CMMI Introduction

نام رشته : مدیریت فناوری اطلاعات

نام درس : مدیریت پروژه های فناوری اطلاعات بر اساس الگوی CMMI

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مقدمه

این مستند مقدمه خلاصه ای است در رابطه با مباحث پایه و کلیدی
Capability Maturity Model Integration (CMMI)

نکات روش CMMI در مدیریت پروژه به صورت اجمالی و بدون ورود به جزئیات ارائه شده است تا مخاطبین را با روشهای مدیریتی و کنترل سازمانها و پروژه ها آشنا کند
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در مرحله اول دانشجویان باید این نکات کلیدی را مطالعه و بعد از آن با مطالعه فصلهای مشخص شده در کتاب درسی مشخص شده با نکات عملیاتی مدیریت پروژه آشنا شوند.

What Is the CMMI

CMMI is an acronym (it is not a four-letter word). The acronym stands for Capability Maturity Model Integration**SM. Some people would say the CMMI is a model, while others would describe it as a set of models. But most will agree that the CMMI is a merger of process improvement models for systems engineering, software engineering, hardware engineering, and integrated teams.

Some of the goals of the CMMI are to provide a common vocabulary across the set of models and to provide clarification on how these areas interrelate. The integrated model has both a continuous and staged perspective.

CMMI Model Structure

The CMMI is structured as follows:

- Maturity Levels (staged representation) or Capability Levels (Continuous representation)
- Process Areas
- Goals—Generic and Specific
- Practices—Generic and Specific

Figure 1 shows the CMMI model components in the staged representation. Basically, maturity levels organize the process areas. Within the process areas are generic and specific goals, as well as generic and specific practices.
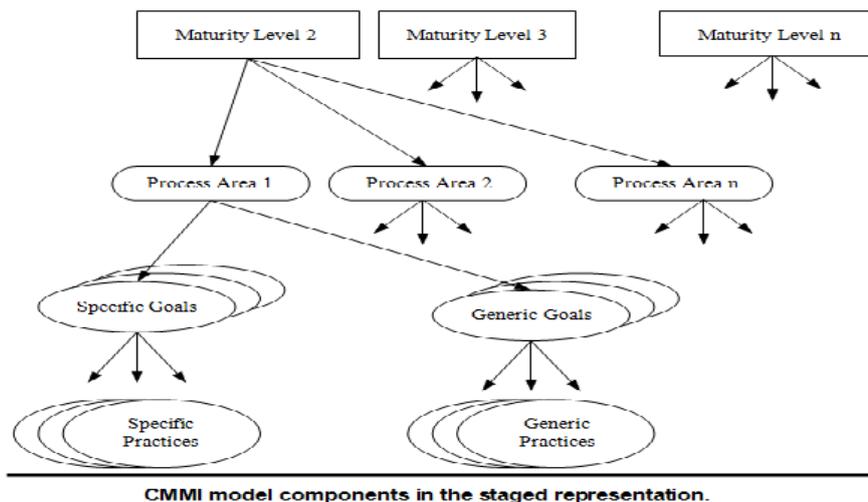

CMMI model components in the staged representation.

Figure 1

Model Structure for the Staged Representation

The staged representation is organized by assigning process areas to maturity levels.

Maturity Levels

A maturity level signifies the level of performance that can be expected from an organization. For example, Maturity Level 1 organizations have ad hoc processes. Maturity Level 2 organizations have a basic project management system in place. There are five maturity levels.

Process Areas (PAs)

Each maturity level consists of several process areas. A process area is a group of practices or activities performed collectively in order to achieve a specific objective. Examples include Requirements Management at Maturity Level 2; Requirements Development at Maturity Level 3; and Quantitative Project Management at Maturity Level 4.

Goals

Each PA has several goals that need to be satisfied in order to satisfy the objectives of the PA. There are two types of goals:

1. Specific goals (SG): goals that relate only to the specific PA under study
2. Generic goals (GG): goals that are common to multiple PAs throughout the model. These goals help determine whether the PA has been institutionalized.

Practices

Practices are activities that must be performed to satisfy the goals for each PA. Each practice relates to only one goal. There are two types of practices:

1. Specific practices (SP): practices that relate to specific goals
2. Generic practices (GP): practices associated with the generic goals for Institutionalization

For example, in the Project Planning PA, one of the specific practices

is to write a Project Plan. Another is to estimate the number of people needed and to derive a schedule. Sub practices and examples are provided to help explain the practices in more detail.

Relationship between Goals and Practices

Every PA has several goals that must be satisfied. Because goals are at a high level, each goal has practices associated with it. Practices are specific tasks that should be performed within the PA to achieve the goal. There are both generic and specific goals. There are both generic and specific practices.

Model Structure for the Continuous Representation

The continuous representation uses the same basic structure as the staged representation. However, each PA belongs to a Process Area Category. A Process Area Category is just a simple way of arranging PAs by their related, primary functions. The Process Area Categories with their associated PAs follow.

