

# Analysis of Software Capability Maturity Model (CMM)

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**Abstract**—CMM software process management and control systems approach, which provides software process improvement guidelines for software process assessment provides a basis. In this paper, the CMM concept and the overall framework in detail, the last of the CMM the problems outlined.

**Key words**—Capability Maturity Model; Maturity Level; Key Process Areas

## I. Introduction

The 21st century is the era of information industry, computer software will be omnipresent to penetrate into all aspects of the economic and social life, the software industry has become one of the hallmarks of measuring a country's comprehensive national strength.

Software development process, new development methods and techniques used did not make the software productivity and production quality to be effective to improve. The fundamental problem of the "software crisis" is not whether the use of new technologies, but rather the software process management. To form a complete set of mature software process, software development on the right track, in order to ensure customer satisfaction of products within an agreed period at a fixed cost to produce.

The U.S. Carnegie the Mellon University Software Engineering Institute (CMU / SEI) Software Capability Maturity Model (Capability Maturity Model, CMM) Software Process Improvement Software Process Assessment, an effective guiding framework. It can guide software organizations on how to control the development and maintenance of software products, how to mature software engineering system evolution and the formation of a virtuous cycle of management culture, therefore, CMM has become the focus of attention in the current software industry.

## II. CMM Overview

### A Software Capability Maturity Model (CMM)

SEI CMM under the definition of: For software organizations in the definition, implementation, measurement, control and improve the description of the various stages of development in the process of the software process, this model is easy to determine the capacity of the existing process of the software organization and find out the most critical issues of software quality and process to improve aspects of, so as to select process improvement strategies to provide guidance. A software development organization's software capability maturity is its definition and use of various software process maturity of a measure, which indicates the organization's software process is clear and effectively define, manage, measure and control the

degree. Maturity Model (CMM) is based on this concept of capacity available for user evaluation software development organization's software process capability can also be specified in the direction of its process improvement efforts. With the improvement of the software organization's software process maturity, development organizations through its principles, standards and organizations to institutionalize Software Process.

Experience has shown that only through the establishment of an organization-

wide software process, the use of rigorous software engineering and management, and make unremitting efforts to put into practice in order to achieve the continuous improvement of the organization-wide software process capability.

### B CMM uses

(1)Software process improvement (Software Process Improvement, SPI), to help software companies plan development and implementation of software process change.

(2)Software Process Assessment (Software Process Assessment, SPA), through the identification of process maturity to organize the current selection process improvement strategies, recognition of minorities on the most critical issues for software quality and process improvement, by focusing on and accomplish these limited activities, software, organizations can steadily improve its software process, software process capacity growth continued.

(3)Software Capability Evaluation (Software Capability Evaluation, SCE), used to identify a specific organization in progress requirements and rules governing the risk to construct high quality software, equivalent of the evaluation results are used for the selection of qualified parties and monitor the production process.

SPA and SCE are fundamentally different: SPA is used to find out the current situation within the enterprise software process improvement, determine the target needs to be improved; SCE is used to identify and select qualified software contract the contractor.

## III. Process maturity framework

The maturity of an organization's software on the one hand indicates that effectively define, manage, measure and control the extent of the software process, the other hand, can also help the organization to find a gap, pointed out the direction and goals to improve.

Immature software development organization, software process does not have a clear and stable definition,

generally by the developers and their managers in the project a temporary patchwork. Sometimes the provisions of the development within the organization, having a number of software process, each item in the software development practice strict adherence to and implementation. Immature software development organization and implementation of software process management is often reactive, that have problems have no choice but to respond.

In order to benefit from these immature and mature software development organizations in the observed data, you need to construct a software process maturity framework. In order to make the software process improvement work will continue to be effective, must be designed to an evolutionary path to the software development organization's software process maturity, this path phased. Process maturity framework is to describe the one to reach maturity from the disorderly, chaotic process, and discipline the process of evolutionary pathways, should the software process, software process capability and performance of the software process and software process maturity such as the concept of set.

