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Software Validation and Verification Practices in CMMI Levels

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Abstract—Validation and verification are mandatory activities that software companies must perform when developing software products with a high degree of quality. Currently, more companies become aware that adopting CMMI (the software process maturity model developed by the Software Engineering Institute) can be a way to develop quality software. However, some companies are resistant to adopt CMMI maturity level 2 because they do not considerer this maturity level a benefit since its implementation is expensive and does not cover the validation and verification efforts.

I. INTRODUCTION

Capability Maturity Model Integration (CMMI) is a process improvement approach that provides organizations with the essential elements of effective processes that ultimately improve their performance. CMMI can be used to guide process improvement across a project, a division, or an entire organization

CMMI in software engineering and organizational development is a trademarked process improvement approach that provides organizations with the essential elements for effective process improvement. It can be used to guide process improvement across a project, a division, or an entire organization

CMMI (Capability Maturity Model Integration) is a software development standard from the Software Engineering Institute (SEI). CMMI is composed by a set of software development process guidelines and is used to improve the quality of the software and its delivery. Using CMMI, SEI addresses practices that companies can use as a guideline for process improvement. It can be seen as a collection of best practices that could be followed to improve the quality of products.

CMMI was developed by the CMMI project, which aimed to improve the usability of maturity models by integrating many different models into one framework. The project consisted of members of industry, government and the Carnegie Mellon Software Engineering Institute (SEI). The main sponsors included the Office of the Secretary of Defense (OSD) and the National Defense Industrial Association.

CMMI is the successor of the capability maturity model (CMM) or software CMM. The CMM was developed from 1987 until 1997. In 2002, CMMI Version 1.1 was released. Version 1.2 followed in August 2006.

However, there are organizations that do not adopt CMMI -- in particular the Maturity Level 2 -- and the main reasons they give is that: the company is small, the cost to implement CMMI is high, they use another Software Process Improvement (SPI) and they not see a clear benefit in using it. Several companies do not want do adopt exclusively CMMI Maturity Level 2 because they are mainly interested in the Engineering processes, which is not the focus of this Maturity Level . Since Maturity Level 2 Process Areas are mainly focused in the project management and support processes, most companies tend to consider that the implementation of Maturity Level 2 does not bring significant benefits to compensate the corresponding cost and time overheads. Companies recognize benefits only in the implementation of Process Areas of Maturity Level 3. The software testing - Validation and Verification - V&V- phase is one of the most important in the software development life cycle of many projects. Companies are becoming more aware of the important role that V&V plays in the production of high quality software

II. IMPORTANCE OF V&V

V&V are very important for companies that develop large scale software products due to the size of the solutions. So, those companies have to demonstrate that the product or product components accomplish its intended use when placed in its intended environment, as well as ensuring that selected work products meet their specified requirements.

Companies that develop software at a large scale become aware that implementing CMMI can be a good choice for developing and delivering software with a high degree of quality. But if a company that is applying for CMMI Level 2 assessment must take into consideration that the validation and verification efforts are not considered for that level. This level of maturity is only concerned if an organization ensures that in their projects the requirements are managed and their processes are planned, performed, measured, and controlled. Therefore, it is important for those companies to have the possibility of simultaneously

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implementing CMMI Level 2 and the V&V Process Areas.

We can find the definitions of validation and of verification. Validation is "the process of evaluating a system or component during or at the end of the development process to determine whether it satisfies specified requirements" and verification is "the process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase". However, validation and verification have also a common definition: "the process of determining whether the requirements for a system or component are complete and correct, the products of each development phase fulfill the requirements or conditions imposed by the previous phase, and the final system or component complies with specified requirements". The difference between the validation and verification can be explained by looking at the purpose of the tests performed. The use of prototypes to test if requirements can be addressed is an example of a verification practice, but if the prototype is evaluated by the users to test if the product fulfils their needs we are on the presence of an example of a validation practice. The main goal that leads to this division of the software test within CMMI in two practices was that separating it in two different processes was a way to emphasize both practices CMMI currently addresses three areas of interest: (1) Product and service development — CMMI for Development (CMMI-DEV), (2) Service establishment, management, and delivery — CMMI for Services (CMMI-SVC), and (3) Product and service acquisition — CMMI for Acquisition (CMMI-ACQ). CMMI models CMMI best practices are published in documents called models, each of which addresses a different area of interest. The current release of CMMI, version 1.2, provides models for three areas of interest: development, acquisition, and services.

CMMI for Development (CMMI-DEV), v1.2 was released in August 2006. It addresses product and service development processes.

CMMI for Acquisition (CMMI-ACQ), v1.2 was released in November 2007. It addresses supply chain management, acquisition, and outsourcing processes in government and industry.

- CMMI for Services (CMMI-SVC), v1.2 was released in February 2009. It addresses guidance for delivering services within an organization and to external customers.
- CMMI Product Suite (includes Development, Acquisition, and Services), v1.3 is expected to be released in 2010. CMMI Version 1.3— Plans for the Next Version

A. Appraisal

An organization cannot be certified in CMMI; instead, an organization is *appraised*. Depending on the type of appraisal, the organization can be awarded a maturity level rating (1-5) or a capability level achievement profile.

