Interpreting Capability Maturity Model® Integration (CMMI®) for Service Organizations – a Systems Engineering and Integration Services Example

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Abstract

Capability Maturity Model® Integration (CMMI®) provides a framework for improving the processes organizations use to develop, deliver, and maintain products and services. This technical note presents one organization's interpretation of CMMI best practices for organizations that primarily provide services. Service organizations can use this example interpretation of CMMI practices to inform management and staff about how CMMI practices apply to their work. The interpretation will also help appraisal team members ensure that implemented practices provide the business value necessary to satisfy the goals for quality process improvement that are stated in the CMMI models.

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1   Systems Engineering and Integration Services

The process improvement concepts embedded in CMMI are based on sound principles developed by Juran, Shewhart, and Deming [Juran 88, Shewhart 31, Deming 86] that were applied successfully in the manufacturing communities for over 60 years. CMMI best practices are focused on product development and maintenance, but can be applied to service development, maintenance, and delivery as well. You will find that many best practices easily apply to both products and services. Others require some interpretation to apply equally as well.

This technical note was developed by members of a service organization who considered how CMMI best practices applied to their environment. Much of this technical note is relevant to other service organizations. However, the section that addresses engineering best practices is more specifically applicable to the authors' organization.

It is important to remember that this is an example of the type of interpretations that a service organization may want to provide to services management and staff to help them understand how CMMI practices apply to their work. Such interpretations also help appraisal team members to assure that implemented practices are providing the business value necessary to satisfy the goals for quality process improvement captured in the CMMI models. As you read through this technical note, decide which interpretations are a good fit for your organization, which do not need any interpretation, and which might need another interpretation to maximize business value.

The service organization used as an example for this technical note provides Systems Engineering and Integration (SE&I) services. In this organization, service teams provide customers with a diverse set of management and technical services. Although these teams may not produce physical products such as cars, computers, tanks, airplanes, software programs, and missiles, the services they provide are essential to the use of existing products or the development of new products. Because of the vital nature of these services, CMMI recognizes them as "products" on their own. These service teams function in an operational environment like those discussed in the technical note, *Interpreting Capability Maturity Model Integration (CMMI) for Operational Organizations* [Gallagher 02]. These teams either provide complete services or function as part of a larger team structure. These teams may provide services for government, military, commercial, or international customers, or for other parts of their own organization.

1.1 SE&I Team Functions

The functions of teams that provide SE&I services are found in a wide variety of application domains, including the following:

- Systems Engineering and Technical Assistance (SETA) organizations that support government or commercial acquisition activities by providing project planning assistance, technical advice, and engineering activity monitoring

- Independent Verification and Validation (IV&V) providers that objectively evaluate the correctness of engineering activities or products against their specifications

- Installation of application systems or hardware environments on behalf of government or commercial operations

- Trusted agents that are given the authority to control projects on the behalf of operational organizations and that provide expertise in some technical or management domain

- Assistance in re-engineering operational processes within an organization, usually to take advantage of an existing or new information system

- On-call assistance providers that supply multi-tier help desks to support fielded products or services

Organizations that provide services can use CMMI best practices to integrate sound management and engineering practices across their management and technology services. Implementing CMMI practices affords higher levels of customer satisfaction, reduced service times, lower costs, improved continuity of services, and increased value of both technical and management services.

1.2 Life-Cycle Model

The life-cycle model used by the organization that serves as the example for this technical note is the Vee model [Arunski 99]. Service organizations that provide SE&I services do not usually develop hardware or software products and may not provide a wide variety of tasks and functions. The specific service and the part of the organization that provides the service are dependent on customer tasking and project organization.

While providing SE&I services, organizations typically provide their own basic management functions to ensure the stability, consistency, and quality of these services while making a fair profit.

The tables in the following sections demonstrate how CMMI process areas (PAs), specific goals, and specific practices can be interpreted for service organizations. The PA name, goal, and practice statements are identical to the language in the CMMI V1.1 models. While we have applied the use of interpretive information intentionally broadly, in some cases "No Further Interpretation" (NFI) was needed, and that has been indicated in the appropriate boxes.

CMMI practices can be used for process improvement in most service organizations with little interpretation. However, by providing interpretation like what is contained in this technical note, organizations can ensure that CMMI interpretation is consistent and straightforward throughout the organization to all that need to know model practices. This technical note offers one service organization's documented interpretations based on its use of CMMI best practices.

2 Applying CMMI Practices to Service Organizations

An organization's decision to invest in process improvement should be an informed one based on understanding the strategic and tactical importance of each of its business objectives. Service organizations, like product development organizations, begin this investment in process improvement by developing a list of prioritized business objectives. Using CMMI to help meet these business objectives is relatively straightforward since a CMMI model is a collection of best practices that are applicable across a wide variety of domains.

The next step in this investment activity is to align these prioritized business objectives with the practices in the CMMI PAs. These practices are useful tools for improving the service organization's activities.

The basic management activities in service organizations are the same as the management activities in development, sustainment, or operational organizations. In service organizations, services are the primary products; therefore, these organizations must plan their service activities, provide these activities within cost and schedule constraints, please their customers, and maintain high levels of quality.

2.1 CMMI Model Characteristics

This technical note does not provide details on the structure and characteristics of CMMI models. However, this section of the technical note is necessary to understand the interpretations provided in other parts of the technical note. CMMI models are available in two representations: staged and continuous. This technical note is based on the implementation of a CMMI model with a continuous representation since it is the representation used by the example organization referenced in this technical note.

There are four PA categories (i.e., Project Management, Support, Engineering, and Process Management) in the continuous representation of the CMMI models. Each of these categories consists of multiple PAs. Each PA contains goals and related practices. Table 1 lists these categories, their constituent PAs, and descriptions of related business objectives typical of a service organization.

Table 1 also shows the relationships of the PAs in each of the four PA categories to the objectives of a service organization. In the Project Management and Support PAs, the project management practices of service organizations are very similar to the practices of development organizations. While the business objectives are quite similar in the Engineering

and Process Management PAs, the processes, practices, and work products are quite different. Service organizations implementing CMMI best practices can benefit from an early understanding of these interpretations. Sections 3 through 6 of this technical note will explore each of the Process Area Categories, interpreting the practices of the process areas comprising each.

Table 1:   CMMI PAs and Related Business Objectives

CMMI PA Categories and PAs	Related Business Objectives of Services Organizations
Project Management: • Project Planning • Project Monitoring and Control • Supplier Agreement Management • Integrated Project Management • Risk Management • Quantitative Project Management • Integrated Teaming	1. Maintain detailed service plans that include the budget and schedule needed to support the customer. 2. Manage the costs and schedule associated with the service. 3. Effectively manage suppliers of tools or resources vital to the success of the service. 4. Integrate the delivery of the service with other projects and stakeholders. 5. Plan for current and future risks to the service project. 6. Establish predictability in their services. 7. Plan and deploy teams that provide the customer base a best value in dynamic environments.
Support: • Configuration Management • Process and Product Quality Assurance • Measurement and Analysis • Decision Analysis and Resolution • Causal Analysis and Resolution • Organizational Environment for Integration	1. Control technical and management work products. 2. Ensure their services meet quality objectives and customer requirements. 3. Understand the measures of cost, profitability, and the cost of quality. 4. Make informed and justifiable selections of products or techniques for their customers. 5. Track service issues to root causes and eliminate them. 6. Provide services, including (in the case of SE&I) establishing work environments that enable engineering and integration tasks.
Engineering: • Requirements Management • Requirements Development • Technical Solution • Product Integration • Verification • Validation	1. Develop and manage their service requirements. 2. Provide services that (in the case of SE&I) provide technical stability and support all aspects of product development and fielding. 3. Ensure that interfaces are compatible prior to their integration. 4. Provide technical support to ensure that products are implemented correctly. 5. Confirm that performed services satisfy their service requirements. 6. Evaluate the suitability of acquired products and services.