#### A Software Capability Maturity Model (CMM)

Software process maturity framework is based on the Software Capability Maturity Model, the model of the software process from disorder to the orderly process of evolution is divided into several stages, and stage of sorting, forming a layer by layer to improve the platform, so that each process capability of the platform can lay the foundation for the next more advanced platform. Therefore, improvement strategies derived from the software process maturity framework, the course of continuous improvement of software process will be a "Map". It guides the software development organization to continue to identify defects in the software process, to guide the development organization or project team on all platforms, "what to do" improvements, but it does not provide the "how" to a specific facility.

Software Capability Maturity Model (CMM) for software organizations to establish and improve the software process maturity framework of the process of a ladder, laid the basis for a step-by-step process of continuous improvement has become a widely accepted process management guidelines. The frame consists of five maturity levels, as in Figure 1.

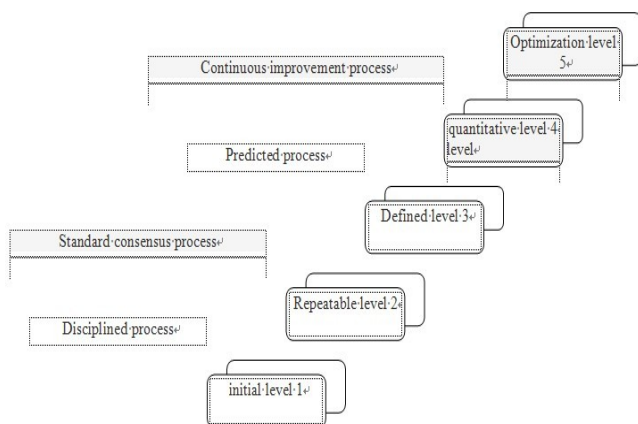


Fig 1 Five levels of software process maturity

The five maturity levels define an ordered scale used to measure an organization's software process maturity

and evaluating its software process capability. Also can help you organize it yourself for improved work prioritization.

#### B CMM maturity level

Maturity level is has been a precise definition of organization to mature soft-

ware platforms on the way forward. Each mature provides a base class to continue to improve the process. Each level contains a set of process goals. When the goal is to meet, make the software process is an important component of stability. Each maturity framework level, establish a corresponding component of the software process, resulting in the growth of a certain degree of organizational process capability.

##### 1) initial level

The organization's process capability is unpredictable, as the work progresses, the software process is often to change or amend (ie, the process is confusing). Software process definition in a state of no tricks no steps to be found. The implementation depends on the individual's abilities. Often when they encounter problems, give up the original plan to only focus on the programming and testing. Level 1 organizations almost the stability of the software process, to rely on the individual's abilities rather than the organization's ability to predict the results of the implementation.

##### 2) Repeatable level

Basic project management process has been established, you can keep track of cost, schedule, and features. Due under the effective control of the software project planning and tracking is stable, the course of the project in the project management system, they are able to repeat the previous success, based on the experience of previous projects to plan and manage new projects. To achieve this level of business process has been institutionalized, disciplined, and repeatable.

##### 3) Defined level

Process standardized. In this level, the entire organization has documented the process of development and maintenance of software, standardization (including software engineering and software management processes), and the formation of the entire software organization standard software process. All projects are consistent with the actual situation, with appropriate modifications of the standard software process to operate. Software process capability of Level 3 organizations can be summarized as standard and consistent.

##### 4) quantitative level

This level, product and process to establish quantitative quality goals, the software process have been equipped with the proper definition of a consistent measure, measure of productivity and quality as a corporate metrics program, the important process of all projects. Project through its process of implementation of change is limited to within the acceptable range of quantitative, in order to achieve control of their products and processes. Therefore have expected high quality software products, has reached the level of enterprise implementation process quantification. The software process capability of Level 4 can be summarized

as predictable.

