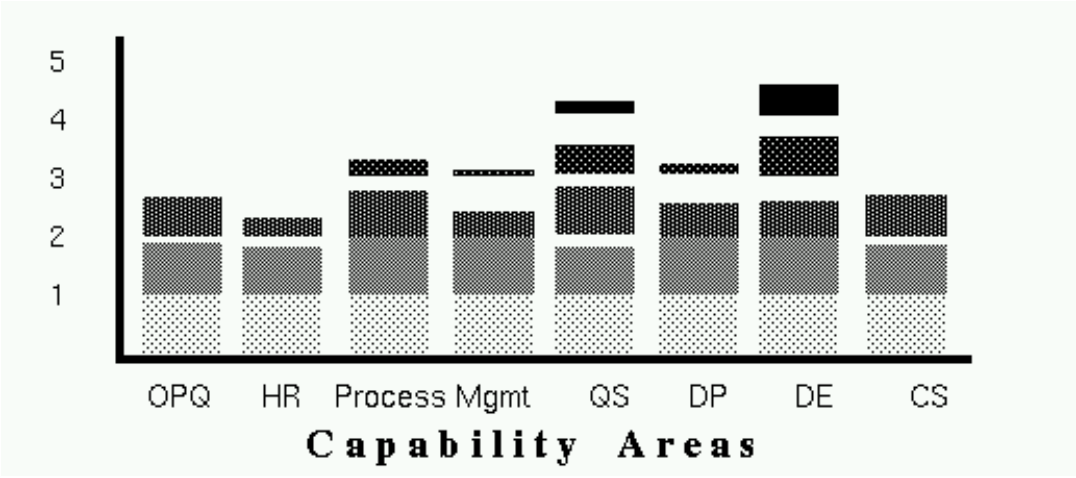
There are 8 Capability Areas within the ***Trillium*** model. Each Capability Area contains practices at multiple Trillium levels. For example, Management spans levels 2 to 4 while Quality System spans levels 2 to 5. The span of each Capability Area is shown in the following table.

Trillium capability area	Contains practices at level 2	3	4	5
Organizational Process Quality	X	X	X	
Human Resource Development and Management	X	X	X	

Process Management	X	X	X	X
Quality	X	X	X	X
System Development Practices	X	X	X	X
Development Environment	X	X	X	X
Customer Support	X	X	X	

Capability Profile

A profile of the Capability Areas is an important measure of a software development organization since it illustrates the relative areas of strength and weakness. The following figure shows a sample profile. As can be seen in this profile, organizations typically achieve some higher level practices without having completed all the practices at the lower levels (e.g., DE, QS).



Capability Level

To achieve a ***Trillium*** level, an organization must satisfy a minimum of 90% of the criteria in each of the 8 Capability Areas at that level. Levels 3, 4 and 5 require the achievement of all lower ***Trillium*** levels (i.e., levels cannot be skipped).

Roadmaps

Each *Capability Area* incorporates one or more *roadmaps*. A *roadmap* is a set of related practices that focus on an organizational area or need, or a specific element within the product development process. Each roadmap represents a significant capability for a software development organization.

Within a given *roadmap*, the level of the practices is based on their respective degree of maturity. The most fundamental practices are at a lower level whereas the most advanced ones are located at the higher level. An organization matures through the roadmap levels.

Lower level practices must be implemented and sustained for higher level practices to achieve maximum effectiveness.

The following table lists the roadmaps contained within each capability area, as well as the distribution of practices by maturity level and capability area.

Trillium Capability Areas	Roadmaps	Number of Practices by Level				Total
		2	3	4	5	
Organizational Process Quality	Quality Management	10	20	5	0	35
	Business Process Engineering					

Human Resource Development and Management	Human Resource Development and Management	9	42	1	0	52
Process	Process Definition Technology Management Process Improvement & Engineering Measurements	16	55	24	4	99
Management	Project Management Subcontractor Management Customer-Supplier Relationship Requirements Management Estimation	74	29	4	0	107
Quality System	Quality System	14	15	2	2	33
Development Practices	Development Process Development Techniques Internal Documentation Verification & Validation Configuration Management Re-Use Reliability Management	41	49	15	5	110
Development Environment	Development Environment	4	6	1	1	12
Customer Support	Problem Response System Usability Engineering Life-Cycle Cost Modelling User Documentation	25	30	5	0	60

	Customer Engineering					
	User Training					
		Total:	193	246	57	12	508

Relationship to other Standards

The following table provides a high level indication of the alignment of ***Trillium*** levels with key industry indicators and the standards which it encapsulates.

Key Industry Indicators	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5
Process Standards	Ad-hoc None	Project based IEEE(a), SEI Level 2+ Bellcore TR-NWT- 000179 (75%)	Organization-wide SEI Level 3+, ISO 9001, IEC 300c (system), IEEE(b), Bellcore TR-NWT-00179	SEI Level 4+,	SEI Level 5
Process Improvement	None	Unstructured	Deployed	Systematic	

(a)

a. Stds. 730, 828, 830, 1016, 1028, 1058.1, 1063.

(b)

b. Std. 1012.c. as applicable to the hardware component of a system

Achieving level 3 on the ***Trillium*** scale means that an organization meets the intent of the following:

- SEI Level 3,
- ISO 9001 (and the associated ISO 9000-3 Guidelines for Software),
- IEC 300 for system,
- IEEE Standards 730, 828, 830, 1012, 1016, 1028, 1058.1, 1063,
- Bellcore TR-NWT-000179,
- the relevant parts of the Malcolm Baldrige National Quality Award Criteria, and
- additional ***Trillium*** practices not covered by these standards.

Meeting the requirements of a ***Trillium*** practice does not necessarily imply meeting all the requirements of the corresponding referenced standards or documents.

Note: The IEEE Software Engineering Standards are mostly oriented towards work products, e.g., software design description, project management plan. For the purpose of ***Trillium***, these are used as guidelines only.

How *Trillium* Practices are Developed

The set of practices in the ***Trillium*** model is built using the following algorithm:

1. Practices are taken from the SEI CMM Version 1.1.
2. ISO 9001 and ISO 9000-3 clauses are mapped to this set of practices and where possible, practices are modified to integrate these requirements.

3. All remaining ISO 9001 and ISO 9000-3 clauses (i.e., which could not be mapped) are added to the set of practices.
4. Bellcore standards clauses are mapped to the practices generated by steps 1, 2 & 3. Where possible practices are modified to integrate these requirements.
5. All remaining Bellcore standards clauses (i.e., which could not be mapped) are added to the set of practices.
6. The same process is repeated with relevant portions of the Malcolm Baldrige National Quality Award Criteria.
7. Practices from IEC 300 are added.
8. References to relevant IEEE standards are added.
9. ***Trillium*** specific practices are added to provide coverage of additional areas important to the telecommunications industry. These are based on professional benchmarks generated through the consensus of subject matter experts and validated in a peer review process.

When practices are extracted from the CMM, or other standards, they go through the following transformation, if applicable:

1. The practice is generalized by either removing references to "software", or replacing them by "product and services" or "systems".
2. The practice is generalized by either removing references to "development", or replacing them by "development and support".
3. References to "group" or other specific organizational units are replaced by "function".
4. Indirect references to specific documents are replaced by references to a process (e.g., "quality plan" by "quality planning"), or to "documentation" or "information".

Practices are assigned to a given level based on the following general guidelines.

- Practices that are considered fundamental for the successful conclusion of a development project are assigned to level 2.
- Practices that are considered to be organization-wide in scope or fundamental to the continuous improvement of the development process are assigned to level 3.
- Practices that deal with CASE technology or characterize advanced process maturity (e.g., change management, integration of defect prevention, statistical process control and advanced metrics) are generally assigned to level 4.
- Level 5 typically deals with advancing technology as it applies to process automation, formal methodologies and strategic utilization of organization repositories.

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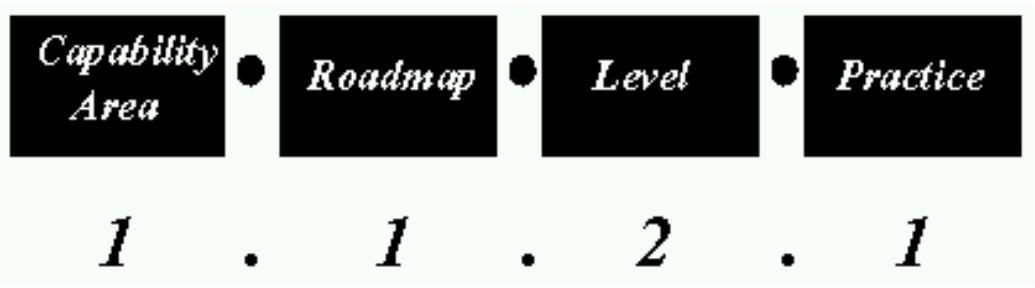
Essential Information About *Trillium* Practices

Conventions

Each practice is uniquely numbered (e.g., 1.1.2.1) according to the following convention:



The following labels are used to provide traceability between ***Trillium*** practices and external references, source standards and practices:

```
SEI        Refers to an SEI CMM v1.1 practice
ISO        Refers to the ISO 9001 Standard or ISO 9000-3 Guideline
Bellcore   Refers to a Bellcore document
MB         Refers to the Malcolm Baldrige National Quality Award Criteria
IEC        Refers to an IEC Standard (i.e., IEC 300)
IEEE       Refers to an IEEE Software Engineering Standard
Trillium   Indicates a practice unique to Trillium which has undergone cus
           tomization in combining one or more of the above references
Roadmap    Indicates a practice that is traceable to the external references
Trillium   given above via another practice within the same roadmap which
           has explicit external references
```

Guidelines for Interpreting Practices

The intent of this section is to help the reader better understand the way the practices have been designed and worded.

Practices are described in three wording *styles* which are progressively more difficult to achieve. These styles are not another scale.

The three wording styles are:

Style 1: *Something is done (informally).*

This style is used to state that:

- something is in place or exists,
- an activity is performed informally within the organization, and/or
- it is performed on a project by project basis.

The practice may or may not state who does the activity. Two examples of this style of practice are:

"1.1.2.1 The organization has a well-defined three-year business plan [Bellcore TR-NWT-000179 3.4.3-4] [MB 3.0] [Trillium]"

"4.1.2.20 Project planning specifies and documents schedules, resources and approval authorities for verification and validation activities [ISO 9001 4.4.2, 4.4.7, 4.4.8] [ISO 9000-3 5.5.2] [Trillium]"

Style 2: *Something is done according to a documented procedure.*

This style states that:

- an activity is performed,
- there is a written procedure explaining how to perform the activity,
- the procedure is understood by the practitioners, and
- the procedure is consistently used by the practitioners.

An example of Style 2 is:

"4.1.3.12 The project's development risks are identified, assessed, documented, and managed according to a documented procedure [SEI CMM Activity 10]."

Style 3: *Something is done formally.*

This third style includes all the requirements of the second style and adds the following activities:

- the content of intermediate product(s) is reviewed,
- adherence to the written procedure is reviewed,
- records of the review(s) are kept (e.g., review report),
- all action items on the review report are tracked until closure, and
- the practice is documented and uniformly applied across the organization.

For example:

"5.1.3.9 The quality system is reviewed formally at appropriate intervals by senior management to ensure its continuing suitability and effectiveness [ISO 9001 4.1.3] [ISO 9000-3 4.1.13] [Bellcore TR-NWT-000179 2.1.1-2 & 4.4.3-1] [Trillium]"

Definitions

The definitions and terms found in ***Trillium*** are based on industry-wide accepted terminology. They can be found in the Glossary (see Appendices).

Where possible, the following order of precedence has been used:

- ISO 8402:1991 Draft International Standard
- ISO/IEC JTC1/SC7 Vocabulary
- ISO/IEC JTC1/SC7 WG10 Vocabulary
- Other sources (e.g., IEEE 610 Software Engineering Standards)

There are some instances where the order of precedence has not been respected. As an example of this, the definition of *specification* from IEEE 610 was used instead of the definition from ISO 8402:1991 as it was more suitable to the context of this document.

When a definition cannot be found in the preceding documents, other sources are used. Only when no definition can be found is a new definition created.

In the process of preparing for an assessment, it may be necessary to adapt or translate the ***Trillium*** terminology and definitions into the common language, culture and context of the organization. This is done to minimize the variation due to interpretation by participants. This must be done carefully to ensure that the scope and intent of each practice is not altered.

The definitions below can also be found in the Glossary. They are included in this section because they are crucial to understanding the Model.

Component:

One of the parts that make up a system. A component may be hardware or software and may be subdivided into other components (IEEE 610:1991).

Development:

All activities performed to create or enhance a product.

Function:

1. In management, a major activity or group of activities that are continuous. For example, the principle functions of management are planning, organizing, staffing, directing, and controlling.
2. In project management: an activity or set of activities that span the entire duration of a software project. Examples of project functions include configuration management, quality assurance, and project cost accounting.
3. In programming: a specific, identifiable task performed by one or more software components.

Intermediate Product:

An item which is produced during some phase of the software development process, and is an input product to a later phase, but is not provided to the user. Examples of intermediate products are: requirements specifications, design specifications, and test reports.

Organization:

A company, corporation, firm, enterprise or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration (ISO 8402:1991).

Note: In the ***Trillium*** context, an assessment is generally applied to a complete organization, or part thereof, that is responsible for the development of a specific product.

Process:

A set of interrelated resources and activities which transform inputs into outputs. Resources may include personnel, facilities, equipment, technology and methodology (ISO 8402:1991).

Product:

The result of activities or processes. A product may include service, hardware, processed materials, software, or combination thereof (ISO 8402:1991).

Note: in the ***Trillium*** context, the customer perceives the product as a black box entity provided by the supplier. The customer sees only the interfaces which provide access to the product's operation. Generally the customer has no view of the internal components inside the black box.

Requirements:

An essential set of conditions that a system has to satisfy (ISO 2382-20:1991).

Software:

A set of programs, associated data, procedures, rules, documentation, and materials concerned with the development, use, operation, and maintenance of a computer system (CSA Q396:1989).

Note: in the ***Trillium*** context, this includes firmware regardless of its final manufactured form (e.g., PROM, Gate Array).

Specification:

A document that specifies, in a complete, precise, and verifiable manner, the requirements, design, behaviour, or other characteristics of a service, product, system or component, and, often, the procedures for determining whether these provisions have been satisfied (IEEE 610:1991).

System:

A collection of components organized to accomplish a specific function or set of functions (IEEE 610:1991).

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Forward to capability area 1.

Trillium Capability Areas, Roadmaps and Practices.
Capability Area 1: Organizational Process Quality

This Capability Area includes two Roadmaps: Quality Management and Business Process Engineering.

The Organizational Process Quality capability covers management strategy, Total Quality Management (TQM) and organizational planning.

Roadmap 1.1: Quality Management

This Roadmap covers the practices that demonstrate that there is organizational leadership in quality management.

Level 2

Business Planning

1.1.2.1

The organization has a well-defined three-year business plan [Bellcore TR-NWT-000179 3.4.3-4] [MB 3.0] [Trillium].

1.1.2.2

Commitment to quality, employees, shareholders and customers is integrated in the business plan, and backed by specific and concrete programs [ISO 9001 4.1.1] [ISO 9000-3 4.1.1.1] [MB 3.1 & 3.2] [Trillium].

TQM Program

1.1.2.3

An organization-wide TQM program has been initiated [MB 1.0] [Trillium].

1.1.2.4

Resources have been allocated to the TQM program [Roadmap Trillium 1.1.2.3].