Process Management

These PAs consist of common functions related to defining, planning, implementing, and monitoring a process. Notice that they all reside at the organizational level, not the project level, and are listed in increasing order of sophistication and complexity. There are five Process Management PAs:

- Organizational Process Focus
- Organizational Process Definition (with Integrated Product and Process Development—IPPD)
- Organizational Training
- Organizational Process Performance
- Organizational Innovation and Deployment

Project Management

These PAs consist of functions related to planning, tracking, and controlling projects, and are listed in increasing order of sophistication and complexity. There are six Project Management PAs:

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Integrated Project Management Development—IPPD)
- Risk Management
- Quantitative Project Management

Engineering

These PAs consist of technical functions related to building and delivering a product, and are listed in increasing order of sophistication and complexity. There are six Engineering PAs:

- Requirements Development
- Requirements Management
- Technical Solution
- Product Integration
- Verification
- Validation

Support

These PAs consist of related support functions related to managing changes, ensuring quality, measuring results and activities, and structured decision making. They are listed in increasing order of sophistication and complexity. There are five Support PAs:

- Configuration Management
- Process and Product Quality Assurance
- Measurement and Analysis
- Decision Analysis and Resolution
- Causal Analysis and Resolution

In the previous version of the CMMI, there were both base practices and advanced practices. Base practices were those practices

that resided at Capability Level 1. Base practices essentially involved identifying the scope of work and performing the process informally without following a documented process description or plan. Advanced practices were those practices that showed more sophistication and rigor in a process area. Advanced practices could build on base practices. Now, in version 1.2, there are only the specific practices. They match the practices in the staged representation.

The degree to which the practices are performed may vary from individual effort to individual effort. A capability level is not a maturity level. Capability Level1 simply means that the specific practices are performed in some way in your organization. So, these practices are very simple building blocks in the stratification of attaining capability levels

Goals and Practices

Specific goals and practices relate to specific process areas and relate to tasks that make sense for that process area only. For example, Project Planning requires a project plan. Quantitative Project Management requires process performance baseline. Generic goals and practices relate to multiple process areas. So, Requirements Management, if desiring a Capability Level 2, would have to establish an organizational policy, plan the process, and train people.

Generic Goals and Practices

Basically, each capability level has one generic goal associated with it. Each generic practice maps to only one generic goal. The generic goals and generic practices map directly to one or more PAs, and basically summarize the concepts of each PA.

Target Profile

A target profile is a list of process areas and their corresponding capability levels. One example is when comparing maturity levels to capability levels. Capability Level 3 can only be determined as equivalent to Maturity Level 3 in the staged representation when all of the goals for all of the process areas at Maturity Levels 2 and 3 in the staged representation have been met. So the target profile 3 would include satisfying seven process areas at Maturity Level 2 plus eleven process areas at Maturity Level 3. An organization may decide on its own unique target profile. For example, a contracting company specializing in providing third-party Independent Verification and Validation services may select a target profile of Capability Level 2 for Project Planning and Project Monitoring and Control, and Capability Level 3 for Verification and Validation.

Target Staging

Target staging is a sequence of target profiles that describe the path of process improvement the organization will take. Care should be taken to ensure that dependencies between the generic practices and process areas are implemented. This is where the organization documents the PAs it will focus on, justifies this approach, and tracks the PAs back to business objectives.

Achievement Profile

Used in the continuous representation, this profile is basically a bar chart of each process area that shows how much of the PA has been achieved and how much has not been achieved. When the reader views it to determine how much of the process area has been achieved, it is called an *achievement profile*. When the reader views it to determine what is left to be achieved, it can be called a *target profile*.

Capability Level Profile

This profile (or chart) is a list of process areas and their corresponding capability level. This profile can be constructed by using the target profile to show what is left to be done or the achievement profile showing what has been successfully performed, or both profiles to show both sets of information.

CMMI Representation

There are two different representations of the CMMI. They are the staged representation and the continuous representation.

The following discussion contains a lot of "CMMI." There is just no way around it. When using the CMMI, you must use the terminology associated with it. However, the words are sometimes confusing. A trick we use is to look at the words as separate entities and then just turn them around. For example, the next paragraph contains the words *process capability*. Well, what is that? Look at the words. *Process capability* is how *capable* is our *process* of actually providing us with the results we are looking for. And so on. Good luck.

The Staged Representation

The staged representation focuses improvement on the process capability an organization can expect to attain; however, this expected capability (or ability to function in a mature manner) is contained within maturity levels, or stages. There are five maturity levels, with each level providing the foundation for further improvements. This structure mirrors that of the previous CMM for Software.

Maturity Level 1—Initial

Organizations have no structured process in place. Development is chaotic and ad hoc. Budgets and schedules are often exceeded. Product quality cannot be predicted. Maturity Level 1 is considered ad hoc—meaning you make it up as you go along, which is something we want to avoid—so this level has no real structure associated with it. That is, this level represents a chaotic approach toward developing products. If chaos were structured, it would not be chaotic. So, there is nothing structured in Level 1, and being Level 1 is a bad thing.

Maturity Level 2—Managed

Basic project management processes are in place and are followed. Institutionalization is achieved by satisfying the generic goals and generic practices for Level 2 that includes:

- Adhering to organizational policies
- Following a documented plan and process description
- Applying adequate funding and resources
- Maintaining appropriate assignment of responsibility and authority

- Training people in their appropriate processes
- Placing work products under appropriate configuration management
- Monitoring and controlling process performance, and taking corrective action
- Objectively reviewing the process, work products, and services, and addressing noncompliance
- Reviewing the activities, status, and results of the process with appropriate levels of management, and taking corrective action
- Identifying and interacting with relevant stakeholders

Level 2 begins with basic management practices and continues with increasingly sophisticated focus areas that belong within a specific level.

