

Capability Maturity Model Integration for Development (CMMI-DEV) v1.2 Quick Guide



What it is CMMI[®]?

- CMMI[®] is a process improvement maturity model for the development of products and services. It consists of best practices that address development and maintenance activities that cover the product lifecycle from conception through delivery and maintenance.

Purpose

- To help organizations improve their development and maintenance processes for both products and services. CMMI for Development is a collection of best practices that is generated from the CMMI Framework. The CMMI Framework supports the CMMI Product Suite by allowing multiple models, training courses, and appraisal methods to be generated that support specific areas of interest.

Scope

- CMMI for Development (CMMI-DEV) is a reference model that covers the development and maintenance activities applied to both products and services. Organizations from many industries, including aerospace, banking, computer hardware, software, defence, automobile manufacturing, and telecommunications, use CMMI for Development.
- Models in the CMMI for Development constellation contain practices that cover project management, process management, systems engineering, hardware engineering, software engineering, and other supporting processes used in development and maintenance. The CMMI for Development +IPPD model also covers the use of integrated teams for development and maintenance activities.

Process Areas (PA) and Process Categories

CMMI-DEV v1.2 includes 22 process areas split by 4 process categories:

- Process Management (5):** Process Management process areas contain the cross-project activities related to defining, planning, deploying, implementing, monitoring, controlling, appraising, measuring, and improving processes.
 - Basic: OT, OPD, OPF
 - Advanced: OID, OPP
- Project Management (6):** Project Management process areas cover the project management activities related to planning, monitoring, and controlling the project.
 - Basic: PP, PMC, SAM
 - Advanced: IPM, RSKM, QPM
- Engineering (6):** Engineering process areas cover the development and maintenance activities that are shared across engineering disciplines.
 - Basic: RM, RD, TS, PI, VAL, VER
- Support (5):** Support process areas cover the activities that support product development and maintenance. The Support PAs address processes that are used in the context of performing other processes. In general, the Support process areas address processes that are targeted toward the project and may address processes that apply more generally to the organization.
 - Basic: CM, ME, PPOA
 - Advanced: DAR, CAR

PA by ML and Process Categories

ML\Categ.	Process Mgmt	Project Mgmt	Engineering	Support
5	OID			CAR
4	OPP	QPM		
3	OPF OPD OT	IPM RSKM IT	RD TS PI VAL VER	DAR
2		PP PMC SAM	RM	CM MEA PPOA
1	Ad-hoc processes			

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Process Areas (PA) purposes

A Process Area (PA) is "a cluster of related practices in an area that, when implemented collectively, satisfy a set of goals considered important for making improvement in that area. All CMMI process areas are common to both continuous and staged representations".

- CAR (Causal Analysis & Resolution)**
 - to identify causes of defects and other problems and take action to prevent them from occurring in the future
- CM (Configuration Management)**
 - to establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.
- DAR (Decision Analysis & Resolution)**
 - to analyze possible decisions using a formal evaluation process that evaluates identified alternatives against established criteria.
- IPM (Integrated Project Management)**
 - to establish and manage the project and the involvement of the relevant stakeholders according to an integrated and defined process that is tailored from the organization's set of standard processes.
- ME (Measurement & Analysis)**
 - to develop and sustain a measurement capability that is used to support management information needs.
- OID (Organizational Innovation & Deployment)**
 - to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies.
- OPD (Organizational Process Definition)**
 - to establish and maintain a usable set of organizational process assets and work environment standards.
- OPF (Organizational Process Focus)**
 - to plan, implement, and deploy organizational process improvements based on a thorough understanding of the current strengths and weaknesses of the organization's processes and process assets.
- OPP (Organizational Process Performance)**
 - to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.
- OT (Organizational Training)**
 - to develop the skills and knowledge of people so they can perform their roles effectively and efficiently.
- PI (Product Integration)**
 - to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.
- PMC (Project Monitoring & Control)**
 - to provide an understanding of the project's progress so that appropriate corrective actions can be taken when the project's performance deviates significantly from the plan.
- PP (Project Planning)**
 - to establish and maintain plans that define project activities.
- PPQA (Process & Product Quality Assurance)**
 - To provide staff and management with objective insight into processes and associated work products.
- QPM (Quantitative Project Management)**
 - to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.
- RD (Requirement Development)**
 - to produce and analyze customer, product, and product component requirements.
- RM (Requirement Management)**
 - to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products.
- RSKM (Risk Management)**
 - to identify potential problems before they occur so that risk-handling activities can be planned and invoked as needed across the life of the product or project to mitigate adverse impacts on achieving objectives.
- SAM (Supplier Agreement Management)**
 - to manage the acquisition of products from suppliers.
- TS (Technical Solution)**
 - to design, develop, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related lifecycle processes either singly or in combination as appropriate.
- VAL (Validation)**
 - to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.
- VER (Verification)**
 - to ensure that selected work products meet their specified requirements.