1.1.2.5

All of the organization's executives have been trained in TQM [Roadmap Trillium 1.1.2.3].

Quality System Leadership

1.1.2.6

The organization has a manager with authority and responsibility for ensuring that quality system requirements (including those of ISO 9001) and needs are implemented and maintained [ISO 9001 4.1.2.3] [ISO 9000-3 4.1.1.2.3] [Trillium].

Level 3

Business Planning

1.1.3.1

The organization has a strategic and business plan with clear organizational (i.e., cross-functional) quality and performance goals [Bellcore TR-NWT-000179 3.4.3-4] [MB 3.2 b&c] [Trillium].

1.1.3.2

All organizational entities, down to the middle management span of control, have their own well-defined three-year business plan, aligned with the organization's business plan [Roadmap Trillium 1.1.2.1].

TQM Program

1.1.3.3

An organization-wide TQM program is fully deployed [MB 1.1 & 1.2] [Trillium].

TQM Training

1.1.3.4

All of the organization's middle managers have been trained in TQM [Roadmap Trillium 1.1.2.5].

1.1.3.5

All managers in the organization receive required training in teamwork [SEI IC Ability 3].

1.1.3.6

The members of marketing, engineering and support groups receive orientation in working as a team [SEI IC Ability 5] [Trillium].

Executive Performance Tracking

1.1.3.7

The organization's executives regularly compare the organization's performance to the business plan objectives and relevant external benchmarks [MB 1.2c, 2.2a & 6.2b] [Trillium].

Communication with Employees

1.1.3.8

The organization's CEO and executives regularly communicate with all their employees [MB 1.1c & 1.2b] [Trillium].

1.1.3.9

The organization's performance related to business plan objectives is communicated to all employees on a regular basis [Roadmap Trillium 1.1.3.8].

1.1.3.10

Customer satisfaction and company performance data are available to all employees [Roadmap Trillium 1.1.3.9].

Customer Data Analysis

1.1.3.11

Customer quality and performance data is analyzed on a regular basis by the organization executives [MB 2.3a & b] [Trillium].

Employee Survey

1.1.3.12

The organization's executives regularly (every 12-18 months), formally and systematically survey their employees to assess their morale, and their perception of the organization's culture (e.g., leadership, teamwork, innovation and self-criticism) and health [MB 4.5c] [Trillium].

1.1.3.13

The organization's executives regularly (every 12-18 months), formally and systematically survey their employees perception of customer satisfaction [MB 7.4a].

1.1.3.14

The organization's executives analyze the results of the employee surveys, and develop and implement a documented action plan based on the findings [MB 4.1c] [Trillium].

1.1.3.15

The results of the organization's executives' employee survey and the action plan are communicated to all employees [Roadmap Trillium 1.1.3.14].

Employee Recognition

1.1.3.16

The organization has a balanced recognition program for both team's and individual's contribution to quality improvement efforts [MB 4.4a].

Level 4

TQM Training

1.1.4.1

All of the organization's employees have been trained in TQM [MB 4.3] [Trillium].

Employee Survey

1.1.4.2

The organization's middle managers regularly (every 12-18 months), formally and systematically survey their employees to assess their morale, and their perception of the organization's culture (e.g., leadership, teamwork, innovation, self-criticism) and health [MB 4.5c] [Trillium].

1.1.4.3

The organization's middle managers regularly (every 12-18 months), formally and systematically survey the employees perception of customer satisfaction [Roadmap Trillium 1.1.3.13].

1.1.4.4

The organization's middle managers analyze the results of the employee surveys, and develop and implement a formal action plan based on the findings [MB 4.1c] [Trillium].

1.1.4.5

The results of the organization's middle managers' employee survey and the action plan are communicated to all employees [Roadmap Trillium 1.1.3.15].

Roadmap 1.2: Business Process Engineering

This Roadmap covers pertinent business process engineering practices.

Level 2

Business Process Documentation

1.2.2.1

The organization has mapped/documented some of its business processes [MB 5.3a] [Trillium].

Functional Responsibilities

1.2.2.2

All of the organization's employees have well-defined and documented functional responsibilities [MB 4.2b] [Trillium].

1.2.2.3

Employees' functional responsibilities are assessed according to a documented procedure [Roadmap Trillium 1.2.2.2].

Organizational Unit Mandate

1.2.2.4

The mandate of each organizational unit is defined and documented [MB 1.1] [Trillium].

Level 3

Business Process Documentation

1.2.3.1

The organization has mapped/documented its business processes [ISO 9001 4.9] [MB 3.1b & 5.3a] [Trillium].

Cross-Functional Activities

1.2.3.2

There are cross-functional teams and organizational structures to enhance the realization of cross-functional goals [MB 5.3] [Trillium].

1.2.3.3

Cross-functional teams are routinely created as part of the continuous improvement of organization processes [MB 5.3] [Trillium].

Employee Initiative

1.2.3.4

The organization encourages employees to innovate and take responsibility [MB 4.2b].


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Back to the general information.


Forward to capability area 2.

Trillium Capability Areas, Roadmaps and Practices
Capability Area 2: Human Resource Development and Management

Roadmap 2.1: Human Resource Development and Management

This Capability Area consists of a single Roadmap, and addresses the certification and training of management and development staff performing activities which are part of the development process.

Level 2

Training Planning

2.1.2.1

Training planning that covers training needs is performed at the project level [SEI TP Activity 1] [MB 4.1a].

Functional Training

2.1.2.2

Engineers, managers and other individuals involved in project planning are trained in the estimating and planning procedures applicable for their areas of responsibility [SEI SPP Ability 4] [Trillium].

2.1.2.3

Managers and other individuals who are involved in establishing and managing contracts are trained to perform these activities [SEI SSM Ability 2] [Bellcore TR-NWT-000179 4.9.2-1,2,3,4,5] [Trillium].

2.1.2.4

Managers and other individuals who are involved in establishing and managing subcontracts receive orientation on the technical aspects of the subcontract [SEI SSM Ability 3] [Trillium].

2.1.2.5

Individuals performing configuration management functions are trained in the objectives, procedures and methods for performing their configuration management activities [SEI SCM Ability 4] [Trillium].

2.1.2.6

Individuals performing engineering functions and other related functions are trained to perform their configuration management activities [SEI SCM Ability 5] [Trillium].

2.1.2.7

Individuals in product development and support related functions receive training on the organization's product development and support process activities and their roles in those activities [SEI OPF Ability 4] [Bellcore TR-NWT-000179 4.9.1-1,2 & 4.9.2-1,2,3,4,5] [Trillium].

2.1.2.8

The members of the project receive orientation on the role, responsibilities, authority, and value of the Quality Assurance group [SEI SQA Ability 4].

2.1.2.9

The individuals implementing or supporting Quality Management receive required training to perform these activities [SEI SQM Ability 2].

Level 3

Human Resource Selection

2.1.3.1

Personnel performing specific assigned tasks are qualified on the basis of appropriate education, training and/or experience [ISO 9001 4.18] [ISO 9000-3 6.9] [Bellcore TR-NWT-000179 4.9-1] [Trillium].

2.1.3.2

Technical topics covered in the personnel qualification process (see 2.1.3.1) are determined considering the specific tool, techniques, methodologies and computer resources used in the development and management of the product [ISO 9001 4.18] [ISO 9000-3 6.9] [Bellcore TR-NWT-000179 4.9-1] [Trillium].

2.1.3.3

The determination of whether an individual possesses the skills and knowledge covered by a particular training course before attending the course is done according to a documented procedure [SEI TP Activity 5] [Bellcore TR-NWT-000179 4.9-1].

Training Responsibility

2.1.3.4

A function responsible for fulfilling the training needs of the organization exists [SEI TP Ability 1]

[Trillium].

2.1.3.5

Individuals performing the training function have the necessary skills and knowledge to perform their training activities [SEI TP Ability 3] [Trillium].

Training Resources

2.1.3.6

Adequate resources and funding are provided for implementing the training program [SEI TP Ability 2] [ISO 9001 4.1.2.2].

Training Planning

2.1.3.7

An organizational training plan that identifies the training needs of all personnel performing activities affecting product development is developed and maintained according to a documented procedure [SEI TP Activity 2] [ISO 9001 4.18] [ISO 9000-3 6.9] [Bellcore TR-NWT-000179 4.9.1-2,5 & 4.9.2-1,2,3,4,5] [Trillium].

2.1.3.8

Individual training is selected and scheduled according to current and planned job responsibilities and needs [Bellcore TR-NWT-000179 4.9.1-1] [Trillium].

Training Program

2.1.3.9

The training for the organization is performed in accordance with the organization training program [SEI TP Activity 3] [Bellcore TR-NWT-000179 4.9.1-5].

2.1.3.10

Managers receive orientation on the training program [SEI TP Ability 4] [Bellcore TR-NWT-000179 4.9.1-4] [Trillium].

2.1.3.11

There is a well-defined apprenticeship program (e.g., a structured and formal on-the-job training program) [Bellcore TR-NWT-000179 4.9.1-5] [Trillium].

2.1.3.12

Individuals in the engineering functions and other related groups receive training on the organization's process activities and their roles in those activities. [SEI OPF Ability 4] [Bellcore TR-NWT-000179

4.9.1-5] [Trillium].

2.1.3.13

There is a documented certification program (e.g., ASQC, QAI) for those individuals performing quality functions as defined by ISO 9001 [Bellcore TR-NWT-000179 4.9.1-1] [ISO 9001 4.1.2.2] [Trillium].

2.1.3.14

All employees are trained in the use of basic quality tools such as fishbone diagrams, and Pareto analysis [MB 4.3] [Trillium].

Training Courses

2.1.3.15

The development and maintenance of training courses prepared at the organizational level is done according to a documented procedure [SEI TP Activity 4] [Trillium].

Training Effectiveness

2.1.3.16

Training quality and effectiveness is measured and used to continuously improve the training program [Bellcore TR-NWT-000179 4.9.1-3] [MB 4.3].

Training Records

2.1.3.17

Appropriate records of training and experience are maintained and used by management for personnel development profiles [SEI TP Activity 6] [ISO 9001 4.18] [ISO 9000-3 6.9].

Functional Training

2.1.3.18

Individuals responsible for the organization's process activities receive training to perform these activities [SEI OPF Ability 3] [Trillium].

2.1.3.19

Individuals who develop and maintain the organization's standard process and related process assets receive required training to perform these activities [SEI OPD Ability 2] [Trillium].

2.1.3.20

Training is provided for all personnel affecting product development and support [ISO 9001 4.18] [ISO 9000-3 6.9] [Bellcore TR-NWT-000179 4.9.1-5] [Trillium].

2.1.3.21

Before undertaking a project management role for the first time, an individual receives formal training in the technical and personnel aspects of project management [SEI SPT&O Ability 4] [Trillium].

2.1.3.22

Members of the engineering technical staff receive required training to perform their technical assignments [SEI SPE Ability 2] [Bellcore TR-NWT-000179 4.9.1-5].

2.1.3.23

Members of the engineering technical staff receive training in related engineering disciplines [SEI SPE Ability 3] [Bellcore TR-NWT-000179 4.9.1-5].

2.1.3.24

The individuals implementing or supporting Quality Management, including Defect Prevention activities, receive training to perform these activities [SEI DP Ability 4] [Trillium].

2.1.3.25

Members of the Quality Assurance group are trained to perform their QA activities [SEI SQA Ability 3].

2.1.3.26

All task leaders in each marketing, engineering and support group receive orientation in the processes, methods, and standards used by the other engineering groups [SEI IC Ability 4] [Bellcore TR-NWT-000179 4.9.2-1].

2.1.3.27

Members of the engineering group and other related groups are trained to perform their requirements management activities [SEI RM Ability 4] [Bellcore TR-NWT-000179 4.9.2-1].

2.1.3.28

The managers and technical staff of the product engineering group and other product related groups receive required training in product process improvement [SEI PCM Ability 3].

2.1.3.29

Senior management receives required training in product process improvement [SEI PCM Ability 4].

2.1.3.30

Peer review leaders receive required training in how to lead peer reviews [SEI PR Ability 2] [Bellcore TR-NWT-000179 4.9.1-5].

2.1.3.31

Product managers receive required training in product process improvement [SEI PCM Ability 2].

2.1.3.32

Reviewers who participate in peer reviews receive required training in the objectives, principles, and method of peer reviews [SEI PR Ability 3].

2.1.3.33

The individuals implementing or supporting quantitative process management receive required training to perform these activities [SEI QPM Ability 4].

2.1.3.34

The members of the engineering and support groups and other engineering-related groups receive orientation on the goals and value of quantitative process management [SEI QPM Ability 5] [Bellcore TR-NWT-000179 4.9.2-1].

2.1.3.35

The members of the engineering and support groups and other engineering-related groups receive required training in Quality Management [SEI SQM Ability 3].

Product Training

2.1.3.36

All new developers receive formal training about the product and product line on which they will work (e.g., functionality, design, implementation) [MB 4.3] [Trillium].

2.1.3.37

All developers receive continuous education on product and product line functionality evolution and changes [MB 4.3] [Trillium].

Project Training

2.1.3.38

Individuals responsible for developing the project's defined process receive required training in how to tailor the organization's standard process and use the related process assets [SEI ISM Ability 2] [Bellcore TR-NWT-000179 4.9.1-5] [Trillium].

2.1.3.39

Project managers received required training in managing the technical, administrative, and personnel aspects of projects based on the project's defined process [SEI ISM Ability 3] [Trillium].

2.1.3.40

Project managers and all related managers receive orientation in the technical aspects of the project [SEI SPE Ability 4] [Trillium].

2.1.3.41

First-line managers receive orientation in the technical aspects of projects in which they are involved [SEI SPT&O Ability 5] [Trillium].

2.1.3.42

Training for the organization's and projects' processes is coordinated across the organization [SEI OPF Activity 6].

Level 4

Functional Training

2.1.4.1

Members of the group responsible for the organization's technology change management activities receive required training to perform these activities [SEI TCM Ability 5].

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 Back to capability area 1.

 Forward to capability area 3.

Trillium Capability Areas, Roadmaps and Practices
Capability Area 3: Process

This Capability Area covers the 4 process-oriented Roadmaps:

- Process Definition,
- Technology Management,
- Process Improvement & Engineering, and
- Measurements.

Collectively, they address the product development process itself, including its definition, development, improvement and maintenance.

Roadmap 3.1: Process Definition

This Roadmap covers practices that address the formalization and coverage of the process.

Level 2

Process Documentation

3.1.2.1

Some product development and support processes are documented, including requirements management, project tracking, planning and estimation, and quality assurance methods [Bellcore TR-NWT-000179 4.2-1] [MB 5.2a] [Trillium].

Project Life-Cycle Model

3.1.2.2

Development projects are organized according to a life-cycle model [Bellcore TR-NWT-000179 3.1-1 & 3.4.2-1,2] [ISO 9000-3 5.1] [Trillium].

Level 3

Resources

3.1.3.1

Appropriate resources and funding are provided for the development and maintenance of the organization's process assets [SEI OPD Ability 1] [ISO 9001 4.1.2.2, 4.9].

Life-Cycle Model

3.1.3.2

A complete product development and support life-cycle with predefined stages of manageable size is flow-charted and documented [SEI SPP Activity 5] [ISO 9000-3 5.1] [Bellcore TR-NWT-000179 3.4.2-1] [Trillium].

3.1.3.3

Life-cycle models that are approved for use by projects are identified and documented [SEI OPD Activity 3] [ISO 9000-3 5.1] [Bellcore TR-NWT-000179 3.4.2-11].