Maturity Level 3—Defined

The organization has achieved all of the goals of Level 2. There is an organizational way of doing business, with tailoring of this organizational method allowed under predefined conditions. The organization has an organization's set of standard processes (OSSP). The following characteristics of the process are clearly stated:

- Purpose
- Inputs
- Entry criteria
- Activities
- Roles
- Measures
- Verification steps
- Outputs
- Exit criteria

Level 3 continue with defining a strong, meaningful, organization wide approach to developing products. An important distinction between Level 2 and Level 3 is that at Level 3, processes are described in more detail and more rigorously than at Level 2. Processes are managed more proactively, based on a more sophisticated understanding of the interrelationships and measurements of the processes and parts of the processes. Level 3 is more sophisticated, more organized, and establishes an organizational identity—a way of doing business particular to this organization.

Maturity Level 4—Quantitatively Managed

For Maturity Level 4, the organization has achieved all of the goals of Levels 2 and 3. The organization controls its processes by statistical and other quantitative techniques. Product quality, process performance, and service quality are understood in statistical terms and are managed throughout the life of the processes.

Level 4 focuses on using metrics to make decisions and to truly measure whether progress is occurring and your product is improving. Distinctions between Level 3 and Level 4 are that at Level 3, processes are *qualitatively* predictable. At Level 4, processes are *quantitatively* predictable. Level 4 addresses *special causes* of process variation and takes corrective action.

Maturity Level 5—Optimizing

The organization has achieved all of the goals of Levels 2, 3, and 4. Processes are continually improved based on an understanding of *common* causes of variation within the processes.

Level 5 is nirvana. Everyone is a productive member of the team, defects are reduced, and your product is delivered on time and within the estimated budget. In the staged representation, the maturity levels serve as process boundaries meaning that the efforts documented in that maturity level relate *only* to that maturity level. For example, Requirements Management is a Level 2 process area. The next process area in Level 2 is Project Planning. Then there is Project Monitoring and Control, Supplier Agreement Management, Measurement and Analysis, Process and Product Quality Assurance, and Configuration Management. So, to be considered a Maturity Level 2 organization, the projects undergoing process improvement need to satisfy the goals for all of the process areas for Maturity Level 2. In Maturity Level 3, there are the following process areas:

- Requirements Development
- Technical Solution
- Product Integration
- Verification
- Validation
- Organizational Process Focus
- Organizational Process Definition + Integrated Product and Process Development (IPPD)
- Organizational Training
- Integrated Project Management + Integrated Product and Process Development (IPPD)
- Risk Management

So, an organization seeking to be Maturity Level 3 would need to structure their process improvement program to satisfy the goals for *both* Level 2 and Level 3. The point to note is that the process areas listed in Level 2 are not listed in Level 3, and vice versa. The same holds true for Maturity Level 4 and Maturity Level 5. You must satisfy all of the goals in the previous levels plus the goals for the current level in order to attain the maturity level rating. Each maturity level consists of process areas. Each process area contains goals that must be satisfied. Each goal has certain practices or actions associated with it

The Continuous Representation

The continuous representation has the same basic information as the staged representation, just arranged differently; that is, in capability levels not maturity levels, and process area categories. The continuous representation focuses process improvement on actions to be completed within process areas, yet the processes and their actions may span different levels. More sophistication in implementing the practices is expected at the different levels. These levels are called capability levels. There are six capability levels:

Level 0: Incomplete
Level1: Performed
Level2 Managed
Level 3: Defined
Level 4: Quantitatively Managed
Level 5: Optimizing

What's a capability level? Capability levels focus on maturing the organization's ability to perform, control, and improve its performance in a process area. This ability allows the organization to focus on specific areas to improve performance of that area. A brief explanation of each capability level follows.

Capability Level 0: Incomplete

An incomplete process does not implement all of the Capability Level 1 specific practices in the process area that has been selected. This is tantamount to Maturity Level 1 in the staged representation.

Capability Level 1: Performed

A Capability Level 1 process is a process that is expected to perform all of the Capability Level 1 specific practices. Performance may not be stable and may not meet specific objectives such as quality, cost, and schedule, but useful work can be done. This is only a start, or baby step, in process improvement. It means you are doing something, but you cannot prove that it is really working for you.

Capability Level 2: Managed

A managed process is planned, performed, monitored, and controlled for individual projects, groups, or stand-alone processes to achieve a given purpose. Managing the process achieves both the model objectives for the process as well as other objectives, such as cost, schedule, and quality. As the title of this level state, you are actively managing the way things are done in your organization. You have some metrics that are consistently collected and applied to your management approach. Remember, metrics are collected *and used* at all levels of CMMI, in both the staged and continuous representations. It is a bitter fallacy to think that an organization can wait until Level 4 to use the metrics.