Many organizations find value in measuring their progress by conducting an appraisal. Appraisals are typically conducted for one or more of the following reasons:

- To determine how well the organization's processes compare to CMMI best practices, and to identify areas where improvement can be made
- To inform external customers and suppliers of how well the organization's processes compare to CMMI best practices
- To meet the contractual requirements of one or more customers

Appraisals of organizations using a CMMI model must conform to the requirements defined in the Appraisal Requirements for CMMI (ARC) document. There are three classes of appraisals, A, B and C, which focus on identifying improvement opportunities and comparing the organization's processes to CMMI best practices. Appraisal teams use a CMMI model and ARC-conformant appraisal method to guide their evaluation of the organization and their reporting of conclusions. The appraisal results can then be used (e.g., by a process group) to plan improvements for the organization.

The benefits you can expect from using CMMI include the following:

- Your organization's activities are explicitly linked to your business objectives.
- Your visibility into the organization's activities is increased to help you ensure product is as per
- Expectation service meets the customer's expectations.
- You learn from new areas of best practice (e.g., measurement, risk)

B. Goals and Practices

There are two categories of goals and practices: generic and specific. Specific goals and practices are specific to a process area. Generic goals and practices are a part of every process area. A process area is satisfied when organizational processes cover all of the generic and specific goals and practices for that process area.

III. INTRODUCTION TO CMMI V1.2

A. Process Areas

CMMI for Development, Version 1.2 contains 22 process areas indicating the aspects of product and service development that are to be covered by organizational processes.

- Configuration Management (CM)

A Support process area at Maturity Level 2

Purpose

The purpose of **Configuration Management** (CM) is to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

- Decision Analysis and Resolution (DAR)
- A Support process area at Maturity Level 3

Purpose

The purpose of **Decision Analysis and Resolution** (DAR) is to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.

- Organizational Innovation and Deployment (OID)

A Process Management process area at Maturity Level 5

Purpose

The purpose of Organizational Innovation and Deployment (OID) is to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process-performance objectives as derived from the organization's business objectives.

- Verification (VER)

An Engineering process area at Maturity Level 3

Purpose

The purpose of Verification (VER) is to ensure that selected work products meet their specified requirements.

Specific Practices by Goal

- SG 1 Prepare for Verification
  - SP 1.1 Select Work Products for Verification
  - SP 1.2 Establish the Verification Environment
  - SP 1.3 Establish Verification Procedures and Criteria
- SG 2 Perform Peer Reviews
  - SP 2.1 Prepare for Peer Reviews
  - SP 2.2 Conduct Peer Reviews
  - SP 2.3 Analyze Peer Review Data
- SG 3 Verify Selected Work Products
  - SP 3.1 Perform Verification
  - SP 3.2 Analyze Verification Results

IV. UPCOMING CMMI VERSION 1.3

It is a release of CMMI models, appraisal method, and training for three areas of interest:

- Product and service development (CMMI for Development) • Service establishment, management, and delivery (CMMI for Serviceshttp://www.sei.cmu.edu/cmmi/tools/svc/)
- Product and service acquisition (CMMI for Acquisition)

CMMI Version 1.3 is the most recent release of CMMI to the public. It is planned for public release on November 1, 2010. This release is special because it updates all three CMMI models (CMMI for Development, CMMI for Services, and CMMI for Acquisition) to make them consistent and to improve their high maturity practices.

A. High Maturity Clarifications

The CMMI Product Development Team has formed a High Maturity Team. This team's members are focusing on improvements to high maturity practices in all three CMMI models to ensure that they are representative of current best practices in the community. This team's work focuses on the four high maturity process areas: Organizational Process Performance (OPP), Quantitative Project Management (QPM), Causal Analysis and Resolution (CAR), and Organizational Innovation and Deployment (OID).

B. Translations

CMMI models are now available in Japanese, Traditional Chinese, Spanish, German, and French. The teams that created these translations have requested that we improve the models' ease of translation. During the development of CMMI Version 1.3, a team with representation from these translation teams is working with the model development team to make model translation easier.

Benefits

The benefits you can expect from using CMMI include the following:

- Your organization's activities are explicitly linked to your business objectives.
- Your visibility into the organization's activities is increased to help you ensure that your product or service meets the customer's expectations.
- You learn from new areas of best practice (e.g., measurement, risk)

CMMI is being adopted worldwide, including North America, Europe, Asia, Australia, South America, and Africa. This kind of response has substantiated the SEI's commitment to CMMI
V1.3 will focus on, but not be limited to:

- High maturity
- More effective GPs
- Appraisal efficiency

All changes to the CMMI Product Suite [i.e., model(s), training materials, and appraisal method] must meet the following primary criteria, which will likely be of the following nature:

- Correct identified model, training material, or appraisal method defects or provide enhancements.

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- Incorporate amplifications and clarifications as needed.
- Accommodate potential additions to model coverage (e.g., safety, security, and life cycle) only by specific direction of the CMMI Steering Group.
- Decrease overall model size in V1.3 if possible; increases, if any, must not be greater than absolutely necessary.
- Model and method changes should avoid adversely impacting the legacy investment of adopting companies and organizations.
- Changes to model architecture will only be incorporated with specific CMMI Steering Group authorization.
- Changes may only be initiated by Change Requests or the CMMI Steering Group.

V. CONCLUSION

V&V activities are used to prove if the product fulfils its intended needs and if the product reflects the requirements captured for the product. Companies become aware that CMMI can be helpful to develop and deliver software with a high degree of quality. But at the same time, some found that CMMI only suggests the adoption of V&V efforts when CMMI ML3, or higher, is considered. CMMI ML2 is only concerned if an organization ensures that, in their software development projects, the requirements are managed and that their processes are planned, performed, measured, and controlled. A company that is assessed with this level and needs to perform software test to guarantee the quality of the products cannot be guided in this task by CMMI in the staged representation.

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