Process Span and Integration

3.1.3.4

An integrated product development process is defined and documented, covering hardware, software, firmware, documentation and other user deliverables (e.g., training) [ISO 9001 4.9] [Trillium].

Concurrent Engineering

3.1.3.5

Cross-functional concurrency among marketing, design, customer engineering, manufacturing, installation and support tasks is planned and managed throughout the product development life-cycle to achieve interval, cost and quality goals [Bellcore TR-NWT-000179 3.4.2-2] [Trillium].

Process Ownership and Management

3.1.3.6

The product and project plans for quantitative process management are developed according to a documented procedure [SEI QPM Activity 1]

3.1.3.7

The integrated product development process is under the responsibility of a single cross-functional organizational entity [Roadmap Trillium 3.1.3.4].

3.1.3.8

An organization-level team to coordinate defect prevention activities exists [SEI DP Ability 1].

Process Documentation

3.1.3.9

The organization's standard process is documented according to established organization standards [SEI

OPD Activity 2] [Bellcore TR-NWT-000179 3.4.2-4 & 4.2-1] [Trillium].

3.1.3.10

All individual product development processes are documented [Bellcore TR-NWT-000179 3.4.2-4 & 4.2-1] [Trillium].

Process Development

3.1.3.11

The organization's standard product development process is developed and maintained according to a documented procedure [SEI OPD Activity 1] [Bellcore TR-NWT-000179 3.4.2-4].

Tailoring

3.1.3.12

Guidelines and criteria for the project's tailoring of the organization's standard product and service development process are developed and maintained [SEI OPD Activity 4] [Bellcore TR-NWT-000179 3.4.2-11] [Trillium].

Process Assets Repository

3.1.3.13

An organizational repository of process assets is developed, documented and used according to a documented procedure [SEI OPD Activity 5] [Trillium].

3.1.3.14

A library of process-related documentation previously developed by projects in the organization is established and maintained [SEI OPD Activity 6].

3.1.3.15

The use of the organization's process repository is coordinated at the organization level [SEI OPF Activity 4] [Trillium].

Level 4

Cross Functional Product Development & Support

3.1.4.1

Product development, support and maintenance activities are managed by a cross-functional team under common management control [MB 5.2c] [Trillium].

Roadmap 3.2: Technology Management

This Roadmap covers practices that address the monitoring, assessment and introduction of technology in the process. The term "Technology" in this section includes methods, techniques and tools.

Level 2

Technology Introduction in Projects

3.2.2.1

New technologies are evaluated and introduced at the project level [Roadmap Trillium 3.2.3.4].

Level 3

New Technology Monitoring

3.2.3.1

Managers and technical staff are kept aware of appropriate new technologies [SEI TCM Activity 3] [Trillium].

Technology Improvement Trial

3.2.3.2

Pilot efforts for improving technology are conducted, where appropriate, before a new technology is introduced on a broad scale [SEI TCM Activity 6].

New Technology In Pilot Use

3.2.3.3

New technologies in pilot use in the organization are monitored, evaluated, and where appropriate, implemented in other parts of the organization [SEI OPF Activity 5].

Technology Selection Procedure

3.2.3.4

Technologies are selected and acquired for the organization and projects according to a documented procedure [SEI TCM Activity 5] [Bellcore TR-NWT-000179 4.6-6] [MB 5.2c].

Level 4

Functional Responsibility

3.2.4.1

A function responsible for the organization's technology change management exists [SEI TCM Ability 1] [Trillium].

Funding & Resources

3.2.4.2

Adequate resources and funding are provided to perform the organization's technology change management activities [SEI TCM Ability 2] [Trillium].

3.2.4.3

Support exists for collecting and analyzing the data needed to evaluate technology changes [SEI TCM Ability 3].

Planning

3.2.4.4

The organization develops and maintains a plan for technology innovation [SEI TCM Activity 1] [Bellcore TR-NWT-000179 4.6-6].

3.2.4.5

The organization analyzes its product development process to identify areas that need or could benefit from new technologies [SEI TCM Activity 4] [MB 5.2c].

Data Collection

3.2.4.6

Appropriate data on the process and work products are available to support analyses performed to evaluate and select technology changes [SEI TCM Ability 4] [Trillium].

Level 5

Functional Responsibility

3.2.5.1

The function responsible for the organization's technology change management activities works with the projects in identifying areas of technology change [SEI TCM Activity 2] [Trillium].

Technology Incorporation

3.2.5.2

Appropriate new technologies are incorporated into the organization's standard process according to a documented procedure [SEI TCM Activity 7] [Trillium].

Roadmap 3.3: Process Improvement & Engineering

This Roadmap covers practices that address process improvement activities.

Level 2

Activities

3.3.2.1

Some process improvement activities have been initiated [ISO 9001 4.9] [Trillium].

Benchmarking

3.3.2.2

The organization product development capability has been benchmarked according to industry accepted methodology (e.g., ISO10011 audits) [Roadmap Trillium 3.3.3.8].

Level 3

Functional Responsibility

3.3.3.1

A function that is responsible for the organization's process activities exists [SEI OPF Ability1] [Bellcore TR-NWT-000179 2.5.1-1] [Trillium].

3.3.3.2

The function responsible for the organization's process activities (e.g., engineering process group) coordinates the process improvement activities [SEI PCM Activity 2] [Trillium].

3.3.3.3

Process improvement projects are documented, reviewed, approved and tracked in the same manner as development projects [Roadmap Trillium 3.3.3.6].

Funding & Resources

3.3.3.4

Adequate resources and funding are provided for the organization process activities [SEI OPF Ability 2] [ISO 9001 4.1.2.2] [Trillium].

Policies & Procedures

3.3.3.5

The organization follows a written policy for implementing process assessment and improvement [SEI PCM Commitment 1] [ISO 9000-3 4.4] [Trillium].

3.3.3.6

The organization plans for process improvement according to a documented procedure [SEI PCM Activity 3] [ISO 9000-3 4.4] [Trillium].

3.3.3.7

Process improvement proposals are submitted by individuals or teams according to a documented procedure [SEI PCM Activity 5] [Bellcore TR-NWT-000179 3.4.2-10].

3.3.3.8

Process assessment is done according to a documented procedure [Bellcore TR-NWT-000179 3.4.2-10] [Trillium].

Planning

3.3.3.9

The organization follows a documented and approved plan to coordinate its activities for process improvement [SEI OPF Activity 2] [SEI PCM Activity 4] [Bellcore TR-NWT-000179 2.5-2] [MB 5.5a].

Scope

3.3.3.10

The product development, support and business processes are assessed periodically throughout the organization, and improvement plans are developed to address the assessment findings [SEI OPF Activity 1] [ISO 9001 4.9] [ISO 9000-3 4.3] [Bellcore TR-NWT-000179 2.3-1] [MB 5.2c, 5.3c & 5.5b] [Trillium].

Coordination

3.3.3.11

The organization's and projects' activities for defining, implementing, measuring, and improving its processes are coordinated at the organization level [SEI OPF Activity 3] [Bellcore TR-NWT-000179

2.5-2].

3.3.3.12

The product development groups are informed of the organization's and project's activities for process development and improvement [SEI OPF Activity 7].

Causal Analysis

3.3.3.13

Causal analysis is performed after the completion of specific tasks according to a documented procedure [SEI DP Activity 3].

3.3.3.14

At the beginning of a product task, the members of the team performing the task meet to prepare for the activities of that task and the related defect prevention activities [SEI DP Activity 2].

3.3.3.15

Each of the teams assigned to coordinate defect prevention activities meets on a periodic basis to review and coordinate implementation of action proposals from the causal analysis meetings [SEI DP Activity 4].

Improvement Deployment

3.3.3.16

Where appropriate, process improvements are installed on a pilot basis to determine their benefits and effectiveness before they are introduced into normal practice [SEI PCM Activity 7] [Trillium].

3.3.3.17

When the decision is made to transfer a process improvement into normal practice, the improvement is implemented according to a documented procedure [SEI PCM Activity 8].

3.3.3.18

All managers are responsible for the effective deployment of the processes used in their departments [Roadmap Trillium 3.3.3.17].

Quality Goals

3.3.3.19

Quantitative quality goals are established and tracked for some process tasks and deliverables including requirements, design, code, test, validation and user documentation [SEI QPM Commitment 4] [Trillium].

Level 4

Functional Responsibility

3.3.4.1

A function exists that is responsible for coordinating the quantitative process management activities for the organization [SEI QPM Ability 1] [Trillium].

Funding & Resources

3.3.4.2

Support exists for collecting, recording, and analyzing data for selected process and product measurements [SEI QPM Ability 2].

3.3.4.3

Adequate resources and funding are provided for process improvement activities [SEI PCM Ability 1].

Policies & Procedures

3.3.4.4

A documented procedure is followed for reviewing, approving, planning, implementing, and tracking process improvement proposals [Roadmap Trillium 3.3.3.6].

Management Reviews

3.3.4.5

The activities for process improvement are reviewed with senior management on a periodic basis [SEI PCM Verification 1].

Quality Goals

3.3.4.6

Quantitative quality goals are established and tracked for all process tasks and deliverables including requirements, design, code, test, verification, validation and user documentation [SEI QPM Commitment 4] [Bellcore TR-NWT-000179 2.5-1] [Trillium].

Data Collection

3.3.4.7

Support exists for collecting, recording and analyzing data for selected process and product measurement [SEI QPM Ability 3] [Bellcore TR-NWT-000179 2.5-1].

3.3.4.8

Defect prevention data are documented and tracked across the teams coordinating defect prevention activities [SEI DP Activity 5].

3.3.4.9

The measurement data used to control the project's defined process quantitatively are collected according to a documented procedure [SEI QPM Activity 4].

Scope

3.3.4.10

An organization-wide program to improve the product development process is established which empowers the organization's staff and managers to improve their own working processes and to participate in the improvements made by others [SEI PCM Activity 1].

Improvement Team Participation

3.3.4.11

Staff and managers actively participate in working groups, quality circles, or technical committees to develop process improvements for assigned process focus areas [SEI PCM Activity 6].

Improvement Deployment

3.3.4.12

Revisions to the organization's standard processes resulting from defect prevention actions are incorporated according to a documented procedure [SEI DP Activity 6] [Trillium].

Feedback

3.3.4.13

Members of the product development group receive feedback on the status and results of the organization's and project's defect prevention activities on a periodic basis [SEI DP Activity 8].

Level 5

Process Improvement Repository

3.3.5.1

Records of process improvement activities are maintained in a repository [SEI PCM Activity 9].

Roadmap 3.4: Measurements

This Roadmap covers practices that address the measurement system and its elements.

Level 2

Costs

3.4.2.1

Project cost factors are measured [MB 2.1] [Trillium].

Product Measurement

3.4.2.2

Product characteristics (e.g., size, system resources, performance) are measured [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1 & 4.4.2-1] [ISO 9000-3 6.4.1] [Trillium].

3.4.2.3

The number of additions, changes and deletions to requirements, design, code and test specifications are measured [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1 & 4.4.2-1] [Bellcore IPQM TA-1315 3.8 & 3.9] [ISO 9000-3 6.4.1].

3.4.2.4

Measurements are made and used to determine the status of activities for managing requirements (e.g., status, change activity, cumulative number of changes) [SEI RM Measurement 1] [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1 & 4.4.2-1] [ISO 9000-3 6.4.1] [Trillium].

Project Measurement

3.4.2.5

Measurements are made and used to determine the status of project planning activities (e.g., milestone completion, work completed, effort extended) [SEI SPP Measurement 1] [Bellcore TR-NWT-000179 4.4.1-4] [Trillium].

3.4.2.6

Measurements are made and used to determine the status of project tracking activities (e.g., effort and resources, change activity for the development plan) [SEI SPT&O Measurement 1] [Bellcore TR-NWT-000179 4.4.1-4] [Trillium].

Process Measurement

3.4.2.7

Measurements are made and used to determine the status of the activities for managing subcontractors (e.g, costs compared to plan, actual delivery date compared to plan) [SEI SSM Measurement 1] [ISO 9000-3 6.4.2] [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1] [Trillium].

3.4.2.8

Measurements are made and used to determine the cost and schedule status of the quality system activities (e.g., costs compared to plan, number of audits compared to plan) [SEI SQA Measurement 1] [ISO 9000-3 6.4.2] [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1] [Trillium].

3.4.2.9

Measurements are made and used to determine the status of configuration management activities (e.g., effort and funds, completion of milestones compared to plan) [SEI SCM Measurement 1] [ISO 9000-3 6.4.2] [Bellcore TR-NWT-000179 4.4-1 & 4.4.1-1] [Trillium].

Process and Product Failures

3.4.2.10

Process and product failures and statistics are systematically measured throughout the life-cycle of the product [ISO 9000-3 6.4.1] [Bellcore TR-NWT-000179 4.4.1-2] [MB 5.2a & 6.1a] [Trillium].

Customer Satisfaction

3.4.2.11

Customer satisfaction is systematically measured [MB 7.4] [Trillium].

Level 3

Measurement Planning

3.4.3.1

Organization's and projects' activities for process measurements and analysis are based on a documented and approved plan [SEI QPM Activity 2] [ISO 9000-3 6.4] [Bellcore TR-NWT-000179 3.4.3-1].

3.4.3.2

The organization's standard product development process is the basis for selecting process and product data to be collected and for the analysis to be performed [ISO 9001 4.9] [Trillium].

Process Measurement

3.4.3.3

Process metrics are identified based on their usefulness to the organization and the projects [ISO 9001

4.20] [ISO 9000-3 6.4.2] [Bellcore TR-NWT-000179 4.4.1-3].

3.4.3.4

Process metrics cover the entire product life-cycle [ISO 9001 4.20] [ISO 9000-3 6.4.2].

3.4.3.5

The organization measures and tracks product and feature delivery interval, key milestones, completion dates and deliverables [Bellcore IPQM TA -1315 3.5, 3.6 & 3.7].

3.4.3.6

Process data are collected and stored in an organizational repository according to a documented procedure [Roadmap Trillium 3.4.3.3].

3.4.3.7

Measurements are made and used to determine the status of the organization's process definition activities (e.g., status of schedule milestones, costs) [SEI OPD Measurement 1] [Trillium].

3.4.3.8

Measurements are made and used to determine the effectiveness of the organization's project management activities (e.g., frequency, causes and magnitude of project replanning effort) [SEI ISM Measurement 1] [Trillium].

3.4.3.9

Measurements are made and used to determine the status of the organization's training activities (e.g., attendance, progress in providing courses) [SEI TP Measurement 1] [Trillium].

3.4.3.10

Measurements are made and used to determine the quality of the organization's training program (e.g., post-training test results, student courses reviews) [SEI TP Measurement 2] [Trillium].

Product Measurement

3.4.3.11

Product metrics are collected and used to manage and improve the product development process [ISO 9001 4.20] [ISO 9000-3 6.4.1] [Bellcore TR-NWT-000179 4.4.1-1 & 4.4.1-3].

3.4.3.12

Product data are collected and stored in an organizational repository according to a documented procedure [Bellcore TR-NWT-000179 4.4.1-1] [Trillium].

Data Analysis

3.4.3.13

Analyses of selected product data are performed according to a documented procedure [ISO 9001 4.20] [Bellcore TR-NWT-000179 4.4.1-2] [Trillium].

3.4.3.14

Analyses of selected process data are performed according to a documented procedure [ISO 9001 4.20] [Bellcore TR-NWT-000179 4.4.1-2] [Trillium].

Process and Product Failures

3.4.3.15

The number of detected and corrected defects are systematically measured for each life-cycle phase [SEI SPE Measurement 1] [Bellcore IPQM TA-1315 4.3].