Capability Level 3: Defined

A defined process is a managed process that is tailored from the organization's set of standard processes. Deviations beyond those allowed by the tailoring guidelines are documented, justified, reviewed, and approved. The organization's set of standard processes is just a fancy way of saying that your organization has an identity. That is, there is an organizational way of doing work that differs from the way another organization within your company

may do it. So, let's say there are two companies developing anvils. Those two companies are Road Runner Industries and Wily Coyote Industries. The people at Road Runner Industries consistently beat the pants off Wily Coyote Industries when developing anvils. Why? Because Road Runner Industries has a special way, specific to them, of developing anvils. It is documented, measured, people are trained in it, and the results are tracked.

Capability Level 4: Quantitatively Managed

A quantitatively managed process is a defined process that is controlled using statistical and other quantitative techniques. Product quality, service quality, process performance, and other business objectives are understood in statistical terms and are controlled throughout the life cycle. Yep, this is where such ideals as statistical process control come into being. However, the point we would like to make is *keep it simple*. Metrics do not have to be difficult to be useful. In fact, the opposite holds true. We don't want to have to grit our teeth and get a tension headache every time we think about collecting and analyzing the metrics collected in our organization. Make them meaningful and associate them with some problem you would like to conquer. For example: Let's say your company makes personal computers and ships them to customers. One day you are sitting at your desk and receive a call from an irate customer. How did it get to you? Who knows, but it did. (This could be an opportunity in disguise.) The customer describes his tale of woe and ends up with stating that the PC arrived at his house with the box intact and unopened, but the monitor was smashed to bits. Well, if this is your first phone call about it, and you are busy, and this is not your job, you might ignore it. But, if you start receiving five such calls every day, you might want to start counting the number of calls, analyzing where the problem was injected into the shipping process, institute a new process for fixing this defect, and track the effectiveness of your process. Then, by analyzing the number of defects expected in prior months versus the actual number of defects this month, you can come up with a standard number of expected defects. When this number is exceeded, the process is broken and must be fixed. Also, you can work on reducing this number. That's quantitatively managing.

Capability Level 5: Optimizing

An optimizing process is a quantitatively managed process that is improved based on an understanding of the common causes of process variation inherent in the process. It focuses on continually improving process performance through both incremental and innovative improvements. Both the defined processes and the organization's set of standard processes are targets of improvement activities. Level 4 focuses on establishing baselines, models, and measurements for process performance. Level 5 focuses on studying performance results across the organization or entire enterprise, finding common causes of problems in how the work is done (the process(es) used), and fixing the problems in the process. The fix would include updating the process documentation and training involved where the errors were injected. So the process may only be broken at the project level; or, it could be entirely broken, and the process at the organizational level and all resultant levels may need to be repaired.

The continuous representation contains the same basic information as the staged model; the information is just arranged differently. The information (process areas, goals, practices) is arranged in what we call functional categories; that is, each process area is grouped by the functionality it performs. There are four types of process categories:

- Process Management Processes
- Project Management Processes
- Engineering Processes
- Support Processes

So, for example, in the continuous representation, the Project Management Processes category contains the following process areas in the following order:

- Project Planning
- Project Monitoring and Control
- Supplier Agreement Management
- Integrated Project Management (with IPPD)
- Risk Management
- Quantitative Project Management

These process areas are all related in some way. They are categorized as Project Management Processes. Although an organization may select which processes to focus improvement efforts on when using the continuous representation, this presentation seems to suggest that if your organization needs help in improving its project management approach to product development, start with these process areas in this order.

The continuous representation does not overtly suggest a sequence to use for process improvement; however, a sequence is implied. In the list of Project Management Processes, it would be ludicrous for an organization to attempt to institute Quantitative Project Management before successfully achieving the goals of the Project Planning process area (as Quantitative Project Management is more sophisticated and more complex than Project Planning). If you review the order of the process areas in the list, you will surmise that the less sophisticated process areas are listed first, with the more sophisticated process areas following. For example, before you can focus on Project Monitoring and Control, Project Planning should be in place. It seems that the continuous representation is saying that Project Planning should be attempted first, followed much later by Risk Management because Risk Management is more sophisticated (and probably more complicated to institute) than Project Planning. Also, without the basis of Project Planning, Risk Management could not be performed effectively.

A subtler, less obvious subject that bears discussing is that of generic practices and how they relate to process areas, maturity levels, and capability levels. Process areas at Maturity Level 2 in the staged representation include entire process areas for planning, managing changes, ensuring quality, and tracking progress. The generic practices for Capability Level 2 in the continuous representation also include statements for the same things—planning, managing changes, ensuring quality, and tracking progress. Generic practices are used to determine whether generic goals have been satisfied. Generic goals must be satisfied to achieve a level—either a capability level or a maturity level. What this means is that because an organization is expected to implement the generic practices, an organization using the continuous representation and selecting separate process areas to focus on must in reality also satisfy the basic concepts of Maturity Level 2 in the staged representation. An example follows.

An organization may decide to use the continuous representation. This organization selects the process area of Technical Solution and is seeking a Capability Level 2 for it. To achieve this capability level, all of the specific practices for Technical Solution are expected to be implemented, and all of the generic practices for this level are expected to be instituted. That means that activities surrounding planning, managing changes, ensuring quality, and tracking progress for Technical Solution must be addressed. To address these issues and institute the generic practices, the organization discovers that it must actually backup a bit and also focus on the process areas of Project Planning, Project Monitoring and Control, and Configuration Management. So, although it may appear that an organization can skip process areas when using the continuous representation, the actions of those process areas must be met.