Maturity Level (ML) & Capability Level (CL)

- Maturity Level**
 - Degree of process improvement across a predefined set of process areas in which all goals in the set are attained.
 - Maturity levels, which belong to a staged representation, apply to an organization's process improvement achievement across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken.
 - There are 5 maturity levels, numbered 1 through 5.
- Capability Level**
 - Achievement of process improvement within an individual process area. A capability level is defined by the appropriate specific and generic practices for a process area.
 - CL, which belong to a continuous representation, apply to an organization's process improvement achievement in individual PA. These levels are a means for incrementally improving the processes corresponding to a given process area.
 - There are six capability levels, numbered 0 through 5.

Lev\Represent.	Continuous Repr. CL	Staged Repr. ML
5	Optimizing	Optimizing
4	Quantit. Managed	Quantitat. Managed
3	Defined	Defined
2	Managed	Managed
1	Performed	Initial
0	Incomplete	N/A

Selecting a Representations: Continuous vs. Staged

Descriptions

- Continuous**
 - The continuous representation offers maximum flexibility when using a CMMI model for process improvement. An organization may choose to improve the performance of a single process-related trouble spot, or it can work on several areas that are closely aligned to the organization's business objectives.
 - The continuous representation also allows an organization to improve different processes at different rates.
 - There are some limitations on an organization's choices because of the dependencies among some process areas.
 - If you know the processes that need to be improved in your organization and you understand the dependencies among the process areas described in CMMI, the continuous representation is a good choice for your organization.
- Staged**
 - The staged representation offers a systematic, structured way to approach model-based process improvement one stage at a time. Achieving each stage ensures that an adequate process infrastructure has been laid as a foundation for the next stage.
 - Process areas are organized by maturity levels that take some of the guess work out of process improvement. The staged representation prescribes an order for implementing process areas according to maturity levels, which define the improvement path for an organization from the initial level to the optimizing level.
 - Achieving each maturity level ensures that an adequate improvement foundation has been laid for the next maturity level and allows for lasting, incremental improvement.
 - If you do not know where to start and which processes to choose to improve, the staged representation is a good choice for you. It gives you a specific set of processes to improve at each stage that has been determined through more than a decade of research and experience with process improvement.

A COMPARISON	
Continuous	Staged
The organization selects process areas and capability levels based on its process improvement objectives.	The organization selects process areas based on the maturity levels.
Improvement is measured using capability levels. Capability levels: <ul style="list-style-type: none"> Measure maturity of a particular process across an organization. Range from 0 through 5. 	Improvement is measured using maturity levels. Maturity levels: <ul style="list-style-type: none"> Measure maturity of a set of processes across an organization. Range from 1 through 5.
Capability level profiles are used to target and track process improvement performance.	Maturity levels are used to target and track process improvement performance.
Equivalent staging allows an organization using the continuous approach to process improvement to derive a maturity level as part of an appraisal.	There is no need for an equivalence mechanism back to the continuous approach.

PROS & CONS	
Continuous	Staged
Grants explicit freedom to select the order of improvement that best meets the organization's business objectives and mitigates the organization's areas of risk.	Enables organizations to have a predefined and proven improvement path.
Enables increased visibility of the capability achieved in each individual process area	Focuses on a set of processes that provide an organization with a specific capability that is characterized by each maturity level
Allows improvements of different processes to be performed at different rates.	Summarizes process improvement results in a simple form a single maturity level number.
Reflects a newer approach that does not yet have the data to demonstrate its ties to return on investment	Builds on a relatively long history of use that includes case studies and data that demonstrate return on investment.

Three criteria for selecting a representation

- **Business Factors**
 - o An organization with mature knowledge of its own business objectives is likely to have a strong mapping of its processes to its business objectives. Such an organization may find the continuous representation useful to appraise its processes and in determining how well the organization's processes support and meet its business objectives.
 - o If an organization with a product-line focus decides to improve processes across the entire organization, it might be served best by the staged representation. The staged representation will help an organization select the critical processes to focus on for improvement.
 - o The same organization may opt to improve processes by product line. In that case, it might select the continuous representation—and a different appraised rating of capability might be achieved for each product line. Both approaches are valid. The most important consideration is which business objectives you would like your process improvement program to support and how these business objectives align with the two representations.
- **Cultural Factors**
 - o Cultural factors to consider when selecting a representation have to do with an organization's capability to deploy a process improvement program. For instance, an organization might select the continuous representation if the corporate culture is process based and experienced in process improvement or has a specific process that needs to be improved quickly. An organization that has little experience in process improvement may choose the staged representation, which provides additional guidance on the order in which changes should occur.
- **Legacy**
 - o If an organization has experience with another model that has a staged representation, it may be wise to continue with the staged representation when using CMMI, especially if it has invested resources and deployed processes across the organization that are associated with a staged representation. The same is true for the continuous representation.