Customer Satisfaction

3.4.3.16

Customer satisfaction metrics are systematically used for improvement [MB 7.2g].

Level 4

Process Measurement

3.4.4.1

The process performance baseline for the organization's standard product development process is monitored on a regular basis and updated as appropriate according to a documented procedure [SEI QPM Activity 7] [Trillium].

3.4.4.2

The results of the measurement and analysis activities are monitored on a regular basis and appropriate adjustments are made to keep process performance baseline in line with the expected performance [SEI QPM Activity 5].

3.4.4.3

Process analysis reports are prepared and distributed to the appropriate groups [SEI QPM Activity 6].

Quality Management

3.4.4.4

Measurements are made to determine the status of the Quality Management activities (e.g., cost of poor quality) [SEI SQM Measurement 1].

Level 5

Statistical Process Control

3.4.5.1

The results from the integrated process and product data analyses are used to bring the organization's processes under statistical control [Roadmap Trillium 3.4.4.2].

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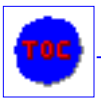

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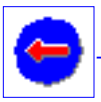 Back to capability area 2.

 Forward to capability area 4.

Trillium Capability Areas, Roadmaps and Practices
Capability Area 4: Management

This Capability Area covers the 5 management-oriented Roadmaps:

- Project Management,
- Subcontractor Management,
- Customer-Supplier Partnership,
- Requirements Management, and
- Estimation.

They address items that interface with customers and suppliers of the organization\qs products, as well as the most significant areas of sizing, scheduling, tracking and managing projects.

Roadmap 4.1: Project Management

This Roadmap covers practices that address project management issues.

Level 2

Statement of work

4.1.2.1

A documented and approved statement of work exists for the project [SEI SPP Ability 1] [Trillium].

4.1.2.2

The engineering group participates on the project proposal team [SEI SPP Activity 1] [Trillium].

4.1.2.3

Project commitments and changes to commitments made to individuals and groups external to the organization are reviewed with senior management prior to making contractual commitment according to a documented procedure [SEI SPP Activity 4] [SEI SPT&O Activity 3] [ISO 9001 4.4.9] [Trillium].

Accountability & Authority

4.1.2.4

A project manager is designated to be responsible for the project's activities and results [SEI SPT&O Commitment 1] [Bellcore TR-NWT-000179 3.4.4.1].

4.1.2.5

For any given project activity or task, there is a single owner having responsibility and authority over the completion of that activity and the quality of its output(s) [Roadmap Trillium 4.1.2.3].

Planning

4.1.2.6

Adequate resources and funding are provided for planning the project [SEI SPP Ability 3] [ISO 9001 4.1.2.2] [Trillium].

4.1.2.7

Project planning includes all project related planning activities (e.g., quality planning, verification and validation planning) [ISO 9000-3 5.4.1] [Bellcore TR-NWT-000179 3.4.1] [Trillium].

4.1.2.8

Project planning activities identify and document methods for ensuring that all activities are carried out correctly [ISO 9001 4.4.2] [ISO 9000-3 6.2.2] [Trillium].

4.1.2.9

Project development and management planning documentation includes purpose, scope, goals, objectives, deliverables and primeships for the project [ISO 9000-3 6.2.2] [Bellcore TR-NWT-000179 3.4-1].

4.1.2.10

Software project planning activities are initiated in the early stages of, and conducted in parallel with, the overall project planning activities [SEI SPP Activity 2].

4.1.2.11

Responsibilities for developing the product development plan are assigned [SEI SPP Ability 2] [Trillium].

4.1.2.12

The project development plan is developed, documented and approved according to a documented procedure [SEI SPP Activity 6 & 7 and SPT&O Ability 1] [ISO 9000-3 5.4.1] [Bellcore TR-NWT-000179 3.4.1-1] (Ref. IEEE Std. 1058.1).

4.1.2.13

The development group participates with other affected groups in the overall project planning throughout the life of the project [SEI SPP Activity 3].

4.1.2.14

Work products that are needed to establish and maintain control of the project are identified [SEI SPP Activity 8].

4.1.2.15

Required inputs and outputs to each project phase are defined and documented [ISO 9001 4.4.3] [ISO 9000-3 5.4.4 & 5.4.5] [Bellcore TR-NWT-000179 3.4-1].

4.1.2.16

Input and output criteria for each project phase are defined and documented [ISO 9000-3 5.5.2] [Trillium].

4.1.2.17

The project manager explicitly assigns responsibilities for work products and activities [SEI SPT&O Ability 2] [ISO 9001 4.4.2] [Trillium].

4.1.2.18

Plans for the project's engineering facilities, environments, and support tools are prepared [SEI SPP Activity 14].

4.1.2.19

Project quality planning specifies and documents measurable product quality objectives [ISO 9000-3 5.5.2] [Trillium].

4.1.2.20

Project planning specifies and documents schedules, resources and approval authorities for verification and validation activities [ISO 9001 4.4.2, 4.4.7, 4.4.8] [ISO 9000-3 5.5.2] [Trillium].

4.1.2.21

Project planning identifies and documents procedures to be used to assure timely compliance with all development performance and review standards to be used throughout the life-cycle [ISO 9001 4.4.2, 4.4.6] [Trillium].

Risk Management

4.1.2.22

The technical, cost, resource and schedule risks are identified, assessed and documented [SEI SPP Activity 13] [ISO 9000-3 5.4.2.2].

4.1.2.23

The technical, cost, resource, and schedule risks are tracked throughout the life of the project [SEI SPT&O Activity 10] [ISO 9000-3 5.4.2.2].

Scheduling

4.1.2.24

The project's schedule is derived according to a documented procedure [SEI SPP Activity 12] [Bellcore TR-NWT-000179 3.4.3-1, 2].

Data collection

4.1.2.25

Planning data are recorded for use by the project [SEI SPP Activity 15].

4.1.2.26

Actual measurement and replanning data for the project are recorded for use by the current project and future projects [SEI SPT&O Activity 11].

Tracking

4.1.2.27

Adequate resources and funding are provided for tracking the project [SEI SPT&O Ability 3] [Trillium].

4.1.2.28

The project development plan is used to track activities and communicate project status [SEI SPT&O Activity 1] [ISO 9000-3 5.4.1] [Bellcore TR-NWT-000179 3.4.1-1] (Ref. IEEE Std. 1058.1).

4.1.2.29

The project's product development plan is revised according to a documented procedure [SEI SPT&O Activity 2].

4.1.2.30

Approved changes to commitments that affect the project are communicated to the members of the development group and other related groups [SEI SPT&O Activity 4] [ISO 9001 4.4.9].

4.1.2.31

The size of the work products is tracked and corrective actions are taken as appropriate [SEI SPT&O Activity 5].

4.1.2.32

The project's costs are tracked and corrective actions taken as appropriate [SEI SPT&O Activity 6].

4.1.2.33

The project's critical target computer resources are tracked and corrective actions are taken as appropriate [SEI SPT&O Activity 7].

4.1.2.34

The project's schedule is tracked and corrective actions taken as appropriate [SEI SPT&O Activity 8] [ISO 9000-3 5.4.3] [Bellcore TR-NWT-000179 3.4-1].

4.1.2.35

Engineering technical activities are tracked and corrective actions taken as appropriate [SEI SPT&O Activity 9].

4.1.2.36

The critical dependencies and critical paths of the project's schedule are managed according to a documented procedure [SEI ISM Activity 9].

4.1.2.37

Representatives of the software development function work with representatives of the other engineering functions to monitor and coordinate activities and resolve project-level technical issues [SEI IC Activity 2].

Reviews

4.1.2.38

The developers and their managers conduct regular reviews to track technical progress, plans, performance, and issues against the software development plan [SEI SPT&O Activity 12] [ISO 9000-3 5.6.4].

4.1.2.39

Formal reviews, to address the accomplishments and results of the project, are conducted at selected project milestones and at the beginning and completion of selected stages according to a documented procedure [SEI SPT&O Activity 13] [ISO 9000-3 5.6.4] [ISO 9001 4.4.6] [Bellcore TR-NWT-000179 3.4-1 & 3.4.4-2].

4.1.2.40

Products produced as input to other project groups are reviewed by representatives of the receiving groups to ensure that the products meet their needs [SEI IC Activity 5].

4.1.2.41

All intergroup issues are documented, negotiated, and, if unresolved, reported to the appropriate managers [SEI IC Activity 6].

4.1.2.42

Periodic technical reviews and interchanges are held with the task leaders of the project groups [SEI IC Activity 7] [Bellcore TR-NWT-000179 3.4.4-2 & 3.4.4-3].

Level 3

Funding

4.1.3.1

Adequate resources and funding are provided for managing the project using the project defined process [SEI ISM Ability 1] [ISO 9001 4.1.2.2].

4.1.3.2

Adequate resources and funding are provided for the internal coordination of all product and service engineering activities [SEI IC Ability 1] [ISO 9001 4.1.2.2] [Trillium].

Policy

4.1.3.3

The organization follows a written policy requiring that projects be managed according to a documented procedure [SEI ISM Commitment 1].

4.1.3.4

The project is managed in accordance with the project's defined product development process [SEI ISM Activity 4] [Trillium].

Process Tailoring

4.1.3.5

The project's defined product development process is developed by tailoring the organization's standard product development process according to documented procedure [SEI ISM Activity 1] [Trillium].

Project Planning

4.1.3.6

The project's development plan, which describes the use of the project's defined process, is developed and changed according to a documented procedure [SEI ISM Activity 2, 3] [Trillium].

4.1.3.7

A documented plan is used to communicate intergroup commitments and coordinate and track the work performed [SEI IC Activity 3] [ISO 9001 4.4.3].

4.1.3.8

Critical dependencies are identified and negotiated according to a documented procedure [SEI IC Activity 4].

Resource Management

4.1.3.9

The size of the work products is managed according to a documented procedure [SEI ISM Activity 6].

4.1.3.10

The project's costs are managed according to a documented procedure [SEI ISM Activity 7].

4.1.3.11

The project's critical target computer resources are managed according to a documented procedure [SEI ISM Activity 8].

Risk Management

4.1.3.12

The project's development risks are identified, assessed, documented, and managed according to a documented procedure [SEI ISM Activity 10].

4.1.3.13

A team exists to coordinate defect prevention activities for the project [SEI DP Ability 2] [Trillium].

4.1.3.14

There is a formal mechanism for independently identifying project's process and product issues and escalating these to the project manager [ISO 9001 4.9] [Trillium].

Management Reviews

4.1.3.15

Formal reviews of the development project are conducted periodically to determine the actions needed to bring the project's performance and results in line with the current and projected business, customer, and end-user needs according to a documented procedure [SEI ISM Activity 11] [ISO 9001 4.4.5, 4.4.6] [Bellcore TR-NWT-000179 3.4.4-3 & 3.4.4-4].

Level 4

Defect Prevention

4.1.4.1

The project develops and maintains a plan for defect prevention activities [SEI DP Activity 1] [Trillium].

4.1.4.2

Revisions to the project's defined process resulting from defect prevention actions are incorporated according to a documented procedure [SEI DP Activity 7] [Trillium].

New Technology Introduction

4.1.4.3

Appropriate new technologies are incorporated into the project defined processes according to a documented procedure [SEI TCM Activity 8] [Trillium].

Roadmap 4.2: Subcontractor Management

This Roadmap covers practices that address the management of suppliers and subcontractors. "Subcontractors" is the term used in the SEI CMM and is thus more focused toward a product development context. "Supplier" is the term used by ISO 9001 and the Malcom Baldridge National Quality Award Criteria and is thus more generic, encompassing "subcontractors". Both terms are used in the set of practices for traceability purposes. These terms do NOT apply to individuals brought in to work as part of the development team on a contract basis.

Level 2

Resources

4.2.2.1

Adequate resources and funding are provided for selecting the subcontractor or supplier and managing the contractual agreement [SEI SSM Ability 1] [ISO 9001 4.1.2.2] [Trillium].

Selection Process

4.2.2.2

Subcontractors and suppliers are selected according to a documented procedure, based on a thorough evaluation of the subcontractor's or supplier's ability to perform the work and/or supplying the product or service. [SEI SSM Activity 2] [ISO 9001 4.6.1, 4.6.2] [ISO 9000-3 6.7.2] [Bellcore TR-NWT-000179 4.7-1] [Trillium].

Contractual Agreement

4.2.2.3

The contractual agreement with the subcontractor (or supplier) establishes the basis for managing the subcontractor (or the supplier) [SEI SSM Activity 3] [ISO 9001 4.6.3] [ISO 9000-3 6.7.1] [Bellcore TR-NWT-000179 4.7-1] [Trillium].

4.2.2.4

The work to be subcontracted is defined and planned according to a documented procedure [SEI SSM Activity 1] [ISO 9001 4.6.3].

Contract Management

4.2.2.5

A documented subcontractor's development plan, which covers (directly or by reference) the appropriate items from the prime contractor's development plan, is reviewed and approved by the prime contractor [SEI SSM Activity 4] [ISO 9001 4.3] [Bellcore TR-NWT-000179 4.7-3].

4.2.2.6

A documented and approved subcontractor's product development plan is used for tracking the development activities and communicating status [SEI SSM Activity 5] [Bellcore TR-NWT-000179 4.7-2].

4.2.2.7

The prime contractor's management conducts regular status and coordination reviews with the subcontractor's management [SEI SSM Activity 7] [ISO 9001 4.3] [Bellcore TR-NWT-000179 4.7-3].

4.2.2.8

Periodic technical reviews and interchanges are held with the subcontractor [SEI SSM Activity 8] [ISO 9001 4.7] [Bellcore TR-NWT-000179 4.7-3].

4.2.2.9

Formal reviews are conducted at selected milestones and the completion of selected stages to address the subcontractor's engineering accomplishments and results according to a documented procedure [SEI SSM Activity 9] [ISO 9001 4.3, 4.4.6, 4.6.4].

4.2.2.10

Changes in the subcontracted scope of work, subcontract terms and conditions, and other commitments are resolved according to a documented commitment review procedure involving affected groups of both the prime contractor and the subcontractor [SEI SSM Activity 6] [ISO 9001 4.3].

4.2.2.11

The prime contractor's quality assurance function monitors the subcontractor's quality assurance activities according to a documented procedure [SEI SSM Activity 10] [Bellcore TR-NWT-000179 4.7-4] [ISO 9001 4.10.2] [Trillium].

4.2.2.12

The prime contractor's configuration management function monitors the subcontractor's configuration management activities according to a documented procedure [SEI SSM Activity 11] [ISO 9001 4.10.2] [Bellcore TR-NWT-000179 4.12-3].

Acceptance

4.2.2.13

The prime contractor conducts acceptance testing as part of the delivery of the subcontractor's product according to a documented procedure [SEI SSM Activity 12] [ISO 9001 4.6.4, 4.7] [ISO 9000-3 6.7.3] [Bellcore TR-NWT-000179 4.7-1].

Subcontractor Performance Evaluation

4.2.2.14

The subcontractor's performance is evaluated on a periodic basis and the evaluation is reviewed with the subcontractor [SEI SSM Activity 13] [ISO 9001 4.6.2].

Level 3

Quality Requirements

4.2.3.1

The organization defines and communicates its quantitative product and process quality requirements to subcontractors [SEI SQM Activity 5] [MB 5.4a] [Trillium].

Quality Performance

4.2.3.2

The organization has in place a formal program to assess trends and current levels for critical indicators of supplier (subcontractor) quality [MB 6.4a] [Trillium].