Process Management:	1. Build and maintain a service culture.
• Organizational Process Focus • Organizational Process Definition • Organizational Training • Organizational Process Performance • Organizational Innovation and Deployment	2. Implement and improve processes to support predictable successful execution. 3. Train staff members to perform service functions. 4. Measure the effectiveness and performance of processes. 5. Introduce new service methods, technologies, and functions.

2.2 CMMI Capability Levels

The degree to which an organization chooses to standardize and improve its processes is determined by implementing the generic practices, which are organized by capability level. A capability level describes the extent to which a service organization may select to achieve best practice objectives within the organization. Table 2 contains a brief description of CMMI capability levels and how they apply to the functioning of service organizations. Selecting a targeted capability level, like the selection of PAs, is an investment decision made by the organization.

The continuous representation is based upon a staircase implementation of the generic practices in each PA. For more information on these practices, please refer to a CMMI V1.1 reference model [SEI 02a & SEI 02b].

Table 2 contains descriptions of the implementation of each capability level in a service organization:

Table 2:   Capability Levels and Associated Implementation

Capability Level	Implementation in a Service Organization
Level 0: Incomplete	The organization implements only some applicable specific practices.
Level 1: Performed	The organization lacks the necessary processes for sustaining service levels.
Level 2: Managed	The organization manages and reacts, but is not able to strategically predict costs of services and compete with lean competitors.
Level 3: Defined	The organization anticipates changes in its environment and plans, but still lacks the ability to forecast changing costs and schedules of services.
Level 4: Quantitatively Managed	The organization statistically forecasts and manages performance against selected cost, schedule, and customer satisfaction levels.
Level 5: Optimizing	The organization can reduce operating costs by improving current process performance or by introducing innovative services to maintain their competitive edge.

Sections 3 through 6 of this technical note provide interpretations of CMMI best practices from the four PA categories to tasks typical of a service organization.

3 Interpreting Project Management for Service Organizations

The management functions in "product-less" organizations are both numerous and vary widely among organizations. Despite this variation, the management tasks typically include planning the costs of providing multiyear service support; implementing these services under a fixed, level-of-effort budget (at least in the case of SE&I organizations); maintaining consistent staff support; managing numerous vendors; and effectively controlling risks. The best practices in the Project Management PAs are as directly applicable to service organizations as they are to development organizations. Tailoring and implementing these practices provides service organizations with techniques for cost and schedule control, supplier management, vendor management, and risk management.

3.1 Planning Resources – Project Planning PA

One of the difficult challenges in managing service contracts is found in estimating and planning resources, including staff, facilities, and special equipment required to provide the service.

Planning the labor mix is complicated because of the unique skills that are required, typically at different times in the service contract. Implementing the practices of the Project Planning PA covers the activities necessary to manage the typical challenges in planning resources, managing risks, and achieving customer satisfaction objectives.

Table 3 provides interpretations of the specific practices of the Project Planning PA for service organizations.

Table 3:   Interpretation of the Project Planning (PP) PA

SG 1: Estimates of project planning parameters are established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish a top-level work breakdown structure (WBS) to estimate the scope of the project.	Determine how many different types of services and service levels, required resources, and schedules are needed for the duration of the contract.
SP 1.2-1 – Establish and maintain estimates of the attributes of the work products and tasks.	Determine the parameters (e.g., size or complexity attributes) that drive the effort required to provide the services.

Specific Practice	Interpretation
SP 1.3-1 – Define the project life-cycle phases upon which to scope the planning effort.	Determine for each service type, an activity flow diagram to baseline resource cost and schedule estimates. This activity flow shows activity dependence and timing that is needed for resource estimations.
SP 1.4-1 – Estimate the project effort and cost for the work products and tasks based on estimation rationale.	Determine the effort and cost using an established rationale. Use data from past projects (or service contracts) that were similar and successful. Include data about necessary management functions. Use lessons learned data, where available, from past service projects or projects of a similar nature.

SG 2: A project plan is established and maintained as the basis for managing the project.

Specific Practice	Interpretation
SP 2.1-1 – Establish and maintain the project's budget and schedule.	NFI
SP 2.2-1 – Identify and analyze project risks.	Identify the risks in providing the services to the customer for the life of the project.
SP 2.3-1 – Plan for the management of project data.	NFI
SP 2.4-1 – Plan for necessary resources to perform the project.	NFI
SP 2.5-1 – Plan for knowledge and skills needed to perform the project.	NFI
SP 2.6-1 – Plan the involvement of identified stakeholders.	NFI
SP 2.7-1 – Establish and maintain the overall project plan content.	NFI

SG3: Commitments to the project plan are established and maintained.

Specific Practice	Interpretation
SP 3.1-1 - Review all plans that affect the project to understand project commitments.	NFI
SP 3.2-1 - Reconcile the project plan to reflect available and estimated resources.	NFI
SP 3.3-1 – Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution.	NFI

3.2 Managing Costs and Schedule – Project Monitoring and Control PA

Service contracts (particularly SE&I service contracts) are typically planned to run on a level of effort, perhaps with an award or incentive fee. Providing a constant level of service in a changing customer environment while meeting quality objectives requires that project performance be monitored regularly.

The practices in the Project Monitoring and Control PA provide useful techniques for implementing and maintaining control of cost and schedule for a service contract. Table 4 provides interpretations of the specific practices of the Project Monitoring and Control PA for service organizations.

Table 4: Interpretation of the Project Monitoring and Control (PMC) PA

SG 1: Actual performance and progress of the project are monitored against the project plan.	
Specific Practice	**Interpretation**
SP 1.1-1 – Monitor the actual values of the project planning parameters against the project plan.	Determine if the current cost and staffing levels are still consistent with that needed to produce the required service types, levels, and quality requirements.
SP 1.2-1 – Monitor commitments against those identified in the project plan.	Monitor the availability of planned resources and committed tools, facilities, and project artifacts.
SP 1.3-1 – Monitor risks against those identified in the project plan.	Regularly determine if the status of each project risk has changed and implement corrective action as required. This status check should include retiring old risks and entering new risks.
SP 1.4-1 – Monitor the management of project data against the project plan.	Monitor the service team to ensure that it is consistently using data reporting formats and implementing planned access control methods.
SP 1.5-1 – Monitor stakeholder involvement against the project plan.	Monitor communication activities to ensure that the customer and team members receive timely project information.
SP 1.6-1 – Periodically review the project's progress, performance, and issues.	Conduct regularly scheduled progress reviews to check on service activities, including their current status and likely future status. Document and resolve issues.
SP 1.7-1 – Review the accomplishments and results of the project at selected project milestones.	Set up service milestone reviews, such as completion of a significant service or contract phase and the introduction of new services.