Generic Goals (GG)

GG is "a required model component that describes the characteristics that must be present to institutionalize the processes that implement a process area".

- **GG 1 – Performed process**
 - o A performed process is a process that accomplishes the work necessary to produce work products. The specific goals of the process area are satisfied.
- **GG 2 – Managed Process**
 - o A managed process is a performed process that is planned and executed in accordance with policy.
 - o A critical distinction between a performed process and a managed process is the extent to which the process is managed. A managed process is planned (the plan may be part of a more encompassing plan) and the performance of the process is managed against the plan. Corrective actions are taken when the actual results and performance deviate significantly from the plan. A managed process achieves the objectives of the plan and is institutionalized for consistent performance.
- **GG 3 – Defined Process**
 - o A defined process is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process improvement information to the organizational process assets. A project's defined process provides a basis for planning, performing, and improving the project's tasks and activities.
 - o A critical distinction between a managed process and a defined process is the scope of application of the process descriptions, standards, and procedures. For a managed process, the process descriptions, standards, and procedures are applicable to a particular project, group, or organizational function. As a result, the managed processes of two projects in one organization may be different.
 - o Another critical distinction is that a defined process is described in more detail and is performed more rigorously than a managed process. This means that improvement information is easier to understand, analyze, and use. Finally, management of the

defined process is based on the additional insight provided by an understanding of the interrelationships of the process activities and detailed measures of the process, its work products, and its services.

- **GG 4- Quantitatively managed Process**
 - o A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques.
 - o A critical distinction between a defined process and a quantitatively managed process is the predictability of process performance. The term quantitatively managed implies using appropriate statistical and other quantitative techniques to manage the performance of one or more critical sub-processes so that the performance of the process can be predicted. A defined process provides only qualitative predictability.
- **GG 5 – Optimizing Process**
 - o An optimizing process is a quantitatively managed process that is changed and adapted to meet relevant current and projected business objectives. An optimizing process focuses on continually improving process performance through both incremental and innovative technological improvements. Process improvements that address common causes of process variation, root causes of defects, and other problems; and those that would measurably improve the organization's processes are identified, evaluated, and deployed as appropriate. These improvements are selected based on a quantitative understanding of their expected contribution to achieving the organization's process improvement objectives versus the cost and impact to the organization.
 - o A critical distinction between a quantitatively managed process and an optimizing process is that the optimizing process is continuously improved by addressing common causes of process variation. A quantitatively managed process is concerned with addressing special causes of process variation and providing statistical predictability of the results. Although the process may produce predictable results, the results may be insufficient to achieve the organization's process improvement objectives.

Generic Practices (GP)

GP is "an expected model component that is considered important in achieving the associated generic goal. The generic practices associated with a generic goal describe the activities that are expected to result in achievement of the generic goal and contribute to the institutionalization of the processes associated with a process area".

- **GP 1.1 – Perform Specific Practices**
 - o Perform the specific practices of the process area to develop work products and provide services to achieve the specific goals of the process area.
- **GP 2.1 – Establish an Organizational Policy**
 - o Establish and maintain an organizational policy for planning and performing the process.
- **GP 2.2 – Plan the Process**
 - o Establish and maintain the plan for performing the process.
- **GP 2.3- Provide Resources**
 - o Provide adequate resources for performing the process, developing the work products, and providing the services of the process.
- **GP 2.4- Assign Responsibility**
 - o Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.
- **GP 2.5- Train People**
 - o Train the people performing or supporting the process as needed.
- **GP 2.6- Manage Configurations**
 - o Place designated work products of the process under appropriate levels of control.
- **GP 2.7- Identify and Involve Relevant Stakeholders**
 - o Identify and involve the relevant stakeholders of the process as planned.
- **GP 2.8- Monitor and Control the Process**
 - o Monitor and control the process against the plan for performing the process and take appropriate corrective action.
- **GP 2.9- Objectively Evaluate Adherence**
 - o Objectively evaluate adherence of the process against its process description, standards, and procedures, and address non-compliance.
- **GP 2.10- Review Status with High Level Management**
 - o Review the activities, status, and results of the process with higher level management and resolve issues.
- **GP 3.1- Establish a Defined Process**
 - o Establish and maintain the description of a defined process.
- **GP 3.2- Collect Improvement Information**
 - o Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.
- **GP 4.1- Establish Quantitative Objectives for the Process**
 - o Establish and maintain quantitative objectives for the process, which address quality and process performance, based on customer needs and business objectives.
- **GP 4.2- Stabilize Subprocess Performance**
 - o Stabilize the performance of one or more subprocesses to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.
- **GP 5.1- Ensure Continuous Improvement**
 - o Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.
- **GP 5.2 - Correct Root Causes of Problems**
 - o Identify and correct the root causes of defects and other problems in the process.