4.2.3.3

The organization has in place a formal program to compare its supplier (subcontractor) quality levels with those of appropriately selected benchmarks [MB 6.4b] [Trillium].

Quality Improvement Program

4.2.3.4

The organization has in place a formal program to help its suppliers improve their ability to meet key quality and response time requirements [MB 5.4b] [Trillium].

Roadmap 4.3: Customer-Supplier Relationship

This Roadmap covers practices that address the relationship between customers and suppliers in a contract environment and, in a more mature environment, a partnering mode.

Level 2

Liaison

4.3.2.1

The organization has a representative with responsibility for dealing with the other party of a given contractual arrangement on contractual matters [ISO 9001 4.7] [ISO 9000-3 4.1.2] [Trillium].

Contractual Information

4.3.2.2

The contractual information (e.g., contract, requirements, warranties, return procedures, purchase orders) is reviewed, agreed to and coordinated formally [ISO 9000-3 5.2.1 & 5.2.2] [Bellcore TR-NWT-000179 3.2-1].

Customer Project Reviews

4.3.2.3

Formal reviews of the project are conducted with the customer at selected project milestones and at the beginning and completion of selected stages to address the accomplishments and results of the project according to a documented procedure [ISO 9000-3 4.1.3] [Bellcore TR-NWT-000179 3.4.2-3 & 3.4.4-3] [Trillium].

Customer Interaction

4.3.2.4

The development function actively participate(s) with the customers and end users to establish their needs [SEI IC Activity 1] [Bellcore TR-NWT-000179 3.4.2-3].

Level 3

Joint Requirements Development

4.3.3.1

Product requirements are developed jointly by representatives from Customer's and Supplier's cross-functional areas (e.g., marketing, design, support, and operations) [Roadmap Trillium 4.3.2.4].

Joint Application Design

4.3.3.2

Product design is developed in consultation with representatives from Customer's and Supplier's cross-functional areas (e.g., marketing, design, support, and operations) [Roadmap Trillium 4.3.2.4].

Quality Assurance Functions Liaison

4.3.3.3

The QA function representative conducts regular reviews of its activities and findings with the customer's QA function representative [SEI SQA Activity 8] [Trillium].

Interface Performance

4.3.3.4

Feedback on human machine interface and product and service interfaces is gathered formally (e.g., from customer and/or user groups) [MB 7.2f] [Trillium].

Roadmap 4.4: Requirements Management

This Roadmap covers practices that are related to the development and the management of requirements.

Level 2

Funding

4.4.2.1

Adequate resources and funding are provided for managing the allocated customer and systems requirements [SEI RM Ability 3] [ISO 9001 4.1.2.2] [Trillium].

Procedure

4.4.2.2

User/customer requirements are developed and documented according to a documented procedure [SEI RM Ability 2] [Bellcore TR-NWT-000179 4.6-3] (Ref. IEEE Std. 830) [Trillium].

User Requirements

4.4.2.3

There is an organizational policy for the management of user/customer requirements. This policy covers purpose, scope, modification, and ownership [ISO 9000-3 5.3] [Bellcore TR-NWT-000179 3.3-1,2,3,4] [Trillium].

4.4.2.4

The requirements include all aspects necessary to satisfy the customer's need and are stated precisely enough to allow validation during product acceptance. These requirements may include, but are not limited to, the following: functionality, performance, safety, reliability, security and privacy [ISO 9001 4.4.4, 4.4.5] [ISO 9000-3 5.3] [Bellcore TR-NWT-000179 3.3-1,2,3,4 & 4.6-3].

System Requirements

4.4.2.5

System requirements are documented in a consistent format and are clearly stated, verifiable and testable (Ref. IEEE Std. 830) [Trillium].

4.4.2.6

System requirements are traceable to user/customer requirements [ISO 9001 4.4.4] [Trillium].

4.4.2.7

System requirements are reviewed by all affected groups [SEI RM Activity 1].

4.4.2.8

System requirements form the basis for the product development plans, requirement specifications and activities [SEI RM Activity 2].

System Requirements Allocation

4.4.2.9

There is a function responsible for analyzing and allocating system requirements to hardware, software and other system components [SEI RM Ability 1].

System Requirements Changes

4.4.2.10

Changes to the system requirements are reviewed and incorporated into all appropriate development plans & activities [SEI RM Activity 3] [ISO 9001 4.4.4] [Bellcore TR-NWT-000179 3.4.1-2].

4.4.2.11

Changes to system requirements are analyzed to identify project impact [Bellcore TR-NWT-000179 3.4.1-2] [Trillium].

Level 3

Market Analysis

4.4.3.1

Market analyses to determine the customer needs and formulate appropriate product requirements are formal and performed according to a documented procedure [MB 7.1].

Quality Goals

4.4.3.2

Quantitative quality goals for requirements are established, and achievement against these goals is measured and tracked [ISO 9001 4.4.5] [Trillium].

Level 4

Customer Requirements

4.4.4.1

A process/method (e.g., Quality Function Deployment) is used to systematically capture all customer requirements and translate them into clear design statements [Roadmap Trillium 4.4.2.4].

Roadmap 4.5: Estimation

This Roadmap covers practices that are related to the estimation process.

Level 2

Work Product Size

4.5.2.1

Estimates for the size of all work products (or changes to the size of the work products) are derived according to a documented procedure [SEI SPP Activity 9] [Bellcore TR-NWT-000179 3.4.3-1,2].

Development Effort

4.5.2.2

Estimates for product development effort, costs and resources are derived according to a documented procedure [SEI SPP Activity 10] [Bellcore TR-NWT-000179 3.4.3-1].

Target Computer Resources

4.5.2.3

Estimates for critical target computing resources are derived according to a documented procedure [SEI SPP Activity 11] [Bellcore TR-NWT-000179 3.4.3-3].

Level 3

Process Repository

4.5.3.1

The organizational process repository is used for planning and estimating according to a documented procedure [SEI ISM Activity 5].

Project Size Management

4.5.3.2

The project's size is quantitatively managed according to a documented procedure [Trillium].

Estimation Model

4.5.3.3

Past project data is used to update a formal estimation model according to a documented procedure [Trillium].

4.5.3.4

The estimation model is maintained according to a documented procedure [Roadmap Trillium 4.5.3.3].

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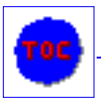

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UH CL

Trillium Capability Areas, Roadmaps and Practices
Capability Area 5: Quality System

This Capability Area comprises a single Roadmap. It deals with all aspects of quality, from policy and commitment to product quality and audits.

Roadmap 5.1: Quality System

Level 2

Roles and Responsibilities

5.1.2.1

The responsibility, authority and interrelation of all personnel who manage, perform and verify work affecting quality are defined [ISO 9001 4.1.2.1] [ISO 9000-3 4.1.1.2.1] [Bellcore TR-NWT-000179 2.1-1] [Trillium].

5.1.2.2

The personnel who manage, perform and verify work affecting quality have the organizational independence and authority to: [SEI SQA Ability 1] [ISO 9001 4.1.2.1, 4.13.2, 4.14.2, 4.14.3] [Bellcore TR-NWT-000179 2.1-1] [ISO 9000-3 4.1.1.2.1] [Trillium]

1. initiate action to prevent the occurrence of product, process and quality system nonconformity,
2. identify and record any problems relating to the product, process and quality system.
3. initiate, recommend or provide solutions through designated channels,
4. verify implementation of solutions, and
5. control further processing, delivery or installation of nonconforming product until the deficiency or unsatisfactory condition has been corrected.

Funding

5.1.2.3

Adequate resources and funding are provided for managing the quality of the product [SEI SQM Ability 1] [ISO 9001 4.1.2.2].

5.1.2.4

Adequate resources and funding are provided for performing the quality assurance activities [SEI SQA Ability 2] [ISO 9001 4.1.2.2].

QA Planning

5.1.2.5

A Quality Assurance Plan is prepared, documented, approved and maintained according to a documented procedure [SEI SQA Activity 1] [SEI SQM Activity 2] [ISO 9000-3 4.2.3 & 5.5] [Bellcore TR-NWT-000179 2.2-1 & 3.5-1,2,3,4,5] [ISO 9001 4.2] (Ref. IEEE Std. 730 & 983).

QA Activities

5.1.2.6

The Quality Assurance activities are performed in accordance with the Quality Assurance plan [SEI SQA Activity 2] [Bellcore TR-NWT-000179 3.5-3] [Trillium].

Audits and Reviews

5.1.2.7

Project development activities are reviewed and audited to ensure process compliance [SEI SQA Activity 3] [ISO 9000-3 4.3].

5.1.2.8

Representative samples of intermediate work products are reviewed to ensure compliance with the designated process requirements [SEI SQA Activity 4].

5.1.2.9

Independent process conformance reviews are held regularly [SEI SQA Activity 5].

Audit and Review Reporting

5.1.2.10

Deviations identified in development activities are documented and handled according to a documented procedure [SEI SQA Activity 7] [ISO 9000-3 4.3].

5.1.2.11

The results of the independent process conformance reviews are reviewed with senior management on a periodic basis [SEI SQA Verification 1] [ISO 9001 4.4.7] [ISO 9000-3 4.3] [Bellcore TR-NWT-000179 2.1.3-1].

5.1.2.12

The results of the Quality (Assurance) activities are periodically reported to the development group [SEI SQA Activity 6] [ISO 9000-3 4.3] [Trillium].

Corrective Action

5.1.2.13

All product and process corrective action activities shall be recorded, analyzed, reviewed and tracked from initiation to closure. Corrective action activities include problem reports, corrective action taken including interim workarounds, verification of impacts, root cause analysis, change control and analysis of corrective action and change control [ISO 9000-3 4.4] [Bellcore TR-NWT-000179 3.4.5-1,2 & 3.10.2-4 & 4.1.3-6].

Quality Records

5.1.2.14

The organization establishes and maintains procedures for identification, collection, indexing, filing, storage, maintenance and disposition of quality records [ISO 9001 4.2, 4.16] [ISO 9000-3 6.3] [Bellcore TR-NWT-000179 4.3-1].

Level 3

Organizational Quality System

5.1.3.1

The organization has and maintains a documented quality system [ISO 9001 4.2] [ISO 9000-3 4.2.1] [Bellcore TR-NWT-000179 2.2-1 & 4.4.3-1].

5.1.3.2

All quality system elements, requirements and provisions are documented in a systematic and orderly manner, e.g., quality manual [ISO 9001 4.2] [ISO 9000-3 4.2.2] [Bellcore TR-NWT-000179 2.2-1].

5.1.3.3

The organization's quality system is an integrated process throughout the entire life cycle, thus ensuring that quality is being built-in as development progresses, rather than being discovered at the end of the process [ISO 9001 4.2] [ISO 9000-3 4.2.1] [Bellcore TR-NWT-000179 2.2-1 & 3.5-1,2,3,4,5].

5.1.3.4

The organization's quality system emphasizes problem prevention rather than problem correction after occurrence [ISO 9001 4.2, 4.14.3] [ISO 9000-3 4.2.1] [Bellcore TR-NWT-000179 2.2-1].

5.1.3.5

The organization provides rules, practices, and conventions in order to make the quality system effective [ISO 9000-3 6.5].

5.1.3.6

The organization uses tools, facilities, and techniques in order to make the quality system effective [ISO 9000-3 6.6] [Bellcore TR-NWT-000179 4.6-1,2].

Policy and Commitment

5.1.3.7

Policy, objectives for, and commitment to quality are defined and documented. The organization ensures that this policy is understood, implemented and maintained at all levels in the organization [SEI SQM Commitment 1] [ISO 9001 4.1.1] [ISO 9000-3 4.1.1.1] [Bellcore TR-NWT-000179 2.1.1-1].

Internal Audits

5.1.3.8

Planned and documented internal quality audits are executed formally: [ISO 9001 4.1.2.2, 4.17] [Bellcore TR-NWT-000179 2.1.1-2 & 2.3-2] [Trillium].

1. to verify that quality activities comply with planned arrangements, and
2. to determine the effectiveness of the quality system.

Senior Management Review

5.1.3.9

The quality system is reviewed formally at appropriate intervals by senior management to ensure its continuing suitability and effectiveness [ISO 9001 4.1.3] [ISO 9000-3 4.1.13] [Bellcore TR-NWT-000179 2.1.1-2 & 4.4.3-1] [Trillium].

Funding

5.1.3.10

Adequate resources and funding are provided for defect prevention activities at the project and organization levels [SEI DP Ability 3] [ISO 9001 4.1.2.2 & 4.14.3].

Corrective Action

5.1.3.11

There are documented and maintained procedures for: [ISO 9001 4.10.5, 4.13.1, 4.14.1, 4.14.2, 4.14.3] [ISO 9000-3 4.4] [Bellcore TR-NWT-000179 2.4-1,2,3,4 & 3.4.5-1,2 & 3.10.2-4 & 4.1.3-6]

1. investigating the cause of nonconforming intermediate products and the corrective action(s) needed to prevent recurrence,
2. analyzing all processes, work operations, concessions, quality records, service reports and customer complaints to detect and eliminate potential causes of non-conforming products,

3. initiating preventive actions to deal with problems to a level corresponding to the risks encountered,
4. applying controls to ensure that corrective actions are taken and that they are effective,
5. implementing and recording changes in procedures resulting from corrective action.

Product Quality

5.1.3.12

The quality of the project's products is measured, analyzed and compared to the products quantitative quality goals on an event-driven basis [SEI SQM Activity 4].

5.1.3.13

Practices are in place to assure the quality needs of the organization, customers and users (e.g., QFD, customer surveys, focus groups) are traceable to the product requirements and quality goals [SEI SQM Activity 1] [ISO 9000-3 5.6.1] [Trillium].

5.1.3.14

The project's quantitative quality goals for the intermediate products are defined, monitored, and revised throughout the software life cycle [SEI SQM Activity 3].

5.1.3.15

Quantitative product quality goals are defined, monitored, and revised throughout the product life-cycle [SEI QPM Activity 3] [ISO 9001 4.9].

Level 4

Quality Goals

5.1.4.1

Quantitative process quality goals are defined, monitored, and revised throughout the product life-cycle [MB 2.1] [Trillium].

Benchmarking

5.1.4.2

The organization constantly measures and compares itself with the best in class in the world [MB 2.2].

Level 5

Benchmarking

5.1.5.1

The organization has a program to assure that its process capability and product quality are comparable to those of world leaders [MB 3.2d].

Leadership

5.1.5.2

Industry-wide quality leadership is exercised by active involvement of senior executive(s) in industry-wide executive forums to raise quality consciousness among members of the community, and active participation by the organization's managers and technical experts in national and international standards setting forums [MB 1.3].

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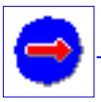 Forward to capability area 6.

Trillium Capability Areas, Roadmaps and Practices
Capability Area 6: Development Practices

This Capability Area covers the following 7 Roadmaps:

- Development Process,
- Development Techniques,
- Internal Documentation,
- Verification & Validation,
- Configuration Management,
- Re-Use, and
- Reliability Management

It addresses most of the processes, procedures and activities central to product development.

Roadmap 6.1: Development Process

Level 2

Implementation

6.1.2.1

Implementation activities (e.g., construction, coding) are conducted according to documented procedures [ISO 9000-3 5.6.3] [Trillium].

Funding

6.1.2.2

Adequate resources and funding are provided for performing the engineering tasks [SEI SPE Ability 1] [ISO 9001 4.1.2.2] [Trillium].

Level 3

Policy

6.1.3.1

The project follows a written organizational policy for performing development activities [SEI SPE Commitment 1] [Bellcore TR-NWT-000179 2.5.1-1 & 3.4.2-5,6,7,8,9,10 & 3.7.2-2].