SG 2: Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.	
Specific Practice	**Interpretation**
SP 2.1-1 – Collect and analyze the issues and determine the corrective actions necessary to address the issues.	Understand the extent and causes of issues to estimate resources that are required to correct the individual issue and possibly prevent similar issues.
SP 2.2-1 – Take corrective action on identified issues.	Decide whether corrective action is possible and cost effective, and whether preventive action is justified or the issues are temporary.
SP 2.3-1 – Manage corrective actions to closure.	Monitor and assure closure of assigned corrective actions by focusing on possible collateral impacts throughout the service community.

3.3 Managing Suppliers – Supplier Agreement Management PA

The profitability of a service organization often reflects its success in managing multiple suppliers for its customers. Timeliness, quality, and reliability of supplier deliveries are crucial in achieving objectives for various service types and levels. In addition to performing due diligence in the selection of supporting service suppliers, service organizations should establish a formal acceptance process for the supplier's service to assure the required performance and quality requirements are met.

The practices in the Supplier Agreement Management PA help service organizations with supplier selection, including commercial off-the-shelf (COTS) selection, contracting, and supplier performance monitoring. Table 5 provides interpretations of the specific practices of the Supplier Agreement Management PA for service organizations.

Table 5:   Interpretation of the Supplier Agreement Management (SAM) PA

SG 1: Agreements with the suppliers are established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 – Determine the type of acquisition for each product or product component to be acquired.	Determine the best contract type for each supplier based on factors such as service type, service level, and schedule.
SP 1.2-1 – Select suppliers based on an evaluation of their ability to meet the specified requirements and established criteria.	Use references, historical performance, financial stability information, and where appropriate, process capability information to make informed supplier selections. Focus on past performance records in responsiveness in initiating and sustaining service levels.
SP 1.3-1 – Establish and maintain formal agreements with the supplier.	Establish formal agreements with selected suppliers that include terms and conditions protecting the service organization when problems in quality and timeliness of services occur. Consider using Terms and Conditions for penalties for not meeting service requirements and incentives for meeting and exceeding.

SG 2: Agreements with the suppliers are satisfied by both the project and the supplier.	
Specific Practice	**Interpretation**
SP 2.1-1 – Review candidate COTS products to ensure they satisfy the specified requirements that are covered under a supplier agreement.	Develop and implement a COTS selection process to ensure the COTS products with the best value are selected. The selection process should emphasize meeting performance requirements and stability requirements as well as minimizing dependence on third parties.
SP 2.2-1 – Perform activities with the supplier as specified in the supplier agreement.	Monitor supplier contracts to ensure that the products/services meet the delivery schedule and performance requirements documented in the supplier agreement.
SP 2.3-1 – Ensure that the supplier agreement is satisfied before accepting the acquired product.	Develop and document in the supplier agreement formal acceptance criteria and a methodology for acceptance of the product or service.
SP 2.4-1 – Transition the acquired products from the supplier to the project.	Manage the transition of these products and services to your organization and to your customer's organization. Estimate the resources required to ensure a smooth transition to existing service functions.

3.4 Managing Risks in Contracts – Risk Management PA

Risk management for service organizations shares the same challenges of predicting, understanding, and managing potential future issues as with development organizations. Risks in providing services stem from potential disruptions of service from suppliers at critical times; inadequate staffing in needed, highly specialized technical areas; rapid changes in customer missions and operations; and general inability to support the customers' daily routines, such as solving difficult technical problems.

The practices in the Risk Management PA provide the techniques for predicting, understanding, and managing risks that are applicable to service organizations. Table 6 provides interpretations of the practices of the Risk Management PA for service organizations.

Table 6:   Interpretation of the Risk Management (RSKM) PA

SG 1: Preparation for risk management is conducted.	
Specific Practice	**Interpretation**
SP 1.1-1 – Determine risk sources and categories.	Develop categories of risks that significantly threaten to disrupt the service organization's ability to meet service performance objectives.
SP 1.2-1 – Define the parameters used to analyze and categorize risks, and the parameters used to control the risk management effort.	Using these categories, define the risk parameters to help manage resources as well as protect service levels and objectives. Risk parameters include probabilities, impacts, and costs of mitigation.

SP 1.3-1 – Establish and maintain the strategy to be used for risk management.	Develop and implement a risk mitigation strategy based on identified threats of disruption of service types and levels. Include in this strategy a review schedule of the current risks as well as emerging risks.

SG 2: Risks are identified and analyzed to determine their relative importance.

Specific Practice	Interpretation
SP 2.1-1 – Identify and document the risks.	List the known risks that will disrupt service types and levels.
SP 2.2-1 – Evaluate and categorize each identified risk using the defined risk categories and parameters, and determine its relative priority.	NFI

SG 3: Risks are handled and mitigated, where appropriate, to reduce adverse impacts on achieving objectives.

Specific Practice	Interpretation
SP 3.1-1 – Develop a risk mitigation plan for the most important risks to the project, as defined by the risk management strategy.	Develop risk mitigation plans for significant risks that include such things as alternative service suppliers and contingency plans. The risk mitigation plans should define thresholds for determining when acceptable risk levels have been exceeded and mitigation plans should be implemented.
SP 3.2-1 – Monitor the status of each risk periodically and implement the risk mitigation plan as appropriate.	NFI

3.5 Integrating with Other Project Functions – Integrated Project Management PA

Service organizations often consist of "stove-piped" groups (i.e., teams or functions) that need to be integrated for effective and efficient delivery of services. Unless such groups can be managed in an integrated way, the service organization cannot react to changing conditions and cannot be expected to achieve the full spirit of CMM Integration[SM].

For example, SE&I organizations typically function in one of three different environments. The first environment is on site with the customer. The second environment is in the service organization's own facility. The third environment is a facility belonging to a third party that the customer wishes the organization to monitor or support. In addition and independent of the actual location, the project management functions are often initially provided by the customer. Such non-centralization of management services may lead to the development of "stove pipes" that are often obstacles to the ability of the organization to react to changing conditions. Integrating these stove pipes provides an infrastructure for more efficient support

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[SM] CMM Integration is a service mark of Carnegie Mellon University.

of the services provided by the services organization. Unless this authority can be gained by the SE&I organization, it cannot be expected to achieve the full spirit of CMM Integration.

In any case, an integrated management infrastructure that is integrated with the services being delivered is important to effectively providing integrated service functions in different environments, and expanding services to new customers. Such an integrated infrastructure also helps achieve the desired coordination in implementing necessary changes due to a change in the scope of the work. Table 7 provides interpretations of the specific practices of the Integrated Project Management PA for service organizations.

