

# Capability Maturity Model

The Capability Maturity Model (CMM), also sometimes referred to as the Software CMM (SW-CMM), was first described by Watts Humphrey in his book *Managing the Software Process*. The CMM is a process capability model based on software development organisation processes/practices.

Though the CMM was retired in 1997 and has not been updated since, having been superseded by CMMI (Capability Maturity Model Integration), it has been used as a generally applicable model to assist in understanding the process capability maturity of organisations in diverse areas. For example, software engineering, system engineering, project management, risk management, system acquisition, information technology (IT) or personnel management, against a scale of five key processes, namely: Initial, Repeatable, Defined, Managed and Optimized.

CMM was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University in Pittsburgh. It has been used extensively for avionics software and government projects around the world. The Capability Maturity Model (CMM) is a process capability maturity model which aids in the definition and understanding of an organisation's processes. The CMM was originally used to enable the assessment of software development processes.

## 1 Maturity model

A maturity model is a structured collection of elements that describe certain aspects of maturity in an organisation. A maturity model may provide, for example:

- a place to start
- the benefit of a community's prior experiences
- a common language and a shared vision
- a framework for prioritizing actions
- a way to define what improvement means for your organization.

A maturity model can be used as a benchmark for assessing different organizations for equivalent comparison. The model describes the maturity of the company based upon the project the company is handling and the related clients.

## 2 Structure of CMM

The CMM involves the following aspects:

- **Maturity Levels:** It is a layered framework providing a progression to the discipline needed to engage in continuous improvement (It is important to state here that an organization develops the ability to assess the impact of a new practice, technology, or tool on their activity. Hence it is not a matter of adopting these, rather it is a matter of determining how innovative efforts influence existing practices. This really empowers projects, teams, and organizations by giving them the foundation to support reasoned choice.)
- **Key Process Areas:** A Key Process Area (KPA) identifies a cluster of related activities that, when performed collectively, achieve a set of goals considered important.
- **Goals:** The goals of a key process area summarize the states that must exist for that key process area to have been implemented in an effective and lasting way. The extent to which the goals have been

accomplished is an indicator of how much capability the organization has established at that maturity level. The goals signify the scope, boundaries, and intent of each key process area.

- **Common Features:** Common features include practices that implement and institutionalize a key process area. These five types of common features include: Commitment to Perform, Ability to Perform, Activities Performed, Measurement and Analysis, and Verifying Implementation.
- **Key Practices:** The key practices describe the elements of infrastructure and practice that contribute most effectively to the implementation and institutionalization of the key process areas.

### 3 Levels of the CMM

There are five levels of the CMM. According to the SEI,

"Predictability, effectiveness, and control of an organization's software processes are believed to improve as the organization moves up these five levels. While not rigorous, the empirical evidence to date supports this belief."

#### 3.1 Level 1 - Initial

At maturity level 1, processes are usually ad hoc, and the organization usually does not provide a stable environment. Success in these organizations depends on the competence and heroics of the people in the organization, and not on the use of proven processes. In spite of this ad hoc, chaotic environment, maturity level 1 organizations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects.

Maturity level 1 organizations are characterized by a tendency to over commit, abandon processes in the time of crisis, and not be able to repeat their past successes again.

Level 1 software project success may depend on having star performers - people with the skills to produce useful results despite there being no consistent or clearly defined process to produce results.

#### 3.2 Level 2 - Repeatable

At maturity level 2, some software development processes are repeatable, possibly with consistent results. The processes may not repeat for all the projects in the organization. The organization may use some basic project management to track cost and schedule.

Process discipline is unlikely to be rigorous, but where it exists it may help to ensure that existing practices are retained during times of stress. When these practices are in place, projects are performed and managed according to their documented plans.

Project status and the delivery of services are visible to management at defined points (for example, at major milestones and at the completion of major tasks).

Basic project management processes are established to track cost, schedule, and functionality. The minimum process discipline is in place to repeat earlier successes on projects with similar applications and scope. There is still a significant risk of exceeding cost and time estimates.

#### 3.3 Level 3 - Defined

The organization's set of standard processes, which are the basis for level 3, are established and subject to some degree of improvement over time. These standard processes are used to establish consistency across the organization. Projects establish their defined processes by applying the organization's set of standard processes, tailored, if necessary, within similarly standardized guidelines.

The organization's management establishes process objectives for the organization's set of standard processes, and ensures that these objectives are appropriately addressed.

A critical distinction between level 2 and level 3 is the scope of standards, process descriptions, and procedures. At level 2, the standards, process descriptions, and procedures may be quite different in each specific instance of the process (for example, on each particular project). At level 3, the standards, process descriptions, and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit.

### ***3.4 Level 4 - Managed***

Using process metrics, management can effectively control the process (e.g., for software development). In particular, management can identify ways to adjust and adapt the process to particular projects without measurable losses of quality or deviations from specifications. Organizations at this level set quantitative quality goals for both software process and software maintenance. Subprocesses are selected that significantly contribute to overall process performance. These selected subprocesses are controlled using statistical and other quantitative techniques. A critical distinction between maturity level 3 and maturity level 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques, and may be quantitatively predictable. At maturity level 3, processes are only qualitatively predictable.

### ***3.5 Level 5 - Optimizing***

Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements. Quantitative process-improvement objectives for the organization are established, continually revised to reflect changing business objectives, and used as criteria in managing process improvement. The effects of deployed process improvements are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities.

Process improvements to address common causes of process variation and measurably improve the organization's processes are identified, evaluated, and deployed.

Optimizing processes that are nimble, adaptable and innovative depends on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning.

A critical distinction between maturity level 4 and maturity level 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. Though processes may produce predictable results, the results may be insufficient to achieve the established objectives. At maturity level 5, processes are concerned with addressing common causes of process variation and changing the process (that is, shifting the mean of the process performance) to improve process performance (while maintaining statistical probability) to achieve the established quantitative process-improvement objectives.