Process

6.1.3.2

The organization's standard product development process defines the development methods to be used and the intermediate products generated during each development phase [ISO 9001 4.4.1] [ISO 9000-3 5.4.2.1, 5.4.3, 5.4.5 & 5.6.1] [Bellcore TR-NWT-000179 3.4-1 & 3.4.2-5 & 3.6-1 & 4.1.1-3 & 4.6-2,7] [Trillium] (Ref. IEEE Std. 1074).

6.1.3.3

The system requirements specification is reviewed and agreed formally [SEI SPE Activity 2].

6.1.3.4

The design specification is developed formally [SEI SPE Activity 3] [ISO 9001 4.4.4] [ISO 9000-3 5.6.2] [Bellcore TR-NWT-000179 3.6.1-1 & 3.6.2-1].

6.1.3.5

Code is developed formally according to a documented procedure to ensure that the design is met [SEI SPE Activity 4] [ISO 9000-3 5.6.3] [Bellcore TR-NWT-000179 3.6.1-1,2].

Product Architecture

6.1.3.6

The product development process requires the development of a well-defined and consistent product architecture [Roadmap Trillium 6.1.3.7].

6.1.3.7

The organization defines a group that *owns* and is accountable for the architecture of each product or product line throughout its entire life-cycle [Bellcore TR-NWT-000179 3.4.2-6,7,8,9] [Trillium].

Level 4

Process Model

6.1.4.1

A process model is maintained and used to evaluate the effect of process changes on the organization [Roadmap Trillium 6.1.3.2].

6.1.4.2

A process model is maintained and used to evaluate the effect of process changes on customer satisfaction [Roadmap Trillium 6.1.3.2].

Roadmap 6.2: Development Techniques

Level 2

High Level Languages

6.2.2.1

State of the practice high-level languages (e.g., PROTEL, C, Pascal, Ada) are used appropriately for all software products [Bellcore TR-NWT-000179 2.5.1-1] [Trillium].

Analysis and Design

6.2.2.2

Analysis and design (e.g., SA/SD, OOA/OOD) are done according to a documented procedure [ISO 9001 4.4.1] [Trillium].

Dependencies

6.2.2.3

The module, process and data dependencies are documented for the project [Bellcore TR-NWT-000179 3.6.2-1] [Trillium].

Level 3

Analysis and Design

6.2.3.1

Analysis and design (e.g., SA/SD, OOA/OOD,) are done formally according to a documented procedure [ISO 9000-3 5.6.2] [Bellcore TR-NWT-000179 3.6.2-1 & 3.10.3-4] [Trillium].

Performance Modeling

6.2.3.2

Modelling techniques are used to assess product performance during the product development process [Trillium].

Prototyping

6.2.3.3

Prototyping techniques are used to verify the correctness of critical specification items (e.g., user interface specification) with the customer [Trillium].

6.2.3.4

Prototyping techniques are used to explore design options and validate design decisions prior to implementation [Trillium].

Code Generation

6.2.3.5

Code skeletons are automatically generated from designs by CASE tools [Roadmap Trillium 6.2.3.1].

Code Metrics

6.2.3.6

Source code metrics (e.g., code complexity) are taken and compared to a predefined set of permissible values according to a documented procedure [Trillium].

Level 4

Formal Methods

6.2.4.1

Formal methods (e.g., VDM, Z, LOTOS) are used for the development of critical software components [Roadmap Trillium 6.2.3.1].

6.2.4.2

Proof of correctness is performed for critical software components [Roadmap Trillium 6.2.3.1].

CASE Tools

6.2.4.3

CASE tools are used to automatically generate prototypes and design specifications [Roadmap Trillium 6.2.3.5].

Design Metrics

6.2.4.4

Design complexity is measured and compared to the organizational baseline according to a documented procedure [Trillium].

Level 5

Constructive development

6.2.5.1

Constructive development methods (i.e., methods in which concrete intermediate products are constructed from abstract intermediate products) are used for most development tasks [Trillium].

Code Generation

6.2.5.2

The majority of source code (>80%) is automatically generated by CASE tools [Trillium].

Executable Generation

6.2.5.3

Executables are automatically generated by CASE tools [Trillium].

Roadmap 6.3: Internal Documentation

Level 2

Requirements

6.3.2.1

Requirements are documented according to a documented procedure [ISO 9001 4.4.1] [Bellcore TR-NWT-000179 3.4.2-9 & 4.2-1] (Ref. IEEE Std. 1016).

Design

6.3.2.2

Design is documented according to a documented procedure [Bellcore TR-NWT-000179 3.4.2-9 & 4.2-1] (Ref. IEEE Std. 1016).

Code

6.3.2.3

Code is documented according to a documented procedure [Bellcore TR-NWT-000179 3.4.2-9 & 4.2-1] [Trillium].

Test Cases

6.3.2.4

Test cases are documented according to a documented procedure [Bellcore TR-NWT-000179 3.4.2-9 & 3.7.2-5 & 4.2-1] (Ref. IEEE Std. 829).

Level 3

Development and Maintenance

6.3.3.1

The documentation that will be used to operate and maintain the product/service is developed and maintained according to the project's defined process [SEI SPE Activity 8] [ISO 9001 4.5.1, 4.5.2] [Bellcore TR-NWT-000179 3.4.2-9 & 3.7.2-2 & 4.2-1] [Trillium].

Requirements

6.3.3.2

Requirements are documented formally [Roadmap Trillium 6.3.2.1].

Design

6.3.3.3

The design is documented formally [Roadmap Trillium 6.3.2.2].

6.3.3.4

The rationale for all aspects of design is formally documented [Trillium].

Code

6.3.3.5

Code is documented formally [Roadmap Trillium 6.3.2.3].

Test Cases

6.3.3.6

Test cases are documented formally according to a documented procedure [Bellcore TR-NWT-000179 3.7.2-3] [Trillium].

Conformance to Standards

6.3.3.7

Conformance to requirement, design, coding, and test case standards is verified by a peer review process

[ISO 9001 4.4.7] [Trillium].

Notation

6.3.3.8

The standard for requirements and design documents specifies the use of structured and formal notations where appropriate [Trillium].

Updates

6.3.3.9

When the product is modified (e.g., to correct a defect or add a feature) the requirements and design documents for affected units are updated if needed to reflect the change [Trillium].

Roadmap 6.4: Verification & Validation

Level 2

Planning

6.4.2.1

The verification and validation activities (e.g., testing, peer reviews) are formally planned and the plans are documented according to a documented procedure [SEI PR Activity 1] [ISO 9001 4.4.1, 4.4.8, 4.10.1, 4.11] [ISO 9000-3 4.1.1.2.2, 5.4.6, 5.7.1, 5.7.2] [Bellcore TR-NWT-000179 2.1.2-1 & 3.7-1 & 3.7.1-6 & 3.7.2-6 & 3.8-2] [Trillium] (Ref. IEEE Std. 1012).

Funding

6.4.2.2

Adequate resources and funding are provided for performing peer reviews on each work product to be reviewed [SEI PR Ability 1] [ISO 9001 4.1.2.2] [ISO 9000-3 4.1.1.2.2, 5.7.2] [Bellcore TR-NWT-000179 3.7.1-6 & 3.8-5].

Peer Reviews

6.4.2.3

Peer reviews are conducted on intermediate work products [ISO 9000-3 4.10.2, 5.4.6, 5.6.4] [Bellcore TR-NWT-000179 3.4.2-12 & 3.6.2-1& 3.7.2-6] [Trillium].

System Testing

6.4.2.4

System and acceptance testing are planned and performed formally to demonstrate that the product satisfies its requirements [SEI SPE Activity 7] [ISO 9001 4.4.1, 4.10.3, 4.10.4, 4.10.5] [ISO 9000-3 5.7.1, 5.7.3 & 5.8] [Bellcore TR-NWT-000179 3.7.1-1,8 & 3.7.2-7 & 3.8-1] (Ref. IEEE Std. 1012).

Operational Testing

6.4.2.5

Where testing under field conditions is required, the following are considered: the features to be tested, responsibilities of both parties, and post-test restoration of the user environment [ISO 9001 4.10.3, 4.10.4, 4.11] [ISO 9000-3 5.7.1, 5.7.3, 5.7.4, 5.7.5] [Bellcore TR-NWT-000179 3.7.1-1,8 & 3.8-3] [Trillium].

Regression Testing

6.4.2.6

Product areas that are impacted by any modifications are identified and retested [ISO 9001 4.10.3, 4.13.2] [ISO 9000-3 5.7.1, 5.7.3] [Bellcore TR-NWT-000179 3.7.1-1,4,8 & 3.7.2-3] [Trillium].

Level 3

Testing Process

6.4.3.1

All testing activities are performed according to the project's defined process [SEI SPE Activity 5] [ISO 9001 4.9, 4.11, 4.12] [ISO 9000-3 4.1.1.2.2, 5.4.6, 5.7.2] [Bellcore TR-NWT-000179 3.7.1-3,5,8,9 & 3.7.3-1 & 3.7.4.1,2 & 3.7.6-1 & 3.8-2 & 3.10.3-4] [Trillium].

6.4.3.2

Test documentation, test cases & testing procedures (e.g., unit, integration, system & regression testing) are developed and documented according to a documented procedure [Bellcore TR-NWT-000179 3.7.4.1,2] [ISO 9001 4.11] (Ref. IEEE Std. 1012 1.2(4), 3.5(1, 2 & 3)) (Ref. IEEE Std. 829) [Trillium].

Test Case Application

6.4.3.3

The application of test cases, principally for regression testing and where practical, is automated [ISO 9000-3 4.1.1.2.2] [Bellcore TR-NWT-000179 3.7.1-2,8] [Trillium].

Integration Testing

6.4.3.4

Integration testing activities are planned and performed according to the project's defined process [SEI

SPE Activity 6] [Bellcore TR-NWT-000179 3.7.1-1,7,8 & 3.7.3-1] [Trillium].

Peer Reviews

6.4.3.5

Peer reviews are performed on all intermediate products according to a documented procedure [SEI PR Activity 2] [ISO 9001 4.4.6] [ISO 9000-3 5.4.6] [Bellcore TR-NWT-000179 3.4.2-12& 3.6.2-1] (Ref. IEEE 1012 figure 1 & table 1, Std. 1028) [Trillium].

V&V Results

6.4.3.6

Information on the results of peer reviews is recorded in an organizational repository [SEI PR Activity 3].

6.4.3.7

Data on defects identified during peer reviews, integration testing, system testing, operational testing and defects reported by customers are collected, documented, analyzed and tracked to closure [SEI SPE Activity 9] [ISO 9001 4.12, 4.13.1] [ISO 9000-3 5.7.3] (Ref. IEEE Std. 1012 3.5(3), 3.6 & 3.7) [Trillium].

V&V Efficiency

6.4.3.8

Verification and validation efficiency is measured and tracked according to a documented procedure [ISO 9001 4.12] [ISO 9000-3 5.7.3] [Bellcore TR-NWT-000179 3.7.1-9 & 3.7.2-1,4 & 3.7.4-3] [Trillium].

V&V Adequacy

6.4.3.9

Verification and validation adequacy (e.g., test coverage) is measured and tracked according to a documented procedure [ISO 9001 4.4.7, 4.4.8, 4.12] [ISO 9000-3 5.7.3] [Bellcore TR-NWT-000179 3.7.1-9 & 3.7.2-1,4] [Trillium].

Level 4

Test Case Generation

6.4.4.1

The generation of test cases is automated from requirements and designs [Trillium].

V&V Efficiency

6.4.4.2

Verification and validation efficiency goals are defined and monitored [Trillium].

V&V Adequacy

6.4.4.3

Verification and validation adequacy (e.g., test coverage,% NCSS inspected) goals are defined and monitored [Trillium].

Defect Density Analysis

6.4.4.4

Defect density is projected and compared with actuals [Trillium].

Roadmap 6.5: Configuration Management

Level 2

Scope

6.5.2.1

Source code is under Configuration Management (CM) control [Bellcore TR-NWT-000179 4.1.1-1 & 4.1.2-2,3] [Trillium].

6.5.2.2

All project and product (internal and external) documents are under CM control [ISO 9001 4.5.1, 4.5.2, 4.5.3] [ISO 9000-3 6.2.1, 6.2.3 & 6.2.4] [Bellcore TR-NWT-000179 4.1.1-1,3 & 4.1.2-1].

Function

6.5.2.3

A board having the authority for managing the project's product baselines (i.e., a product configuration control board - PCCB) exists or is established [SEI SCM Ability 1] [Trillium].

6.5.2.4

There is a function responsible for coordinating and implementing CM for the project [SEI SCM Ability 2] [IEEE Std. 828 2.2] [Trillium].

Funding

6.5.2.5

Adequate resources and funding are provided for performing the CM activities [SEI SCM Ability 3] [ISO 9001 4.1.2.2] [Bellcore TR-NWT-000179 4.1.3-5] [Trillium].

Planning

6.5.2.6

A CM plan is prepared for each project according to a documented procedure [SEI SCM Activity 1] [ISO 9000-3 6.1.1, 6.1.2, 6.1.3.1, 6.1.3.2] [Bellcore TR-NWT-000179 3.7.3-2 & 3.8-4 & 4.1.3-5 & 4.6-7] [Trillium].

6.5.2.7

A documented and approved CM plan is used as the basis for performing the CM activities [SEI SCM Activity 2] [ISO 9001 4.5.3, 4.8] [ISO 9000-3 6.1.1, 6.1.2, 6.1.3.1, 6.1.3.2] [Bellcore TR-NWT-000179 4.1.3-5] [Trillium].

Repository

6.5.2.8

A CM system is established as a repository for product baselines [SEI SCM Activity 3] [ISO 9000-3 6.1.3.1, 6.1.3.3].

6.5.2.9

The product repository ensures secure storage of configuration items (e.g., code units, design documents) and the secure and controlled retrieval of current and previous versions of configuration items [SEI SCM Activity 4] [Bellcore TR-NWT-000179 3.7.3-2 & 4.1.1-1,2 & 4.1.3-7 & 4.1.4-1,3].

6.5.2.10

The product repository ensures the secure and controlled retrieval of current and previous baselines [Bellcore TR-NWT-000179 4.1.4-1,2,3] [Trillium].

6.5.2.11

The status of configuration items/units is recorded according to a documented procedure [SEI SCM Activity 8] [ISO 9000-3 6.1.3.1, 6.1.3.3] [Bellcore TR-NWT-000179 4.1.3-2,3].

6.5.2.12

The product repository maintains records of the status and change history of all configuration items and baselines [Bellcore TR-NWT-000179 4.1.3-2,3,4] [Trillium].

Traceability

6.5.2.13

There is traceability between design specifications and source code and also between design specifications and integration test cases [ISO 9001 4.8] [ISO 9000-3 6.1.3.1] [Bellcore TR-NWT-000179 3.7.3-2 & 3.8-4 & 4.1.3-4] [Trillium].

Change Control

6.5.2.14

Change requests and problem reports for all configuration items/units are initiated, recorded, reviewed, approved and tracked according to a documented procedure [SEI SCM Activity 5] [ISO 9001 4.5.3] [ISO 9000-3 6.1.1, 6.1.3.3] [Bellcore TR-NWT-000179 4.1.1-1,3 & 4.1.2-1] [IEEE Std. 828 2.3.2].

6.5.2.15

Configuration items and baselines are changed formally according to a documented procedure [SEI SCM Activity 6] [ISO 9001 4.5.3] [ISO 9000-3 6.1] [Bellcore TR-NWT-000179 3.7.3-3 & 4.1.1-1,2,3 & 4.1.2-1] (Ref. IEEE Std. 730 3.4.2.6) (Ref. IEEE Std. 828 & 1052).