Table 7:   Interpretation of the Integrated Project Management (IPM) PA

SG 1: The project is conducted using a defined process that is tailored from the organization's set of standard processes.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain the project's defined process.	Tailor the service processes of the organization for the specific service contract.
SP 1.2-1 – Use the organizational process assets and measurement repository for estimating and planning the project's activities.	Use the service organization's process assets (e.g., lessons learned, cost models of maintaining service levels) in planning for the specific service contract.
SP 1.3-1 – Integrate the project plan and the other plans that affect the project to describe the project's defined process.	Integrate service management and support function plans with the plans for other existing functions, including functions for providing related services.
SP 1.4-1 – Manage the project using the project plan, the other plans that affect the project, and the project's defined process.	NFI
SP 1.5-1 – Contribute work products, measures, and documented experiences to the organizational process assets.	Add lessons learned, measurements, and other types of process improvement information to the organization's process improvement repository. This repository should be available for planning new service functions and new customers.

SG 2: Coordination and collaboration of the project with relevant stakeholders is conducted.	
Specific Practice	**Interpretation**
SP 2.1-1 – Manage the involvement of the relevant stakeholders in the project.	Focus on strategies that manage the challenges of geographically distributed stakeholders via collaborative technologies.
SP 2.2-1 – Participate with relevant stakeholders to identify, negotiate, and track critical dependencies.	NFI

SP 2.3-1 – Resolve issues with relevant stakeholders.	Document and resolve all issues that were raised at these forums using collaborative technologies to minimize the impact of geographic location.

SG 3: The project is conducted using the project's shared vision.

Specific Practice	Interpretation
SP 3.1-1 – Identify expectations, constraints, interfaces, and operational conditions applicable to the project's shared vision.	Emphasis importance of meeting service goals, such as balancing performance requirements and customer satisfaction.
SP 3.2-1 – Establish and maintain a shared vision for the project.	Be prepared to revise the vision to meet changing customer perceptions and other stakeholder needs.

SG 4: The integrated teams need to execute to execute the project are identified, defined, structured, and tasked.

Specific Practice	Interpretation
SP 4.1-1 – Determine the integrated team structure that will best meet the project objectives and constraints.	Structure the service teams by evaluating functions to be provided. Consider best value of service, current and projected costs, and future business opportunities.
SP 4.2-1 – Develop a preliminary distribution of requirements, responsibilities, authorities, tasks and interfaces to teams in the selected integrated team structure.	Plan the initial allocation of roles and responsibilities based upon an analysis of cost versus achieving and maintaining service level requirements. Be prepared to consider factors, such as availability of collaborative technologies, labor costs and team member past performance records.
SP 4.3-1 – Establish and maintain teams in the integrated structure.	Develop a plan to evaluate team performance. Recognize and plan for the changing environment in the customer base. Identify and mitigate risks, such as loss of key personnel, changes in customer perception of service quality or even changes in corporate ownership.

3.6 Measuring Process Predictability – Quantitative Project Management PA

Reacting quickly to changing marketplaces, staff reductions, and changing environments at customer sites is a necessity for service organizations. Organizations that have established achievable measures of performance and are experiencing predictable performance of critical processes are better positioned to respond rapidly to needed changes.

The practices in the Quantitative Project Management PA cover management techniques to increase agility in meeting the challenges of change. Table 8 provides interpretations of the specific practices of the Quantitative Project Management PA for service organizations.

Table 8:   Interpretation of the Quantitative Project Management (QPM) PA

SG 1: The project is quantitatively managed using quality and process-performance objectives.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain the project's quality and process-performance objectives.	Choose the critical service functions that have a business case for developing statistical predictability and define the quality and performance objectives for the project.
SP 1.2-1 – Select the subprocesses that compose the project's defined process based on historical stability and capability data.	Select from the organization's process repository the key processes that have the best chance of meeting the established service performance objectives.
SP 1.3-1 – Select the subprocesses of the project's defined process that will be statistically managed.	Select critical subfunctions that are within the service organization's control and have a business case for statistically managing their performance. Identify process and product attributes of the selected subprocesses that should be measured and controlled.
SP 1.4-1 – Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.	Implement the necessary analytical and statistical methods for the identified subprocesses. Review the results of process performance and be prepared to take corrective action to improve the performance of the subprocess. Be very sensitive to changes in customer's perceptions to process performance.

SG 2: The performance of selected subprocesses within the project's defined process is statistically managed.	
Specific Practice	**Interpretation**
SP 2.1-1 – Select the measures and analytic techniques to be used in statistically managing the selected subprocesses.	Both the owners and performers of the critical subfunction should understand and select achievable performance measures. Expect to use collaborative technologies when these communities are geographically separated. Define the measures and analytic techniques to be used in (or proposed for) statistically managing the subprocesses.
SP 2.2-1 – Establish and maintain an understanding of the variation of the selected subprocesses using the selected measures and analytic techniques.	Ensure that the owners and performers of the selected subfunctions recognize and understand, from past experiences, common (routine) and special (exceptional) causes of variation of process performance when implementing the techniques selected in SP 2.1-1.
SP 2.3-1 – Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process-performance objectives, and identify corrective action as necessary.	Monitor the statistical performance of the subfunctions and be prepared to identify, and if appropriate, correct special (exceptional) causes of process variation. When identifying corrective actions, consider both near term and long term factors, such as changing customer needs.
SP 2.4-1 – Record statistical and quality management data in the organization's measurement repository.	Record the performance history of the subprocess, including the statistical analysis, corrective actions (including the actual costs benefits of the corrective actions), and trends in the organization's process repository. Be able to quantitatively justify the impact on changing a service process.

3.7 Planning and Deploying Teams – Integrated Teaming PA

Major challenges in implementing an Integrated Product and Process Development (IPPD) approach in service organizations include the lack of a tangible evolving hard product and positioning the service product to meet the rapid changes in customer expectations.

The practices in Integrated Teaming (IT) are useful in helping to define a realistic team vision, charter, and performance expectations in the dynamic environment typical of a service organization. Applying the practices in IT to service organizations supports the continuity of team performance that is essential to meeting service-level requirements in the dynamic services environment. Table 9 provides interpretations of the specific practices of the Integrated Teaming PA for service organizations.

Table 9: Interpretation of the Integrated Teaming (IT) PA

SG 1: A team composition that provides the knowledge and skills required to deliver the team's product is established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 – Identify and define the team's specific internal tasks to generate the team's expected output.	The fluid, dynamic nature of service projects requires particular attention to avoid performance bottlenecks.
SP 1.2-1 – Identify the knowledge, skills, and functional expertise needed to perform team tasks.	Service functions are susceptible to dynamic requests for either additional staff or new expertise. Identify likely sources of additional staff and needed cross training.
SP 1.3-1 – Assign the appropriate personnel to be team members based on required knowledge and skills.	Service functions with high service level requirements need to consider the impact of lack of continuity and availability of team members with specialized skills. Develop agreements for rapid reallocations to meet customer requirements.