#### 5) Optimization level

At this level, quantitative analysis by a variety of useful information from the process, new concepts and technologies, constant, continuous process improvement, optimization.

Table 1 describes the different maturity levels in CMM process visibility and process capability.

Tab1. Visibility and process capability			
level	Maturity	Visibility	process capability
1	initial level	Limited visibility	Generally fail to progress and cost targets
2	Repeatable level	Management visibility on the milestone	Realistic based on past performance, project development plan
3	Defined level	Project definition activities of the software process visibility	Based on the defined software process, the organization continues to improve process capability
4	quantitative level	Quantitative control of the software process	Based on the process and product metrics, the organization continued to improve process capability
5	Optimization level	Constantly improve the software process	Organizations to continuously improve process capability

#### C The relationship between CMM maturity level

CMM maturity level describes the characteristics of the Organization at a particular maturity level, each level for its subsequent levels build the implementation of strong and efficient basis. However, the organization can also be a destination for use in the process is described in the higher level of maturity than own. However, potential of these higher level processes or activities only after establishing an adequate basis in order to be fully realized. Skip grades will have the opposite effect, because each level, including some of the necessary foundation, from the foundation to improve in order to reach the next level, an organization must be step by step through these levels in order to build good software engineering culture.

Process improvement should focus on the needs of the organization's business environment and development, software capability maturity level of increase is a gradual process. Has a higher maturity level does not mean you can skip maturity levels.

#### D Key Process Areas(KPA)

In addition to the initial level of CMM maturity level is in accordance with the exact same structure (Figure 2). Maturity level for the top level, the different maturity levels reflect the organization's software process capability of the software and the organization may realize the extent of the expected results. Each maturity level (except for the initial level) are included to achieve this target a number of key process areas (KPA), each one of the KPA further includes a number of key practices.

KPA specified organizations to improve software process capability should be concerned about the area, and that should be tackled to reach a mature level. Achieve a maturity level must implement all of the levels of the KPA. In order to meet a key process area must meet all the objectives of the process domain. These goals summarize the key practices of the key process area and can be used to judge an organization or project has been effective in achieving the key process areas. With the organization promoted to a higher level of process maturity, the specific practices in each key process area should be carried out in the content will be developed.

Table 2 to management processes, organizational processes, and 3 category description of the works of CMM key process areas.

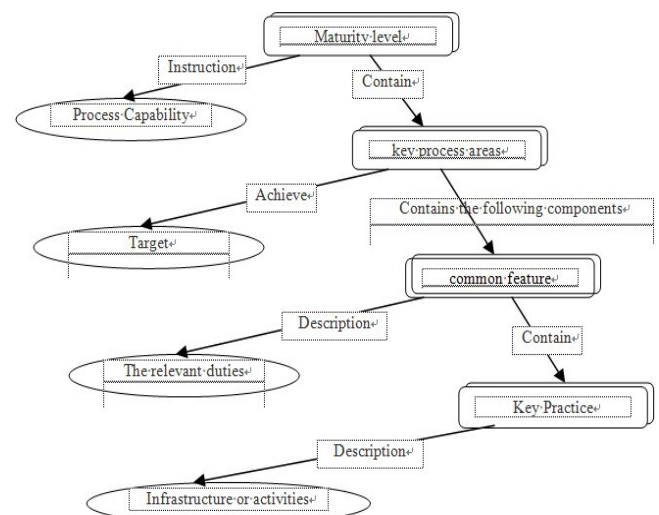


Fig 2. CMM maturity level composition

Tab2 cmm kpa			
	Management process	Organizational processes	Engineering process
5、Optimization level		Technology change management, Process change management	Defect Prevention
4、quantitative level	Quantitative Process Management		Software Quality Management
3、Defined level	Integrated Software Management, Coordination between the two groups	The focus of organizational processes, Organizational Process Definition, Training programs	Software Product Engineering, Peer-reviewed
2、Repeatable level	Demand management, Software project planning, Software project tracking and oversight, Software sub-contract management, Software Quality Assurance, Software Configuration Management		
1、initial level	Disorderly process	Disorderly process	Disorderly process

#### IV. CMM Several problems

CMM proposal has now been more than 10 years of time, and now it has been widely used in major global organizations and sectors of the economy, the CMM implementation of strengthened corporate software process management and control, software product quality is improved, resulting in customer increased satisfaction. However, CMM there are many problems, following elaborate on a few outstanding issues.