Maturity Level 2: Managed

Two new concepts are introduced in Level 2 in CMMI. They are:

- Supplier Agreement Management (SAM)
- Integrated Product and Process Development (IPPD)

SAM has to do with ensuring that any organization or business external to the actual project is selected and monitored appropriately. This external source (supplier) may be responsible for delivering either a product or a service and may be involved in the design, development, maintenance, manufacture, modification, upgrade, or supply of any of the items required to produce the product. This supplier generates an agreement (contract) with the acquiring body, and it is this agreement that is used to effectively manage the effort provided by the supplier. This agreement must be properly defined, documented, used, monitored, and measured. SAM replaced Software Subcontract Management (SSM) in the CMM for Software. SSM was the key process area most often tailored out of assessments and software process improvement activities because if there were no subcontractors used, then this area did not apply. Although SAM has been broadened somewhat, it is still the most tailored-out process area. In fact, it is the only process area that is allowed to be tailored out—that means, SAM may be declared "not applicable" to the organization's business. Including SAM in the CMMI also makes a correlation to the Software Acquisition Capability Maturity Model (SA-CMM) more plausible. Although both SAM and the Software Acquisition Model discuss suppliers, vendors, procurements, and acquisition roles, more information from a different perspective (i.e., that of an acquisition or procurement office) may be found in the Acquisition Model.

IPPD is about forming teams that include subject matter experts from all areas needed to produce the product for the customer. Suffice it to say that IPPD is about establishing and conducting integrated teams in a formal manner. An example might be when building a new jet fighter. This effort would require hundreds or thousands of individuals to work on developing all parts of the plane, including the sophisticated software systems for navigation, landing, communications, and attack; the actual construction of the hardware and fuselage of the plane; safety engineers to test safety-critical parts and functioning; mechanics to ensure that the plane would be easy and quick to repair under emergency and nonemergency conditions; pilots to ensure that the plane could actually be flown; documentation experts to ensure that all necessary documentation and manuals were written correctly; and others. In cases such as this one, rather than try to include comments and ideas from everyone working on the project (that is, to design and deliver a working jet fighter plane), representatives from each area would be assigned to an Integrated Product Team (IPT). This team would develop a shared vision of what the final product should look like and what its final functionality should include. They would also be responsible for ensuring that input from all areas was included in the requirements gathering, design, development, testing, and final delivery of the product.

Moving from Level 1 to Level 2

The biggest hurdle that most organizations face when embarking on the journey from an immature organization to a more mature one is the jump from Level 1 to Level 2. Level 1 is characterized by ad hoc processes; that is, processes that the people doing the work have created themselves to accomplish their tasks. The problem with this method is that redundant work is often done, people do not share their methods across the organization, and some approaches are in opposition to actually making the organization run more effectively. While some individual approaches may work for a particular individual, that person's approach may actually conflict with work being done downstream. The results are more rework, delays, and frustration. Turf wars are common, and the organization functions due to the heroics

of its people. When these people move on (or burn out), the organization suffers.

Level 2 is characterized by individuals sharing their lessons learned and best practices, and devising preliminary processes that will function at the project level, and in some cases, across the organization as a whole. Level 2 focuses on management issues that affect normal, day-to-day work routines. Level 2 consists of seven process areas that contribute to project management efficiencies.

There are seven process areas (PAs) that make up Level 2. They are:

Requirements Management
Project Planning
Project Monitoring and Control
Supplier Agreement Management
Measurement and Analysis
Process and Product Quality Assurance
Configuration Management

The Process Areas for Maturity Level 2: Managed

Requirements Management

The purpose of Requirements Management (REQM) is 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.

Specific Goals and Practices for This Process Area:
SG1 Manage Requirements
SP 1.1   Obtain an Understanding of Requirements
SP 1.2   Obtain Commitment to Requirements
SP 1.3   Manage Requirements Changes
SP 1.4   Maintain Bidirectional Traceability of Requirements
SP 1.5   Identify Inconsistencies between Project Work and Requirements

Project Planning

The purpose of Project Planning (PP) is to establish and maintain plans that define project activities.

Specific Goals and Practices for This Process Area:
SG Establish Estimates
SP 1.1   Estimate the Scope of the Project
SP 1.2   Establish Estimates of Work Product and Task Attributes
SP 1.3   Define Project Life Cycle
SP 1.4   Determine Estimates of Effort and Cost
SG2   Develop a Project Plan
SP 2.1   Establish the Budget and Schedule
SP 2.2   Identify Project Risks
SP 2.3   Plan for Data Management
SP 2.4   Plan for Project Resources
SP 2.5   Plan for Needed Knowledge and Skills

SP 2.6   Plan Stakeholder Involvement
        SP 2.7   Establish the Project Plan
    SG3   Obtain Commitment to the Plan
        SP 3.1   Review Plans That Affect the Project
        SP 3.2   Reconcile Work and Resource Levels
        SP 3.3   Obtain Plan Commitment

Project Monitoring and Control

The purpose of Project Monitoring and Control (PMC) is 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.