SG 2: Operation of the integrated team is governed according to established principles.	
Specific Practice	**Interpretation**
SP 2.1-1 – Establish and maintain a shared vision for the integrated team that is aligned with any overarching or higher level vision.	Develop a shared vision that reflects not only achieving current service level goals, which will be dynamically changing with the customer environment, but also long term impacts on the participating service organizations.
SP 2.2-1 – Establish and maintain a team charter based on the integrated team's shared vision and overall team objectives.	Expect and plan for changes to the language in the service organization charter that identifies measurement goals to keep pace with the dynamics of the customer base.
SP 2.3-1 – Clearly define and maintain each team member's roles and responsibilities.	Initially defined roles and responsibilities will be influenced by changes in the customer's requirements and environment. Expect frequent modifications.

SP 2.4-1 – Establish and maintain integrated team operating procedures.	Operating procedures in service organizations are particularly susceptible to the dynamics of the customer base or changes in team composition. Minimize these impacts by establishing communication and training networks using collaborative technologies.
SP 2.5-1 – Establish and maintain collaboration among interfacing teams.	Minimize impacts from geographical and time zone separation for team hand offs by conducting team meetings using collaborative technologies.

4 Interpreting Support Functions for Service Organizations

The range of services offered by service organizations is rather diverse. For example, "seat management" services may provide help desk support, upgrading the customer's networks to support wireless access, licenses for online mail order firms, as well as integrating tools and other packages that support customer operations. The complexities of each of these examples require a "backbone" of effective support functions. The PAs in the Support PA category provide practices for developing and maintaining the support functions.

4.1 Understanding the Cost of Providing Services – Measurement and Analysis PA

A crucial activity in understanding the costs associated with providing services is planning what data to collect. The range of this information is vast and has the hidden costs of collection, analysis, and reporting. At a high level, these costs are typically viewed as only direct labor costs. To better capture the cost of providing services, a service organization should develop a measurement plan and implement a measurement program.

The purpose of the measurement program is not only to collect and analyze existing stovepipe measurements, but also to integrate these existing measurements into use when evaluating business objectives. Developing this strategic view starts with first identifying the business objectives of the service organization. After identifying its business objectives, the service organization can then determine which existing measures are useful in evaluating these objectives as well as any new measurements that may be needed. Table 10 provides interpretations of the specific practices of the Measurement and Analysis PA for service organizations.

Table 10: Interpretation of the Measurement and Analysis (MA) PA

SG 1: Measurement objectives and activities are aligned with identified information needs and objectives.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain measurement objectives that are derived from identified information needs and objectives.	Define measurement objectives based upon the information needs of the project/contract (or organization), such as improving customer satisfaction and managing actual costs.

SP 1.2-1 – Specify measures to address the measurement objectives.	The life cycle of a service organization, unlike development organizations, may not have convenient schedules for collection of measurements. Remember when selecting the measures to specify measures that are both easy to collect and validate.
SP 1.3-1 – Specify how measurement data will be obtained and stored.	Plan how to non-intrusively collect measurements without influencing either the providers or the customers.
SP 1.4-1 – Specify how measurement data will be analyzed and reported.	Develop analysis procedures that will be used to assess how well measurement objectives are met. Expect these procedures to change as the measurement objectives change to reflect changing customers' needs or environments.

SG 2: Measurement results that address identified information needs and objectives are provided.

Specific Practice	Interpretation
SP 2.1-1 – Obtain specified measurement data.	Consider using collaborative technologies to streamline data collection according to procedures established in SP 1.3-1.
SP 2.2-1 – Analyze and interpret measurement data.	Plan for the appropriate service team members to analyze measurement data according to procedures established in SP 1.4-1. Be prepared to address issues arising from a lack of understanding of the measurements by the domain experts in the service team.
SP 2.3-1 – Manage and store measurement data, measurement specifications, and analysis results.	Establish and communicate to the service team functions the access rights to performance measurements.
SP 2.4-1 – Report results of measurement and analysis activities to all relevant stakeholders.	Use and keep relevant stakeholders updated through tailoring by service function using techniques such as management dashboards and flash reports that summarize the performance of the service team functions.

4.2 Controlling Customer Information – Configuration Management PA

All service organizations receive and generate volumes of work products, including sensitive and proprietary information, much of which belongs to their customers. Large projects may manage numerous teaming partners and subcontractors to perform the service. Access to this information may be distributed across user sites and require the implementation of different access privileges.

The practices in the Configuration Management PA cover deciding what information to control and practices for maintaining integrity and controlling access to the library. Table 11 provides interpretations of the specific practices of the Configuration Management PA for service organizations.

Table 11: Interpretation of the Configuration Management (CM) PA

SG 1: Baselines of identified work products are established.	
Specific Practice	**Interpretation**
SP 1.1-1 – Identify the configuration items, components, and related work products that will be placed under configuration management.	Identify services and processes to control, including customer-furnished information, service work products, supplier data, and service processes to be placed under configuration management.
SP 1.2-1 – Establish and maintain a configuration management and change management system for controlling work products.	Define control and change procedures including media, tools, and access privileges for each of the items on the list of configuration items. Some may have more formal procedures than others.
SP 1.3-1 – Create or release baselines for internal use and for delivery to the customer.	Create or release baselines. Communicate baseline release information to relevant stakeholders preferably by electronic change notices on service function dashboards.

SG 2: Changes to the work products under configuration management are tracked and controlled.	
Specific Practice	**Interpretation**
SP 2.1-1 – Track change requests for the configuration items.	Implement a documented process for collecting and analyzing change requests for work products and service processes under CM control. For geographically distributed service teams, consider using collaborative technologies for efficiency.
SP 2.2-1 – Control changes to the configuration items.	NFI

SG 3: Integrity of baselines is established and maintained.	
Specific Practice	**Interpretation**
SP 3.1-1 – Establish and maintain records describing configuration items.	NFI
SP 3.2-1 - Perform configuration audits to maintain integrity of the configuration baselines.	Depending upon the complexity of the service, consider distributing the CM audit function responsibilities to each team to confirm that the baselines and documentation are accurate.

4.3 Ensuring Services Meet Quality Objectives – Process and Product Quality PA

To remain viable in a highly competitive marketplace, service organizations must define and meet achievable quality objectives. These quality objectives are achieved in part by performing objective evaluations of service functions. Performance results can be measured by sampling customer satisfaction.

The practices in the Process and Product Quality Assurance PA can help organizations to decide which service functions and work products to audit. The practices in the Process and Product Quality Assurance PA do not require a separate quality organization. In smaller service organizations, these practices typically are incorporated as part of peer reviews of service products and processes using checklists.

The peer review implementation requires an open communication path to resolve non-compliance issues as well as sufficient training in objective evaluation. Service organizations typically provide process and work product checklists that are used by the staff to implement Process and Product Quality Assurance practices. Table 12 provides interpretations of the specific practices of the Process and Product Quality Assurance PA for service organizations.

Table 12: Interpretation of the Process and Product Quality Assurance (PPQA) PA

SG 1: Adherence of the performed process and associated work products and services to applicable process descriptions, standards, and procedures is objectively evaluated.	
Specific Practice	**Interpretation**
SP 1.1-1 – Objectively evaluate the designated performed processes against the applicable process descriptions, standards, and procedures.	Determine which service processes are critical to quality objectives. Objectively evaluate the adherence of the team's performance to these service processes when the team is providing the service function.
SP 1.2-1 – Objectively evaluate the designated work products and services against the applicable process descriptions, standards, and procedures.	Each team should participate in determining which service products are critical to quality objectives. Consider using peers to objectively evaluate the adherence of these service products to defined standards.