Baselines

6.5.2.16

Baseline(s) are created and released formally [SEI SCM Activity 7] [Bellcore TR-NWT-000179 4.1.3-1].

6.5.2.17

Product baseline audits are conducted according to a documented procedure [SEI SCM Activity 10] [Trillium].

Reporting

6.5.2.18

Standard reports documenting the CM activities and the contents of the product baselines are developed and made available to affected groups and individuals [SEI SCM Activity 9] [Trillium].

Level 3

Scope

6.5.3.1

Plans, descriptions, product test procedures, requirements specifications, design specifications, review results and test cases (e.g., integration, system, operation) are under CM control [SEI SPE Activity 10] [ISO 9001 4.11] [Bellcore TR-NWT-000179 3.7.3-1] [Trillium].

6.5.3.2

All development tools are under CM control [Trillium].

Traceability

6.5.3.3

There is full forward and backward traceability between all configuration items (e.g., design specification forward to code units, design specification backward to requirement specification) [Bellcore TR-NWT-000179 3.7.2-7] (Ref. IEEE Std. 1012).

Level 5

Scope

6.5.5.1

The complete development history (e.g., design decisions, design rationale) is captured and maintained under CM control [Roadmap Trillium 6.5.3.1].

Roadmap 6.6: Re-Use

This Roadmap covers practices that are related to reuse. A few practices have been taken from the "Reuse Adoption Guidebook", SPC-92051-CMC, version 02.00.05 November 1993.

Level 2

Cloning

6.6.2.1

Cloning (i.e., copying and modifying) of existing software units in new designs is tracked [Trillium].

6.6.2.2

Tools are provided to aid propagation of changes from one software unit to cloned units or to cloned from units [Trillium].

Third Party Components

6.6.2.3

Third-party components are selected, verified, validated and tracked formally according to a documented procedure [ISO 9000-3 6.8] [Bellcore TR-NWT-000179 4.6-7 & 4.8-1] [Trillium].

Level 3

Process

6.6.3.1

Standard reuse processes are defined and integrated with the organization's standard development process [SPC-92051-CMC PI-1] [Trillium].

6.6.3.2

Performance of the standard reuse processes is measured [SPC-92051-CMC CI-1] [Trillium].

6.6.3.3

Management and staff are aware of new and evolving technologies and standards that may affect their products and reusable assets [SPC-92051-CMC TI-1].

Cloning

6.6.3.4

Pre-developed and certified source code templates are provided in a template repository as a basis for cloning [Trillium].

Component Repository

6.6.3.5

Pre-developed and certified source code units are provided in a software component repository [Trillium].

Component Development

6.6.3.6

A component development function exists to develop, certify and maintain the items in the template and component repository [Trillium].

Component Re-Use

6.6.3.7

Specific steps are included in the organization's standard product development process for the purpose of maximizing component re-use [Trillium].

6.6.3.8

Re-use of pre-developed components is measured, encouraged, and rewarded by the organization's

reward system [Trillium].

Re-Use Across the Product Line

6.6.3.9

Product line reuse strategies are developed to maximize the benefits of reuse over sets of related products [SPC-92051-CMC PD-2].

Level 4

Product Line Re-Use Process

6.6.4.1

Plans are established to systematically address weaknesses identified in the standard reuse processes [SPC-92051-CMC CI-2].

Pre-Developed Designs

6.6.4.2

Pre-developed and certified designs are provided in a software component repository for the use of developers [Trillium].

CASE Tool Support

6.6.4.3

CASE tools are provided to support re-use of software components in product developments [Trillium].

Factoring Re-Use into Product Costing

6.6.4.4

Product costing and funding strategies take into account expected costs and anticipated benefits of reuse over the product line [SPC-92051-CMC CP-3].

Level 5

CASE Tools

6.6.5.1

Knowledge based CASE tools are provided to automate re-use of components in new product developments [Trillium].

Roadmap 6.7: Reliability Management

Level 2

Planning

6.7.2.1

Product and service reliability and maintainability plans and objectives are established [Trillium] [IEC 300].

Availability Criteria

6.7.2.2

Product and system availability criteria are defined during the preparation of the requirements specification. They include but are not limited to failure definition/classification (e.g., critical, major, minor) and operational modes definition (e.g., nonstop, mission-oriented, batch) [Trillium] [IEC 300].

6.7.2.3

Software availability criteria are defined during the preparation of the requirements specification. They include but are not limited to product or system availability during enhancements and upgrades, failures, and the maximum number of failures allowed for the various classes of failure [Trillium].

Data

6.7.2.4

The following data is collected and analyzed prior to product release (Ref. IEEE Std. 982.1 & 982.2):

1. Test Log (Test Execution Time),
2. Failure Log (including failure classification), and
3. Cumulative Execution Time per release.

6.7.2.5

The following field data is collected and analyzed (Ref. IEEE Std. 982.1 & 982.2):

1. Cumulative Execution Time per release.
2. Failure-related down time,
3. Enhancement-related down time.

Level 3

Operational Profile

6.7.3.1

The Operational Profile is determined during the preparation of the requirements specification. The profile includes I/O Classes Definition and I/O Distribution per Class [Trillium].

Design

6.7.3.2

Product design guidelines consistent with reliability objectives are established and enforced [Trillium] [IEC 300].

6.7.3.3

FMECA and Fault Tree Analysis are performed on all critical modules (H/W, S/W) as part of the design activities and are part of the design reviews [Trillium] [IEC 300].

6.7.3.4

Reliability modelling influences the selection of design alternatives for non-software sub-systems, and at system level for software [Trillium] [IEC 300].

Reliability Growth Models

6.7.3.5

Reliability growth models are used for resources and/or schedule estimation using past project parameters (size, initial failure intensity and intensity decay parameters). These models are continually updated [Trillium].

6.7.3.6

Field reliability estimation is based on the determination of the testing acceleration factor and the reliability growth model [Trillium].

Level 4

Reliability Modeling

6.7.4.1

Reliability modelling influences software design alternative selection from both static code properties and dynamic code behavior data (in-line with re-use philosophy) i.e., Reliability Block Diagram, Markov modelling, Fault Tree Analysis, Strength-Stress Analysis, Stochastic Petri-Net Modelling [Trillium] [IEC 300].


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Trillium Capability Areas, Roadmaps and Practices
Capability Area 7: Development Environment

This Capability Area is a single Roadmap. It deals with the working environment and tools provided for software development staff.

Roadmap 7.1: Development Environment

Level 2

Work Environment

7.1.2.1

Software developers are provided with an ergonomically designed, acceptably noise-free work environment [Trillium].

7.1.2.2

Adequate meeting rooms are provided for meetings associated with development activities [Trillium].

Computing Resources

7.1.2.3

Every software developer has a computer terminal or personal workstation with adequate performance and resources to perform their job functions [Bellcore TR-NWT-000179 4.6-4] [Trillium].

7.1.2.4

Coding, design testing and debugging is supported by an integrated, rapid turn around edit-compile-debug environment [Trillium].

Level 3

Computing Resources

7.1.3.1

Every software developer has a graphical workstation [Bellcore TR-NWT-000179 4.6-4] [Trillium].

Cooperative Development Support

7.1.3.2

All developer's workstations are networked, and software supporting cooperative development is provided [Bellcore TR-NWT-000179 4.6-4,5] [Trillium].

Repository Access

7.1.3.3

All configuration items stored in the repository can be accessed from a developer's workstation with appropriate security clearance [Bellcore TR-NWT-000179 4.6-5] [Trillium].

Test Bed Access

7.1.3.4

Most software testing can be performed at the developer's workstation, through emulation or through network connection to the target system [Trillium].

CASE Environment

7.1.3.5

State-of-the-practice software development tools (e.g., CASE tools) and methods are provided to support all development phases [SEI SPE Activity 1].

7.1.3.6

The support tools used by the different engineering and support groups are compatible to enable effective communication and coordination [SEI IC Ability 2].

Level 4

CASE Environment

7.1.4.1

A tool framework (e.g., PCTE) is used to integrate all development tools and ensure the usage of the proper tool at the proper step in the product development process [Trillium].

Level 5

CASE Tools

7.1.5.1

Knowledge-based tools are used in the product development process [Trillium].

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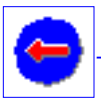 Back to capability area 6.

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Trillium Capability Areas, Roadmaps and Practices
Capability Area 8: Customer Support

The following 6 Roadmaps comprise this Capability Area:

- Problem Response System,
- Usability Engineering,
- Life-Cycle Cost Modelling,
- User Documentation,
- Customer Engineering, and
- User Training.

They primarily deal with processes and procedures that affect the end customer of the product. In so doing, they also address the interfaces with groups not generally considered performing core product development work, such as Marketing, Customer Support, Documentation and Training.

Roadmap 8.1: Problem Response System

Level 2

Customer Interface

8.1.2.1

There is a single point of contact to provide direct assistance to customers [ISO 9000-3 5.10.4] [Bellcore TR-NWT-000179 3.4.1-3 & 4.10.1-2,3,4,5].

Function

8.1.2.2

There is a customer support function to help analyze and solve customer's problems and analyze the performance of the product [Bellcore TR-NWT-000179 3.4.1-3 & 3.10.3-3 & 4.10.1-1 & 4.10.2-1].

Process

8.1.2.3

The organization utilizes a formally documented delivery and installation procedure [ISO 9000-3 5.9.3] [Bellcore TR-NWT-000179 3.7.4-4,5 & 3.10.3-3] [Trillium].

Planning

8.1.2.4

The organization utilizes a comprehensive, formally documented maintenance plan for the product [ISO 9000-3 5.10] [Bellcore TR-NWT-000179 3.10.1-1& 3.10.2-1] [Trillium].

Customer Reports

8.1.2.5

Customer reports (e.g., failures, changes) are captured and tracked according to a documented procedure [ISO 9001 4.19] [Bellcore TR-NWT-000179 3.7.4-4,5 & 3.10.2-5& 4.10.2-6] [Trillium].

8.1.2.6

Every customer report is acknowledged in a timely manner, according to a documented procedure [ISO 9001 4.19] [Bellcore TR-NWT-000179 4.10.2-2,3] [Trillium].

8.1.2.7

Customers are regularly apprised of progress on open customer reports, according to a documented procedure [ISO 9001 4.19] [Bellcore TR-NWT-000179 4.10.2-2,3,5,8] [Trillium].

Problem Fix Dissemination

8.1.2.8

A problem fix is formally disseminated to the user(s) who encountered the problem and also to other user(s) who could be affected by this problem in the future according to a documented procedure [ISO 9001 4.19] [Bellcore TR-NWT-000179 3.9.1-7,8 & 3.10.2-2,5 & 4.10.2-4,5,6,7,9].

Change Confirmation

8.1.2.9

The organization verifies that appropriate changes (including patches) are installed in all delivered versions of the product in a timely manner [Bellcore TR-NWT-000179 3.7.1-5 & 3.9.1-7,8 & 4.10.2-5,9 & 4.10.3-1] [Trillium].

Level 3

Process

8.1.3.1

The problem response process is integrated with the process improvement process [Bellcore TR-NWT-000179 3.10.3-2 & 4.10.2-4] [MB 2.3 & 7.2f] [Trillium].

Customer Reports

8.1.3.2

Customer reports (e.g., failures, changes) are captured and tracked formally in an organizational repository according to a documented procedure [Bellcore TR-NWT-000179 3.10.3-2 & 4.10.2-4,6,7] [Trillium].

Patching Policy

8.1.3.3

The organization has a policy that guides the decision to solve problems by patching, including development procedures, propagation (backward and forward) and resolution [Bellcore TR-NWT-000179 3.4.2-5 & 3.7.1-5 & 3.10.2-4 & 3.10.3-1,4 & 4.10.2-5].

Roadmap 8.2: Usability Engineering

Level 2

Product Benchmarking

8.2.2.1

Existing competing products are assessed [MB 2.2] [Trillium].

Customer Site Visits

8.2.2.2

Customer/user locations are visited by designers before initiation of design [Trillium].

User Involvement

8.2.2.3

Users are involved in the design process [Trillium].

Human-Machine Interface

8.2.2.4

The design of the Human-Machine Interface (e.g., screens, messages) is formally coordinated with the user according to a documented procedure [Trillium].

Level 3

Product Benchmarking

8.2.3.1

Comparative analysis of competing products is performed at appropriate points in the product life-cycle [MB 2.2] [Trillium].

User Work Flow Analysis

8.2.3.2

User's work flow and work habits are analyzed to ensure that the final product integrates well with the user's work flow [Trillium].

8.2.3.3

Users are visited to determine how the system is used [Trillium].

8.2.3.4

User actions on the system are logged [Trillium].

Measurements

8.2.3.5

Measurable levels are specified for important usability goals [Trillium].

Usability Parameters

8.2.3.6

Explicit priorities between usability parameters are set [Trillium].

Human-Machine Interface

8.2.3.7

All user interfaces (e.g., HMI, documentation, training) are formally coordinated with the user according to a documented procedure [Trillium].

8.2.3.8

Prototyping is used to help develop all user interfaces [Trillium].

8.2.3.9

User interfaces are empirically tested with real users before operational testing [Trillium].

8.2.3.10

Direct feedback from the users to the user interface developers is done formally [Trillium].

Level 4

User Needs Evolution

8.2.4.1

Evolution of user needs and abilities is projected [Trillium].

Design Rationale

8.2.4.2

The rationale for the user interface design is explicitly documented [Trillium].

Roadmap 8.3: Life-Cycle Cost Modelling

Level 2

Cost Models

8.3.2.1

Cost models are developed that include the following costs elements: product development, customer support and warranty, and future product enhancements [Trillium].

Level 3

Cost Models

8.3.3.1

The cost model includes customer operational costs, customer obsolescence costs as well as product downtime impact [Trillium].

Life-Cycle Cost Analysis

8.3.3.2

The Life-Cycle Cost (LCC) analysis is performed during the development of the requirements specification then updated during subsequent development activities [Trillium].

8.3.3.3

LCC considerations are used as input for product specification, design implementation, and release to the customer [Trillium].

Level 4

Life-Cycle Cost Models

8.3.4.1

Analytical models are used for life-cycle costs models [Trillium].

Roadmap 8.4: User Documentation

Level 2

Process

8.4.2.1

User documentation is developed according to a documented procedure [Bellcore TR-NWT-000179 4.2-1] (Ref. IEEE Std. 1063) [Trillium].

Level 3

Process

8.4.3.1

User documentation is developed formally [Bellcore TR-NWT-000179 4.2-1] (Ref. IEEE Std. 1063) [Trillium].

Concurrent Engineering

8.4.3.2

User documentation is developed in parallel with the product development [Trillium].

Prototype

8.4.3.3

A prototype of the user documentation is made available to product designers to assist them in their design work [Trillium].

Testing

8.4.3.4

User documentation is tested during system testing [Trillium].

8.4.3.5

User documentation is tested by the user during acceptance testing [Trillium].

Features

8.4.3.6

Where applicable, the product includes an on-line help facility [Bellcore TR-NWT-000179 4.10.3-2] [Trillium].

8.4.3.7

Where applicable, all the user documentation is available on-line [Bellcore TR-NWT-000179 4.10.3-2] [Trillium].

Level 4

Features

8.4.4.1

Where applicable, the product includes a context-sensitive help facility [Trillium].

8.4.4.2

Where applicable, all the user documentation is customized to satisfy specific customer needs [Trillium].