    Specific Goals and Practices for This Process Area:
    SG1   Monitor Project against Plan
        SP 1.1   Monitor Project Planning Parameters
        SP 1.2   Monitor Commitments
        SP 1.3   Monitor Project Risks
        SP 1.4   Monitor Data Management
        SP 1.5   Monitor Stakeholder Involvement
        SP 1.6   Conduct Progress Reviews
        SP 1.7   Conduct Milestone Reviews
    SG2   Manage Corrective Action to Closure
        SP 2.1   Analyze Issues
        SP 2.2   Take Corrective Action
        SP 2.3   Manage Corrective Action

Supplier Agreement Management

The purpose of Supplier Agreement Management (SAM) is to manage the acquisition of products from suppliers.

    Specific Goals and Practices for This Process Area:
    SG1   Establish Supplier Agreements
        SP 1.1   Determine Acquisition Type
        SP 1.2   Select Suppliers
        SP 1.3   Establish Supplier Agreements
    SG2   Satisfy Supplier Agreements
        SP 2.1   Execute the Supplier Agreement
        SP 2.2   Monitor Selected Supplier Processes
        SP 2.3   Evaluate Selected Supplier Work Products
        SP 2.4   Accept the Acquired Product
        SP 2.5   Transition Products

Measurement and Analysis

The purpose of Measurement and Analysis (M&A) is to develop and sustain a measurement capability that is used to support management information needs.

    Specific Goals and Practices for This Process Area:
    SG1   Align Measurement and Analysis Activities
        SP 1.1   Establish Measurement Objectives
        SP 1.2   Specify Measures
        SP 1.3   Specify Data Collection and Storage Procedures
        SP 1.4   Specify Analysis Procedures

SG2   Provide Measurement Results
    SP 2.1   Collect Measurement Data
    SP 2.2   Analyze Measurement Data
    SP 2.3   Store Data and Results
    SP 2.4   Communicate Results

Process and Product Quality Assurance

The purpose of Process and Product Quality Assurance (PPQA) is to provide staff and management with objective insight into processes and associated work products.

Specific Goals and Practices for This Process Area:
    SG1   Objectively Evaluate Processes and Work Products
        SP 1.1 Objectively Evaluate Processes
        SP 1.2 Objectively Evaluate Work Products and Services
    SG2   Provide Objective Insight
        SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues
        SP 2.2 Establish Records

Maturity Level 3: Defined

Moving from Level 2 to Level 3

Maturity Level 3 differs from Level 2 in that now an organizational way of doing business has been developed. What that means is that the best practices and lessons learned from the projects have bubbled up to the organizational level to create an organizational identity. There are common, shared approaches for performing daily tasks on each project. For example, estimating the size of a project may be done using the Delphi Technique (basically subject matter experts discussing best-case and worst-case estimates), a standard metric may have been institutionalized (such as using function points instead of lines of code), and a standard tool may be in use to actually calculate the size.

To perform at Level 3, an organization must have satisfied all of the goals for all of the process areas (PAs) in both Level 2 and Level 3. Sometimes exceptions may be made. Caution should be exercised however. Entire *process areas* are generally not allowed to be tailored out of consideration. *Practices* may be tailored out if replaced by sufficient alternative practices. Remember: the more tailoring done, the less likely an organization is to achieve improvement, and the less likely the organization is to achieve a maturity level through an appraisal.

There are 11 process areas for Level 3. They are:

Requirements Development
Technical Solution
Product Integration
Verification
Validation
Organizational Process Focus
Organizational Process Definition (with IPPD)
Organizational Training
Integrated Project Management (with IPPD)
Risk Management
Decision Analysis and Resolution

For the continuous approach, the generic goals and generic practices for each capability level that must be satisfied for each selected process area are: the abbreviations GG for generic goal and GP for generic practice.

Capability Level 1:
    GG1   Achieve Specific Goals
        GP 1.1   Perform Specific Practices
Capability Level 2:
    GG2   Institutionalize a Managed Process
        GP 2.1   Establish an Organizational Policy
        GP 2.2   Plan the Process
        GP 2.3   Provide Resources
        GP 2.4   Assign Responsibility
        GP 2.5   Train People
        GP 2.6   Manage Configurations
        GP 2.7   Identify and Involve Relevant Stakeholders
        GP 2.8   Monitor and Control the Process
        GP 2.9   Objectively Evaluate Adherence
        GP 2.10   Review Status with Higher Level Management
Capability Level 3:
    GG3   Institutionalize a Defined Process
        GP 3.1   Establish a Defined Process
        GP 3.2   Collect Improvement Information
Capability Level 4:

GG4   Institutionalize a Quantitatively Managed Process
    GP 4.1   Establish Quantitative Objectives for the Process
    GP 4.2   Stabilize Sub-process Performance
Capability Level 5:
    GG5   Institutionalize an Optimizing Process
    GP 5.1   Ensure Continuous Process Improvement
    GP 5.2   Correct Root Causes of Problems

Process Areas for the Maturity Level 3: Defined

Requirements Development

The purpose of Requirements Development (RD) is to produce and analyze customer, product, and product component requirements.