Appraisal Rules (from ARC v1.2)

- **Classes of Appraisals:**
 - o **Class A:** it must satisfy all ARC requirements; it is the only class considered suitable for providing ratings for benchmarking. It can be ISO 15504-conformant.
 - o **Class B:** it is required to comply with a subset of ARC requirements. It does not produce ratings and is not intended to be ISO 15504-conformant.
 - o **Class C:** is required to comply with a subset of ARC requirements. These types of appraisals would most likely be used when the need for a "quick look" arises or for periodic self-assessments by projects and organizational support groups.

Requirements	Class A	Class B	Class C
Types of Objective Evidences Gathered	Documents and Interviews	Documents and Interviews	Documents and Interviews
Ratings Generated	Goal ratings required	Not Allowed	Not Allowed
Organizational Unit Coverage	Required	Not Required	Not Required
Minimum Team Size	4	2	1
Appraisal Team Leader Requirements	Lead Appraiser	Person Trained and Experienced	Person Trained and Experienced

Rating Requirements (Section 4.6)

4.6.1 The method shall define a rating process that specifies, at a minimum, the following:

- An appraisal team can rate a specific or generic goal when corroborated objective evidence for each practice related to the goal meets the method's defined data coverage criteria.
- An appraisal team can rate a process area when it has rated each of the process area's specific goals and generic goals within the appraisal scope.
- An appraisal team can determine a maturity level rating once it has rated all of the process areas within that level and each level below.
- An appraisal team can determine the capability level of a process area when it has rated each of the generic goals at or below the target capability level.

4.6.2 The method shall require that maturity level ratings and/or capability level ratings be based on the definitions of capability levels and maturity levels in the CMMI models.

4.6.3 The method shall rate each specific and generic goal (provided the prerequisites of rating have been met) within the appraisal scope in accordance with the following rules:

- Rate the goal "satisfied" when the associated generic or specific practices (or acceptable alternative practices) are judged to be implemented and the aggregate of weaknesses does not have a significant negative impact on goal achievement.
- Rate the goal "not rated" if the goals cannot be rated in accordance with the method's defined criteria for data sufficiency.
- Rate the goal "unsatisfied" otherwise.

4.6.4 The method shall rate each process area within the appraisal scope, if requested by the appraisal sponsor, in accordance with the following rules:

- When a process area is determined to be outside of the organizational unit's scope of work, the process area is designated as "not applicable" and is not rated.
- When an applicable process area is outside of the scope of the model used for the appraisal, the process area is designated as "out of scope" and is not rated.
- When one or more goals cannot be rated in accordance with the method's defined criteria for data sufficiency, the process area is designated as "not rated" and is not rated.
- Otherwise, when a process area is to be rated for a staged representation, the process area is "satisfied" if and only if all of its specific goals and all of its generic goals at the maturity level of interest and below are rated "satisfied." Else, it is "unsatisfied."
- Otherwise, when a process area is to be rated for a continuous representation, the process area is given a capability level rating based on the highest level for which all of its specific goals and generic goals have been satisfied.

4.6.5 The method shall rate the maturity level, if requested by the appraisal sponsor, in accordance with the following rules:

- A maturity level for a staged representation is achieved if all process areas within the level and within each lower level are either "satisfied" or "not applicable."
- A maturity level for a continuous representation is achieved if the capability level profile is at or above the target profile for all process areas for that maturity level and all lower maturity levels in the equivalent staging, excepting those process areas that are designated as "not applicable."

Equivalent Staging

- Equivalent staging is a way to compare results from using the continuous representation to those of the staged representation.
- The following rules summarize equivalent staging:
 - o To achieve ML2, all process areas assigned to ML2 must achieve CL2 or higher.
 - o To achieve ML3, all process areas assigned to ML2 and ML3 must achieve CL3 or higher.
 - o To achieve ML4, all process areas assigned to ML2, 3, and 4 must achieve CL3 or higher.
 - o To achieve ML5, all process areas must achieve CL3 or higher.