Roadmap 8.5: Customer Engineering

Level 2

Release Schedule

8.5.2.1

Customers are provided with product introduction and enhancement release schedules [ISO 9000-3 5.10.7] [Bellcore TR-NWT-000179 3.9.1-3,4].

Fixed and Residual Problems

8.5.2.2

Customers are provided with a description of problems fixed in the release and known problems remaining [Bellcore TR-NWT-000179 3.4.2-3 & 3.9.1-7,8,9 & 3.9.4-5 & 3.10.3-3 & 4.10.3-1].

Features

8.5.2.3

Customers are provided with a complete list and detailed description of features of new product releases, including their effect on operations [Bellcore TR-NWT-000179 3.4.2-3 & 3.10.2-1 & 4.10.3-1,2].

Order Processing

8.5.2.4

Customer orders are processed according to a documented procedure [ISO 9000-3 5.9.1] [Bellcore TR-NWT-000179 3.9.1-1].

Manufacturing, Delivering, Installation and Maintenance Processes

8.5.2.5

Products are manufactured, delivered, installed and maintained according to a documented procedure [ISO 9001 4.15] [ISO 9000-3 5.8, 5.9 & 5.10] [Bellcore TR-NWT-000179 3.7.5-1 & 3.9.1-9 & 3.9.4-1,2,3,4 & 3.9.5-1,2,3& 3.10.1-1].

8.5.2.6

Coordination of the installation, site-testing, and maintenance of the product with the user is done according to a documented procedure [ISO 9001 4.11, 4.15] [Bellcore TR-NWT-000179 3.7.4-3,4,5 & 3.7.5-1 & 3.7.6-1,3,4 & 3.9.1-2 & 4.10.3-4].

8.5.2.7

Procedures for the installation of software changes (including installation documentation) are designed to minimize disruption of the day-to-day operation of the system at the customer's site [ISO 9001 4.10.4, 4.10.5, 4.15] [ISO 9000-3 5.8, 5.9 & 5.10] [Bellcore TR-NWT-000179 3.7.6-2 & 3.9.1-2].

Customer Information

8.5.2.8

There is a repository to store and update customer specific information [ISO 9000-3 5.10.4] [Bellcore TR-NWT-000179 3.9.1-3,4,6 & 3.9.2-3 & 3.9.4-5 & 4.10.3-2].

Level 3

Order Processing

8.5.3.1

Orders are processed formally according to a documented procedure [ISO 9000-3 5.10.7] [Bellcore

TR-NWT-000179 3.9.2-1,2 & 3.9.3-1].

Customization

8.5.3.2

Any product customization is done formally, including the storage and maintenance of customer-specific information [ISO 9000-3 5.10.3] [Bellcore TR-NWT-000179 3.9.1-5 & 3.9.3-1].

Installation Process

8.5.3.3

Procedures for installation and on-site testing are developed according to a documented procedure. The procedures describe the supplier and customer personnel involved during installation and testing [ISO 9001 4.10.4, 4.10.5] [ISO 9000-3 5.9.3, 5.10.3] [Bellcore TR-NWT-000179 3.9.5-1,2,3].

Customer Familiarization

8.5.3.4

Customers are introduced to new products formally according to a documented procedure [ISO 9000-3 5.10.3] [Bellcore TR-NWT-000179 3.9.1-3] [Trillium].

Customer Impact

8.5.3.5

The system is designed to ensure minimal disruption of day-to-day operation [Bellcore TR-NWT-000179 3.9.1-4 & 3.10.2-3 & 3.10.3-3] [Trillium].

Roadmap 8.6: User Training

Level 2

Training Material Development

8.6.2.1

The development of training material is done according to a documented procedure [Trillium].

Training Material V&V

8.6.2.2

The training material is verified and validated according to a documented procedure [Trillium].

Level 3

8.6.3.1

There are explicit product design attributes aimed at reducing the training time for the users (e.g, product/service operators, end users) [Trillium].

Training Material V&V

8.6.3.2

The training material is verified and validated formally [Trillium].

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Appendix 1: List of Abbreviations

4GL	Fourth Generation Language
ASQC	American Society for Quality Control
CASE	Computer Aided Software/System Engineering
CI	Continuous Improvement
CM	Configuration Management
CMM	Capability Maturity Model
COCOMO	Constructive Cost Model
DP	Defect Prevention
ERD	Entity Relationship Diagram
FMECA	Failure Mode and Effect Criticality Analysis
FSM	Finite State Machine
GPC	General Purpose Computer
HLL	High Level Language
HMI	Human Machine Interface
H/W	Hardware
IC	Intergroup Coordination
ISM	Integrated Software Management
KLOC	Thousands of lines of source code
LCC	Life-Cycle Cost
MIS	Management Information System
MLOC	Millions of lines of source code
NE	Network Element
OO	Object Oriented
OOA	Object Oriented Analysis
OOD	Object Oriented Design
OPD	Organization Process Definition
OPF	Organization Process Focus
OS	Operating System
OSS	Operations Support System
PCM	Process Change Management
PCTE	Portable Common Tool Environment
PM&A	Process Measurement & Analysis
PR	Peer Review
PROM	Programmable Read-Only Memory
QAI	Quality Assurance Institute
QC	Quality Control
QE	Quality Engineering
QPM	Quantitative Process Management
RM	Requirements Management
SA/SD	Structured Analysis / Structured Design
SCM	Software Configuration Management

SDL	Specification Design Language
SEI	Software Engineering Institute
SPE	Software Product Engineering
SPP	Software Project Planning
SPT&O	Software Project Tracking & Oversight
SQA	Software Quality Assurance
SQM	Software Quality Management
SSM	Software Subcontract Management
S/W	Software
TCM	Technology Change Management
TI	Technology Information
V&V	Verification & Validation

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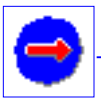 Forward to appendix 2.

Appendix 2: Glossary

Acceptance Testing	Formal testing conducted to determine whether or not a system satisfies its acceptance criteria and to enable the customer to determine whether or not to accept the system (IEEE 610:1991)
Analytical Model	A formal model based on the use of mathematical equations
Baseline	A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development, and that can be changed only through formal change control procedures (IEEE 610:1991)
Capability Evaluation	The process of comparing the capability of an organization with a set of criteria...in order to identify, analyze and quantify strengths, weaknesses and particularly, risks. Capability evaluation has a major use in procurement in the selection of suppliers, but it also has a use internally within an organization (ISO/IEC JTC1 SC7 N944R).
Certification	The act of having your quality system assessed by an independent, accredited third-party for the purpose of confirming its conformance to a series of standards and attesting to it in writing (ISO)
Causal Analysis	The process of studying the symptoms of a problem and determining their cause(s)
Co-Engineering	The engineering and management activities, techniques and processes that facilitate the co-development of subsystems of a different nature e.g., electronic hardware, mechanical hardware, silicon, software, user documentation, and training material
Component	One of the parts that make up a system; a component may be hardware or software and may be subdivided into other components (IEEE 610:1991)
Concurrent Engineering	The engineering and management activities, techniques and processes that minimize the development time and schedule (cycle-time) of a product; this is achieved through an optimization of the concurrency in the performance of product development tasks (e.g. specifications, design, code), and minimization of inter-organizational/functional

communication	through multifunctional teams.
Configuration Item	An entity within a configuration that satisfies an end use function and that can be uniquely identified at a given reference point (ISO/IEC JTC1/SC7 Vocabulary, 1993)
Contractual Information	All items having to do with the contract, e.g., the requirements, warranties, return procedures and purchase orders, as well as the contract itself
Customer Support/Partnership	Helping analyze and solve customer\qs problems and analyzing the performance of the product
Development	All activities performed to create/enhance a product
Development Environment	The tools and methods directly involved in the development of a product, as well as the office and laboratory working environments
Documentation	Any written or pictorial information describing, defining, specifying, reporting, or certifying activities, requirements, procedures or results
Engineering Technical Activities	Any required tasks in support of the development effort
Fault	The state of an item characterized by its inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external sources (Mellor:1993)
Failure Mode and Effect Criticality Analysis (FMECA)	A qualitative method of reliability analysis which involves a fault modes and effects analysis, together with a consideration of the probability of their occurrence and a ranking of the seriousness of the faults (Mellor:1993)
Fault Tree Analysis	An analysis to determine which fault modes of the sub-items or external events, or combinations thereof, may result in a stated fault mode of the item, presented in the form of a fault tree (Mellor:1993)
Formal Notation	The use of structured formatting within product development documentation, e.g., design documents
Formal Review	A formal meeting at which a product or document is presented to the user, customer, or other interested parties for comment and approval; it can be a review of the management and technical progress of the hardware/software development project
Function	1 : In management, a major activity or group of activities that are continuous. For example, the principle functions of management are:

	planning, organizing, staffing, directing, and controlling 2 : In project management: an activity or set of activities that span the entire duration of a software project. Examples of project functions include configuration management, quality assurance, and project cost accounting 3 : In programming: a specific, identifiable task performed by one or more software components
Groupware	Software supporting cooperative development
Intermediate Product	An item which is produced during some phase of the software development process, and is an input product to a later phase, but is not provided to the user; examples of intermediate products are requirements specification, design specification, and test report (Mellor:1993).
Item	Any part, component, device, subsystem, functional unit, equipment or system that can be individually considered; an item may consist of hardware, software or both, and may also in particular cases, include people (Mellor:1993)
I/O Class	Input/Output (I/O) access to/from a computer-based system is often provided to a range of different I/O devices, having different speeds (e.g. 300 baud, 9600 baud, T1), supporting different character sets or protocols (e.g., ASCII, EBCDIC, asynchronous, Facsimile, SONET), or differing in other characteristics (e.g., line-oriented vs. screen-oriented display, TrueType and PostScript character and page description languages). Devices are thus classed by systems to which they are connected, according to such distinguishing features. This simplifies the implementation of the device driving software.
I/O Distribution	Input/Output (I/O) access to/from a computer-based system is often controlled by that system by spreading the load across various components or subsystems, such as controllers, or communications lines. I/O is also often handled according to characteristics of the various I/O devices. These classifications (I/O Classes) and load sharing activities provide techniques for distributing the I/O load to/from the computer-

	based system.
Life-Cycle Cost	The overall cost of a product, from the time it was conceived to the time it was no longer available for use
Markov Modelling	A discrete, stochastic model in which the probability that the model is in a given state at a certain time depends only on the value of the immediately preceding state (IEEE 610:1991).
Organization	A company, corporation, firm, enterprise or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration (ISO 8402:1991)
	In the Trillium context, an assessment is generally applied to a complete organization, or part thereof, that is responsible for the development of a specific product.
Operational Profile	Consists of the function environmental conditions and probability of executing the function in a given condition for a new product development
Operational Testing	Generic term which means either beta testing, field trial or VO (verification office) testing
Prime Contractor	An individual, partnership, corporation, or association that administers a subcontract to design, develop, and/or manufacture, one or more products.
Process	A set of interrelated resources and activities which transform inputs into outputs; resources may include personnel, facilities, equipment, technology and methodology (ISO 8402:1991).
Process Assessment	The disciplined examination of the processes used by an organization to determine the capability of those processes to perform within quality, costs and schedule goals; the aim is to characterize current practices, identifying strengths and weaknesses and the ability of the process to control or avoid significant causes of poor quality, cost and schedule performance (ISO/IEC JTC1 SC7 N944R)
Process Assets	Process-related documentation previously developed by projects in the organization
Process Performance	A calculated measurement of the efficiency of a process
Process Repository	A library of documented processes
Product	The result of activities or processes. A product may include service, hardware, processed materials, software, or combination

thereof (ISO 8402:1991)	
	In the Trillium context, the customer perceives the product as a black box entity provided by the supplier. The customer sees only the interfaces which provide access to the product operation. Gen erally the customer has no view of the internal components inside the black box.
Proof of Correctness	The construction of a mathematical proof that an output product of a given phase is a correct implementation of an input product; this requires that the input product be written in a formal language, employing mathematical set theoretic notation to describe each required function, and defining its preconditions and postconditions (Mellor:1991).
Quality Management	All activities of the overall management function that determine the quality policy, objectives and responsibilities and implement them by means such as quality planning, quality control, quality assurance and quality improvement, within the quality system. Quality management is the responsibility of all levels of management but must be driven by top management and its implementation involves all members of the organization.
Quality Function Deployment	An overall concept that provides a means of translating customer requirements into the appropriate technical requirements for each stage of product development and production
Reliability Block Diagram	A graphically represented mathematical model of the system based on the functions and interfaces of the hardware at all levels
Reliability Engineering	Collection of tools used to determine the probability that a system or component will operate without failure for a specified period of time in a specific environment
Reliability Growth Model	Graphical or pictorial representation of predicted reliability
Requirements (ISO 2382-20:1991)	An essential set of conditions that a system has to satisfy
Software documentation,	A set of programs, associated data, procedures, rules, and materials concerned with the development, use,

operation, and maintenance of a computer system (CSA Q396:1989) In the Trillium context, this includes firmware regardless of its final manufactured form (e.g., PROM, Gate Array).	
Specification	A document that specifies, in a complete, precise, verifiable manner, the requirements, design, behavior, or other characteristics of a service, product, system or component, and, often, the procedures for determining whether these provisions have been satisfied (IEEE 610:1991)
Stochastic	Pertaining to a process, model, or variable whose outcome, result, or value depends on chance (IEEE 610:1991)
Stochastic Petri-net	A model used to represent systems with concurrency or parallelism, extended for performance analysis with time as a random variable
Strength-Stress Analysis	The evaluation of a product based on the strength of the parts versus expected stress placed on the respective parts of the product
System	A collection of components organized to accomplish a specific function or set of functions (IEEE 610:1991)
Systems Engineering	The application of the mathematical and physical sciences to develop systems that utilize economically the materials and forces of nature for the benefit of mankind
System Failure	The event of an item not providing its full required service. A failure is an event in time. A fault is a state of the system. A failure may be due to physical failure of a hardware component, to activation of a latent design fault, or to an external failure. Following a failure, an item may recover and resume its required service after a break, partially recover and continue to provide some of its required functions (fail degraded) or it may remain down (complete failure) until repaired (Mellor:1993).
System Testing	Testing software under conditions that simulate, to the extent possible, typical installation environments
Target Computer Resources	Same as target machine(software): the computer on which a program is intended to execute (IEEE 610:1991)
Testing Acceleration Factor	Incremental value of environmental stress to show product weakness in the shortest time period
Testing Compression	The ratio of execution time required in the operational phase to execution

Factor	time required in the test phase to cover all the possible input states of a program
Traceability	The ability to trace the history, application or location of an entity (e.g., product, activity, process, organization, person) by means of recorded identifications
Usability Engineering	The engineering and management activities, techniques and processes that optimizes the usability of a product (e.g., minimization of user training, minimization of potential operator errors, optimization of time needed to perform the most used functions)
User (end user)	The individual or group who will use the system for its intended operational use when it is deployed in its environment (SEI)
Validation	The process of evaluating a system or components during or at the end of the development process to determine whether it satisfies specified requirements (IEEE 610:1991)
Verification	The process of determining whether or not the product(s) of a given phase of the software development cycle fulfils the requirements established during the previous phase (IEEE 610:1991)
Verification & Validation	The process of determining whether the requirements for a system or component are complete and correct, the products of each development phase fulfil the requirements or conditions imposed by the previous phase, and the final system or component complies with the specified requirements (IEEE 610:1991)


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Appendix 4: Bibliography

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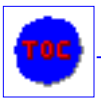

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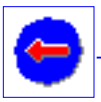
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