Specific Goals and Practices for This Process Area:
    SG1   Develop Customer Requirements
        SP 1.1   Elicit Needs
        SP 1.2   Develop the Customer Requirements SG 2
    Develop Product Requirements
        SP 2.1   Establish Product and Product Component Requirements
        SP 2.2   Allocate Product Component Requirements
        SP 2.3   Identify Interface Requirements
    SG3   Analyze and Validate Requirements
        SP 3.1   Establish Operational Concepts and Scenarios
        SP 3.2   Establish a Definition of Required Functionality
        SP 3.3   Analyze Requirements
        SP 3.4   Analyze Requirements to Achieve Balance SP
        3.5   Validate Requirements

Technical Solution

The purpose of Technical Solution (TS) is to design, develop, and implement solutions to requirements. Solutions, designs, and implementations encompass products, product components, and product-related life-cycle processes either singly or in combination as appropriate.

Specific Goals and Practices for This Process Area:
    SG1   Select Product Component Solutions
        SP 1.1   Develop Alternative Solutions and Selection Criteria
        SP 1.2   Select Product Component Solutions
    SG2   Develop the Design
        SP 2.1   Design the Product or Product Component
        SP 2.2   Establish a Technical Data Package
        SP 2.3   Design Interfaces Using Criteria
        SP 2.4   Perform Make, Buy, or Reuse Analyses SG3
    Implement the Product Design
        SP 3.1   Implement the Design
        SP 3.2   Develop Product Support Documentation

Product Integration

The purpose of Product Integration (PI) is to assemble the product from the product components, ensure that the product, as integrated, functions properly, and deliver the product.

Specific Goals and Practices for This Process Area:
    SG1   Prepare for Product Integration
        SP 1.1   Determine Integration Sequence
        SP 1.2   Establish the Product Integration Environment
        SP 1.3   Establish Product Integration Procedures and Criteria
    SG2   Ensure Interface Compatibility
        SP 2.1   Review Interface Descriptions for Completeness
        SP 2.2   Manage Interfaces
    SG3   Assemble Product Components and Deliver the Product
        SP 3.1   Confirm Readiness of Product Components for Integration
        SP 3.2   Assemble Product Components
        SP 3.3   Evaluate Assembled Product Components
SP 3.4   Package and Deliver the Product or Product Component

Verification

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

Specific Goals and Practices for This Process Area:
    SG1   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 SG2
    Perform Peer Reviews
        SP 2.1   Prepare for Peer Reviews
        SP 2.2   Conduct Peer Reviews
        SP 2.3   Analyze Peer Review Data SG3
    Verify Selected Work Products
        SP 3.1   Perform Verification
        SP 3.2   Analyze Verification Results

Validation

The purpose of Validation (VAL) is to demonstrate that a product or product component fulfils its intended use when placed in its intended environment.

Specific Goals and Practices for This Process Area:
    SG1   Prepare for Validation
        SP 1.1   Select Products for Validation
        SP 1.2   Establish the Validation Environment
        SP 1.3   Establish Validation Procedures and Criteria SG2
    Validate Product or Product Components
        SP 2.1   Perform Validation
        SP 2.2   Analyze Validation Results

Organizational Process Focus

The purpose of Organizational Process Focus (OPF) is 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.

Specific Goals and Practices for This Process Area:
SG1   Determine Process Improvement Opportunities
    SP 1.1   Establish Organizational Process Needs
    SP 1.2   Appraise the Organization's Processes
    SP 1.3   Identify the Organization's Process Improvements
SG2   Plan and Implement Process Improvements
    SP 2.1   Establish Process Action Plans
    SP 2.2   Implement Process Action Plans
SG3   Deploy Organizational Process Assets and Incorporate Lessons Learned
    SP 3.1   Deploy Organizational Process Assets
    SP 3.2   Deploy Standard Processes
    SP 3.3   Monitor Implementation
    SP3.4   Incorporate Process-Related Experiences into the Organizational Process Assets

Organizational Process Definition + IPPD

The purpose of Organizational Process Definition (OPD) is to establish and maintain a usable set of organizational process assets and work environment standards.

For IPPD: Organizational Process Definition + IPPD also covers the establish-ment of organizational rules and guidelines that enable conducting work using integrated teams.

Specific Goals and Practices for This Process Area:
SG1   Establish Organizational Process Assets
    SP 1.1   Establish Standard Processes
    SP 1.2   Establish Life Cycle Model Descriptions
    SP 1.3   Establish Tailoring Criteria and Guidelines
    SP 1.4   Establish the Organization's Measurement Repository
    SP 1.5   Establish the Organization's Process Asset Library
    SP 1.6   Establish Work Environment Standards
IPPD Addition:
SG2   Enable IPPD Management
    SP 2.1   Establish Empowerment Mechanisms
    SP 2.2   Establish Rules and Guidelines for Integrated Teams
    SP 2.3   Balance Team and Home Organization Responsibilities

Organizational Training

The purpose of Organizational Training (OT) is to develop the skills and knowledge of people so they can perform their roles effectively and efficiently

Specific Goals and Practices for This Process Area:
SG1   Establish an Organizational Training Capability
    SP 1.1   Establish the Strategic Training Needs
    SP 1.2   Determine Which Training Needs Are the Responsibility of the Organization
    SP 1.3   Establish an Organizational Training Tactical Plan

SP 1.4   Establish Training Capability
SG2   Provide Necessary Training
    SP 2.1   Deliver Training
    SP2.2   Establish Training Records
    SP 2.3   Assess Training Effectiveness

Integrated Project Management + IPPD

The purpose of Integrated Project Management (IPM) is 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.

For IPPD: Integrated Project Management + IPPD also covers the establishment of a shared vision for the project and the establishment of integrated teams that will carry out the objectives of the project.