##### A CMM on the scope of use

CMM began as a service for the U.S. military for the military to find qualified software vendors. It may not be suitable for most of the relatively small business software development company.

CMM structure, each level contains several key process areas for each key process area consists of five common characteristics, each common feature contains a series of critical practice. These key practice requires one or more persons to operate, although one can practice held a variety of roles, but for small businesses, this appears to be too complicated. CMM relative rigorous structure for the small business is too sluggish. The key process areas and with the level of increase required to achieve more and more, to fulfill the key practices will continue to increase. The complexity of the structure is a factor that may affect the CMM implementation in the SME.

##### B CMM implementation time and cost

Enterprises implementing CMM for quality improvement at the same time, has implemented cost problems. Although the use of software process improvement software quality has increased, but productivity have reduced. Therefore, the implementation cost of the CMM software companies have to consider the practical problems.

Enterprises implementing CMM level rose to another level of about 2 years, implementation time is too long. For small businesses, the implementation of a long, crossing the repeatable level and after the defined level how much motivation to implement quantitative philosophy of CMM, people will have no idea.

##### C CMM influence on enterprise culture

CMM is a software process improvement methods and theories, conclusions and principles of general systems and its consistent. CMM as a systematic approach to improve software quality, the effect of its implementation depends on the system internal state variables (personnel, organizational structure, management model, capital equipment, etc.) and the external environment (government support, the social recognition of the CMM, etc.). Therefore, any system that ignores the internal culture and external environment improved methods are imperfect. This leads to the following questions:

(1) Model is always an abstract model to assess the existence of such a risk: understanding of software process for the model is not suitable for CMM assessment, rather than the realities of the problems.

(2) CMM implementation must take into account the existing quality of personnel of the enterprise, the choice of management mode, background and implementation time.

(3) The process of change must be based on understanding the real situation, while not based on issues that may arise certain expectations or understanding of the solution.

(4) The model may ignore the corporate executor aware of the problem.

In a sense, CMM ignore corporate culture. Although the CMM proponents stressed the CMM only specifically addressed what to do, but have not explained how to do, so businesses have more space for the implementation of CMM. However, from the CMM structure and general structure of the system, by definition, the model itself is a constraint. For the above-mentioned debate on the issue continues, pending further empirical study.

#### V. Conclusion

In a sense, CMM is a descriptive model, which describes in a certain maturity level on the organization (or key) attribute. Another sense CMM is a standard model, a standard type of behavior is characterized by detailed practice. An application of CMM, you should use a reasonable description of the practice. CMM not be applied mechanically, it does not tell an organization how to improve. Which describes the organization at all levels of maturity levels, with no limit to reach the target method. CMM is a continuous development of the theory and methods.

CMM represents the software development of an idea, a way to improve the software process capability of the way. Despite the existence of certain deficiencies. For example, the maturity level, the key process areas, public property and critical practice in the software industry also need further discussion and revision, but it does the development of software industry provides a good framework, but is useful to promote the software process capability improvement tools.

The CMM Although general recognition, and computer software industry has had a profound impact, import CMM model in terms of most software companies may also need a difficult course. There is a theory with practice, CMM localized. However, the CMM ideological principles, tools, methods, undoubtedly the development of China's software industry has played a huge role in promoting the optimization and development of assessment, certification, and guide, and software companies within China's software industry will have a significant impact, but also China's software enterprises to the world the only way.

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