SG 2: Noncompliance issues are objectively tracked and communicated, and resolution is ensured.	
Specific Practice	**Interpretation**
SP 2.1-1 – Communicate quality issues and ensure resolution of noncompliance issues with the staff and managers.	NFI
SP 2.2-1 – Establish and maintain records of the quality assurance activities.	Keep records of audits, issues, and their resolution for analysis, including measurements such as number and severity of findings, customer satisfaction values and cost of corrections. Use this information to perform cost analysis of the value of the service quality program.

4.4 Selecting Products, Resources, and Methods – Decision and Analysis PA

One important activity of a service organization is making informed decisions about what products or services to buy or what engineering or design methodology to implement. Implementing an informed decision process requires both understanding the service product

offerings and having a set of criteria on which to base decisions. Maintaining staff with the appropriate labor skills is also another ongoing challenge for service organizations. This challenge is also an opportunity to implement structured decision making techniques.

The Decision Analysis and Resolution PA provides best practices from industry on how to make informed decisions. Table 13 provides interpretations of the specific practices of the Decision Analysis and Resolution PA for service organizations.

Table 13: Interpretation of the Decision Analysis and Resolution (DAR) PA

SG 1: Decisions are based on an evaluation of alternatives using established criteria.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain guidelines to determine which issues are subject to a formal evaluation process.	Focus on understanding the key decisions affecting service organizations, such as staffing, selection of COTS, make or buy, and service levels. Develop guidelines for determining when these issues will be subject to a formal structured decision process.
SP 1.2-1 – Establish and maintain the criteria for evaluating alternatives, and the relative ranking of these criteria.	Use service level categories and performance goals to develop and rank evaluation criteria for each type of key decision.
SP 1.3-1 – Identify alternative solutions to address issues.	Develop alternative solutions to each decision to be made based upon a ranking of service levels and costs.
SP 1.4-1 – Select the evaluation methods.	Develop techniques to evaluate the alternative solutions to each type of key decision, such as simulations, cost performance analysis, customer surveys, and testing. Keep evaluation methods current with the changing customer expectations and needs.
SP 1.5-1 – Evaluate alternative solutions using the established criteria and methods.	NFI
SP 1.6-1 – Select solutions from the alternatives based on the evaluation criteria.	NFI

4.5 Tracking Problems and Issues to Causes – Causal Analysis and Resolution PA

Service organizations are typically plagued with recurring problems and issues, even when there is no ongoing service or product development. Examples of issues that service organizations face are lack of trained resources, changing operational requirements, and poor vendor performance. A common symptom of these issues is seen in increasing customer dissatisfaction. Treating only the symptoms of these problems is a temporary solution and often results in costs not adequately anticipated.

The practices in the Causal Analysis and Resolution PA are helpful in implementing techniques of understanding the root causes that lead to problems. Understanding root causes is the first step to eliminating recurring problems that would otherwise ultimately erode profits for a service organization. Table 14 provides interpretations of the specific practices of the Causal Analysis and Resolution PA for service organizations.

Table 14: Interpretation of the Causal Analysis and Resolution (CAR) PA

SG 1: Root causes of defects and other problems are systematically determined.	
Specific Practice	**Interpretation**
SP 1.1-1 – Select the defects and other problems for analysis.	Use service level goals and cost impact information to guide the selection of defect data and issues to be subject to causal analysis.
SP 1.2-1 – Perform causal analysis of selected defects and other problems and propose actions to address them.	Form a "tiger team" to perform causal analysis of the issues. The members of the "tiger team' should be comprised of both managers and service staff that perform the service. Develop action proposals to address the root causes.

SG 2: Root causes of defects and other problems are systematically addressed to prevent their future occurrence.	
Specific Practice	**Interpretation**
SP 2.1-1 – Implement the selected action proposals that were developed in causal analysis.	NFI
SP 2.2-1 – Evaluate the effect of changes on process performance.	In certain types of service organizations, recognize the necessity for rapidly evaluating the effects of implemented action proposals to see if the problem has been corrected.
SP 2.3-1 – Record causal analysis and resolution data for use across the project and organization.	Record causal analysis data and improvement information for use across the project, contract, and organization, realizing that service requirements can change quickly and result in outdated information.

4.6 Establishing Effective Environments – Organizational Environment for Integration PA

In this subsection of the technical note, we consider how the practices of the Organizational Environment for Integration (OEI) process area may benefit the service organization. This process area contains IPPD best practices that may also help the service organization. In addition to OEI, IPPD best practices are found in the Integrated Teaming process area and in two additional specific goals of the Integrated Project Management process area. IPPD best practices are covered only for OEI in this technical note.

Having a proper environment set up for performing services is an important part of starting the project. This environment can include sufficient work area space, terminals, phones, access to special test equipment and ranges, and critical support functions. The challenge

increases as the team size increases to include numerous separate organizations and corporations because, in this more complex environment, different cultures, roles and responsibilities, and management policies may clash.

The practices in the Organizational Environment for Integration PA are helpful in developing a process that establishes and maintains this environment for IPPD. Table 15 provides interpretations of the specific practices of the Organizational Environment for Integration PA for service organizations.

Table 15: Interpretation of the Organizational Environment for Integration (OEI) PA

SG 1: An infrastructure that maximizes the productivity of people and affects the collaboration necessary for integration is provided.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain a shared vision for the organization.	Recognize that defining the integrated service organization vision to support IPPD, including attributes and strengths of all the team members, may need to be more seamless than development organizations, depending upon service time requirements.
SP 1.2-1 – Establish and maintain an integrated work environment that supports IPPD by enabling collaboration and concurrent development.	NFI
SP 1.3-1 – Identify the unique skills needed to support the IPPD environment.	The dynamic services marketplace often demands additional cross-training of additional staff to assure that backup capability can be quickly provided to meet team commitments.

SG 2: People are managed to nurture the integrative and collaborative behaviors of an IPPD environment.	
Specific Practice	**Interpretation**
SP 2.1-1 – Establish and maintain leadership mechanisms to enable timely collaboration.	NFI
SP 2.2-1 – Establish and maintain incentives for adopting and demonstrating integrative and collaborative behaviors at all levels of the organization.	Use service level goals and customer satisfaction levels as a basis for establishing incentives for adopting and demonstrating integrative and collaborative behaviors.
SP 2.3-1 – Establish and maintain organizational guidelines to balance team and organization responsibilities.	Establish guidelines to balance incentives and responsibilities based upon the service team's vision and both the team's and organization's performance objectives.

5 Interpreting Engineering Practices for Service Organizations

In this section on engineering practices, the interpretations may apply more directly to SE&I organizations than to other types of service organizations. For other types of service organizations, these interpretations may often be suitable; but it is also possible that different interpretations would be more appropriate to your specific business situation.