Specific Goals and Practices for This Process Area:
SG1   Use the Project's Defined Process
    SP 1.1   Establish the Project's Defined Process
    SP 1.2   Use Organizational Process Assets for Planning Project Activities
    SP 1.3   Establish the Project's Work Environment
    SP 1.4   Integrate Plans
    SP 1.5   Manage the Project Using the Integrated Plans
    SP 1.6   Contribute to the Organizational Process Assets
SG2   Coordinate and Collaborate with Relevant Stakeholders
    SP 2.1   Manage Stakeholder Involvement
    SP 2.2   Manage Dependencies
    SP 2.3   Resolve Coordination Issues
    IPPD Addition:
SG3   Apply IPPD Principles
    SP 3.1   Establish the Project's Shared Vision
    SP 3.2   Establish the Integrated Team Structure
    SP 3.3   Allocate Requirements to Integrated Teams
    SP 3.4   Establish Integrated Teams
    SP 3.5   Ensure Collaboration among Interfacing Teams

Risk Management

The purpose of Risk Management (RSKM) is 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.

Specific Goals and Practices for This Process Area:
SG1   Prepare for Risk Management
    SP 1.1   Determine Risk Sources and Categories SP
    1.2   Define Risk Parameters
    SP 1.3   Establish a Risk Management Strategy SG2
Identify and Analyze Risks
    SP 2.1   Identify Risks
    SP 2.2   Evaluate, Categorize, and Prioritize Risks SG3
Mitigate Risks
    SP 3.1   Develop Risk Mitigation Plans
    SP 3.2   Implement Risk Mitigation Plans

Decision Analysis and Resolution

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.

Specific Goals and Practices for This Process Area:

SG1 Evaluate Alternatives

- SP 1.1 Establish Guidelines for Decision Analysis
- SP 1.2 Establish Evaluation Criteria
- SP 1.3 Identify Alternative Solutions
- SP 1.4 Select Evaluation Methods
- SP 1.5 Evaluate Alternatives
- SP 1.6 Select Solutions

Maturity Level 4: Quantitatively Managed

Moving from Level 3 to Level 4

There are two process areas (PAs) for Level 4. They are:

Organizational Process Performance
Quantitative Project Management

GG2   Institutionalize a Managed Process
   GP 2.1   Establish an Organizational Policy
   GP 2.2   Plan the Process
   GP 2.3   Provide Resources
   GP 2.4   Assign Responsibility
   GP 2.5   Train People
   GP 2.6   Manage Configurations
   GP 2.7   Identify and Involve Relevant Stakeholders
   GP 2.8   Monitor and Control the Process
   GP 2.9   Objectively Evaluate Adherence
   GP 2.10   Review Status with Higher-Level Management
GG3   Institutionalize a Defined Process
   GP 3.1   Establish a Defined Process
   GP 3.2   Collect Improvement Information

Quantitatively Managed

Organizational Process Performance

Specific Goals and Practices for This Process Area:
   SG1   Establish Performance Baselines and Models
      SP 1.1   Select Processes
      SP 1.2   Establish Process-performance Measures
      SP 1.3   Establish Quality and Process-performance Objectives
      SP 1.4   Establish Process-performance Baselines
      SP 1.5   Establish Process-performance Models

Quantitative Project Management

The purpose of Quantitative Project Management (QPM) is to quantitatively manage the project's defined process to achieve the project's established quality and process-performance objectives.

Specific Goals and Practices for This Process Area:
   SG1   Quantitatively Manage the Project
      SP 1.1   Establish the Project's Objectives
      SP 1.2   Compose the Defined Process
      SP 1.3   Select the Subprocesses That Will Be Statistically Managed
      SP 1.4   Manage Project Performance
   SG2   Statistically Manage Subprocess Performance
      SP 2.1   Select Measures and Analytic Techniques
      SP 2.2   Apply Statistical Methods to Understand Variation

SP 2.3   Monitor Performance of the Selected Subprocesses
SP 2.4   Record Statistical Management Data

Maturity Level 5: Optimizing

Moving from Level 4 to Level 5

There are two process areas (PAs) for Level 5. They are:

Organizational Innovation and Deployment
Causal Analysis and Resolution

The Process Areas for Maturity Level 5: Optimizing

Organizational Innovation and Deployment

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.

Specific Goals and Practices for This Process Area:
SG1   Select Improvements
    SP 1.1   Collect and Analyze Improvement Proposals
    SP 1.2   Identify and Analyze Innovations
    SP 1.3   Pilot Improvements
    SP 1.4   Select Improvements for Deployment
SG2   Deploy Improvements
    SP 2.1   Plan the Deployment
    SP 2.2   Manage the Deployment
    SP 2.3   Measure Improvement Effects

Causal Analysis and Resolution

The purpose of Causal Analysis and Resolution (CAR) is to identify causes of defects and other problems and take action to prevent them from occurring in the future.

Specific Goals and Practices for This Process Area:
SG1   Determine Causes of Defects
    SP 1.1   Select Defect Data for Analysis
    SP 1.2   Analyze Causes
SG2   Address Causes of Defects
    SP 2.1   Implement the Action Proposals
    SP 2.2   Evaluate the Effect of Changes
    SP 2.3   Record Data