Unclear requirements and the inability to manage changing requirements can cause customer dissatisfaction and erode profits. Service organizations, depending upon the criticality of response, implement alternative ways to provide services to minimize disruption as a key service engineering function. Additionally, service organizations will often need to integrate products and services from multiple sources seamlessly into what appears to be a single service from the viewpoint of the customer. Practices that support the understanding of service requirements, service function interfaces, and verification of services against their requirements are often directly applicable to service organizations. Thus, the practices of the six PAs in the Engineering PA category are often directly applicable to SE&I (and many service) organizations.

5.1 Managing and Developing Requirements – Requirements Development and Requirements Management PAs

Service organizations must manage requirements as closely as traditional development organizations. Since service tasks (especially for SE&I organizations) are typically funded on a level-of-effort basis, the challenge is to control cost growth due to either an initially misunderstood scenario, poor requirements, changing customer environments, or "hidden costs."

When combined, the practices in the Requirements Management and Requirements Development PAs suggest that to control the costs of providing service functions, service organizations should proactively manage and develop requirements to the service being provided. The range of these service planning and execution activities include developing requirements from the input of all relevant stakeholders, evaluating these requirements using realistic scenarios, itemizing and tracking changes, and taking corrective actions to re-align the service functions being provided with their requirements. Table 16 and Table 17 provide interpretations of the specific practices of the Requirements Management and Requirements Development PAs for service organizations.

Table 16:   Interpretation of the Requirements Management (REQM) PA

SG 1: Requirements are managed and inconsistencies with project plans and work products are identified.	
Specific Practice	**Interpretation**
SP 1.1-1 – Develop an understanding with the requirements providers on the meaning of the requirements.	NFI
SP 1.2-2 – Obtain commitment to the requirements from the project participants.	NFI
SP 1.3-1 – Manage changes to the requirements as they evolve during the project.	NFI
SP 1.4-2 – Maintain bidirectional traceability among the requirements and the project plans and work products.	Maintain the traceability between the required services and the deployed services.
SP 1.5-1 – Identify inconsistencies between the project plans and work products and the requirements.	Recognize inconsistencies between the service requirements and the on-going work and take corrective actions, when necessary, to bring these into alignment.

Table 17:   Interpretation of the Requirements Development (RD) PA

SG 1: Stakeholder needs, expectations, constraints, and interfaces are collected and translated into customer requirements.	
Specific Practice	**Interpretation**
SP 1.1-1 Identify and collect stakeholder needs, expectations, constraints, and interfaces for all phases of the product life cycle.	Use surveys and checklists to collect the service needs of the stakeholders.
SP 1.1-2 – Elicit stakeholder needs, expectations, constraints, and interfaces for all phases of the product life cycle.	NFI
SP 1.2-1 – Transform stakeholder needs, expectations, constraints, and interfaces into customer requirements.	NFI
SG 2: Customer requirements are refined and elaborated to develop product and product-component requirements.	
Specific Practice	**Interpretation**
SP 2.1-1 – Establish and maintain product and product-component requirements, which are based on the customer requirements.	Establish the requirements for the service to be provided, and allocate these requirements to functions and subfunctions as appropriate.

SP 2.2-1 – Allocate the requirements for each product component.	Identify subfunctions for each service function and track their requirements in the requirements database.
SP 2.3-1 – Identify interface requirements.	Identify organization interfaces necessary for implementing the subfunction for each service function.

SG 3: The requirements are analyzed and validated, and a definition of required functionality is developed.

Specific Practice	Interpretation
SP 3.1-1 – Establish and maintain operational concepts and associated scenarios.	Define operational concepts for how the service will be performed within the service environment.
SP 3.2-1 – Establish and maintain a definition of required functionality.	Define service function tasks.
SP 3.3-1 – Analyze requirements to ensure that they are necessary and sufficient.	Analyze the service requirements to understand if all appropriate requirements have been identified.
SP 3.4-3 – Analyze requirements to balance stakeholder needs and constraints.	Balance the demands on resources using the scenarios to meet the performance requirements. Use cost and service level tradeoff analysis.
SP 3.5-1 - Validate requirements to ensure the resulting product will perform appropriately in its intended use environment.	Validate that services will meet customer requirements with cost, schedule, and time performance parameters.
SP 3.5-2 – Validate requirements to ensure the resulting product will perform as intended in the user's environment using multiple techniques as appropriate.	Use different techniques, such as live or performance models, as appropriate, to obtain different perspectives on performing service scenarios.

5.2 Providing Technical Stability – Technical Solution PA

Service organizations rely on the expertise of their staff to maintain high levels of customer satisfaction. Despite the importance of the staff's expertise, there are other critical factors, such as the changing customer environment. Due to changes in this environment, established procedures or interfaces may change rapidly and therefore become useless or may even disappear. Since service organizations (particularly SE&I organizations) often function on level of effort, reacting to changing environments can be painful and costly.

Borrowing a well-established practice from the development community, a key element of providing technical stability is to develop architectures for the services functions. The stability of providing technical services is as sound and flexible as the architecture.

Implementing this architecture of providing services requires dividing up each major service function into subfunctions. All interfaces, including staff, must be clearly documented and performance requirements should be defined.

The practices in the Technical Solution PA are useful in identifying factors that may need to be planned. Table 18 provides interpretations of the specific practices of the Technical Solution PA for service organizations.

Table 18: Interpretation of the Technical Solution (TS) PA

SG 1: Product or product-component solutions are selected from alternative solutions.	
Specific Practice	**Interpretation**
SP 1.1-1 Develop alternative solutions and selection criteria.	Establish alternative approaches to providing the services, service subfunctions, and criteria for selecting between the alternatives.
SP 1.1-2 – Develop detailed alternative solutions and selection criteria.	NFI
SP 1.2-2 – Evolve the operational concept, scenarios, and environments to describe the conditions, operating modes, and operating states specific to each product component.	Evolve the operational concept and scenarios as appropriate to understand states specific to each service subfunction.
SP 1.3-1 – Select the product-component solutions that best satisfy the criteria established.	Select the service subfunctions that meet the requirements of service function architecture and selection criteria.

SG 2: Product or product-component designs are developed.	
Specific Practice	**Interpretation**
SP 2.1-1 – Develop a design for the product or product component.	Document the service or service subfunction.
SP 2.2-3 – Establish and maintain a technical data package.	Develop and provide other documentation needed to capture the rationale for the service approaches.
SP 2.3-1 – Establish and maintain the solution for product-component interfaces.	Describe the interfaces necessary in providing the service function, taking into account that different subfunctions may be geographically distributed.
SP 2.3-3 – Design comprehensive product-component interfaces in terms of established and maintained criteria.	NFI
SP 2.4-3 - Evaluate whether the product components should be developed, purchased, or reused based on established criteria.	NFI

SG 3: Product components, and associated support documentation, are implemented from their designs.	
Specific Practice	**Interpretation**
SP 3.1-1 - Implement the designs of the product components.	Implement the service function (perform the service).
SP 3.2-1 – Develop and maintain the end-use documentation.	Develop and maintain user-oriented documentation on the service functions.

5.3 Ensuring Interface Compatibility Prior to Integration – Product Integration PA

Service providers should consider the benefits of planning and managing the required staging to perform service functions and service subfunctions. The risks of unrecognized timing sequences, critical path component bottlenecks, and incorrectly documented interfaces are well recognized as potential issues.

The practices in the Product Integration PA cover a wide range of proven activities, including development of guidebooks, reviewing interfaces, and performing readiness evaluations. Table 19 provides interpretations of the specific practices of the Product Integration PA for service organizations.

Table 19: Interpretation of the Product Integration (PI) PA

SG 1: Preparation for product integration is conducted.	
Specific Practice	**Interpretation**
SP 1.1-1 – Determine the product-component integration sequence.	Understand the sequencing necessary to implement a service by documenting the sequencing of the subfunctions for each service function.
SP 1.2-2 – Establish and maintain the environment needed to support the integration of the product components.	Obtain and install the necessary resources for providing the service functions.
SP1.3-3 – Establish and maintain procedures and criteria for integration of the product components.	Develop procedures and criteria for determining whether the service functions and subfunctions have been effectively integrated.
SG 2: The product-component interfaces, both internal and external, are compatible.	
Specific Practice	**Interpretation**
SP 2.1-1 – Review interface descriptions for coverage and completeness.	Review interfaces among the service subfunctions and between the service and environment, for coverage and completeness.

SP 2.2-1 – Manage internal and external interface definitions, designs, and changes for products and product components.	Manage changes in the interfaces.

SG 3: Verified product components are assembled and the integrated, verified, and validated product is delivered.	
Specific Practice	**Interpretation**
SP 3.1-1 – Confirm, prior to assembly, that each product component required to assemble the product has been properly identified, functions according to its description, and that the product-component interfaces comply with the interface descriptions.	Perform dry runs of the service functions and service subfunctions to determine their readiness for implementing the service.
SP 3.2-1 – Assemble product components according to the product integration sequence and available procedures.	Build the service function from the service subfunctions.
SP 3.3-1 – Evaluate assembled product components for interface compatibility.	Evaluate the performance parts of the service functions and service subfunctions against required performance objectives.
SP 3.4-1 – Package the assembled product or product component and deliver it to the appropriate customer.	Package the service for delivery to the customer.

5.4 Supporting Correct Implementation of Services – Verification PA

Before implementing service functions that contain costly defects, the functions should be verified. Verification of service functions minimizes the occurrence of latent defects just as testing is used to minimize the occurrence of latent defects in products. (Similarly, a "subfunction" might be verifiable, just as a "work product" might be the subject of a verification activity in a product development endeavor.)

An example of the importance of correctness is a service function for maintaining critical medical life support equipment. If the maintenance service function is incorrectly performed, then the results could cause loss of life as well as massive litigation for the service provider.

The practices in the Verification PA provide examples of verification processes for service organizations. Table 20 provides interpretations of the specific practices of the Verification PA for service organizations.

Table 20: Interpretation of the Verification (VER) PA

SG 1: Preparation for verification is conducted.	
Specific Practice	**Interpretation**
SP 1.1-1 – Select the work products to be verified and the verification methods that will be used for each.	NFI
SP 1.2-2 – Establish and maintain the environment needed to support verification.	NFI
SP1.3-3 – Establish and maintain verification procedures and criteria for the selected work products.	NFI

SG 2: Peer reviews are performed on selected work products.	
Specific Practice	**Interpretation**
SP 2.1-1 – Prepare for peer reviews of selected work products.	NFI
SP 2.2-1 – Conduct peer reviews on selected work products and identify issues resulting from the peer review.	NFI
SP 2.3-2 – Analyze data about preparation, conduct, and results of the peer reviews.	NFI

SG 3: Selected work products are verified against their specified requirements.	
Specific Practice	**Interpretation**
SP 3.1-1 – Perform verification on the selected work products.	NFI
SP 3.2-2 – Analyze the results of all verification activities and identify corrective action.	NFI

5.5 Determining How Well Services Meet User Needs – Validation PA

Service providers must often experience a painful trial period to understand whether the service functions truly satisfy the customer's needs. This trial period often occurs in the first months of service delivery. During this trial period, the service managers' experience cost growth and schedule performance issues until the service functions mature. Customer dissatisfaction is measured in the increasing number of complaints sent to management.

Service providers often select test sites or test facilities that can be used as validation platforms before distributing the service functions to all of the customer sites. The validation of key service functions at these test sites is an effective risk mitigation technique for controlling cost growth and detecting latent defects.

The practices in the Validation PA provide information on ways to minimize the impact of these problems by planning and establishing test sites before "going live" with the service. Table 21 provides interpretations of the specific practices of the Validation PA for service organizations.

Table 21: Interpretation of the Validation (VAL) PA

SG 1: Preparation for validation is conducted.	
Specific Practice	**Interpretation**
SP 1.1-1 – Select products and product components to be validated and the validation methods that will be used for each.	Select the critical service functions to validate in test sites.
SP 1.2-2 – Establish and maintain the environment needed to support validation.	NFI
SP 1.3-3 – Establish and maintain procedures and criteria for validation.	NFI
SG 2: The product or product components are validated to ensure that they are suitable for use in their intended operating environment.	
Specific Practice	**Interpretation**
SP 2.1-1 – Perform validation on the selected products and product components.	NFI
SP 2.2-1 – Analyze the results of the validation activities and identify issues.	NFI

6 Interpreting Process Management for Service Organizations

Lessons learned and best practices from service organizations emphasize the importance of providing an organizational structure that is conducive to their business. Even though many of the staff work on site with the customer or at remote sites, the concept of establishing and providing an "identity" with planned resources is crucial. The next five PAs provide best practices to help service organizations establish their organizations, set performance objectives, and introduce better ways of providing services to their customers.

6.1 Building and Maintaining Organizational Culture – Organizational Process Definition PA

The challenges in establishing and maintaining an organizational presence has much in common with development organizations. As with development organizations, a service infrastructure needs commitment from higher level management, process asset library assets such as templates for plans, review and audit checklists, guidebooks for services, service life-cycle models, measurements and scenarios, and lessons learned and measurement information.

The practices in the Organizational Process Definition PA provide examples of practices that, when implemented, establish a friendly culture for service organizations. Table 22 provides interpretations of the specific practices of the Organizational Process Definition PA for service organizations.

Table 22: Interpretation of the Organizational Process Definition (OPD) PA

SG 1: A set of organizational process assets is established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain the organization's set of standard processes.	Establish a set of standard processes for your service functions. Establish regular intervals to update these processes to include changes in customer requirements and environments.
SP 1.2-1 – Establish and maintain descriptions of the life-cycle models approved for use in the organization.	Develop a set of service life-cycle models for your market. These may be subsets of larger development life cycles.
SP 1.3-1 – Establish and maintain the tailoring criteria and guidelines for the organization's set of standard processes.	Develop a guidebook and criteria describing how your projects and contracts are to tailor the standard processes for their needs.

| SP 1.4-1 – Establish and maintain the organization's measurement repository. | Develop a measurement database to store the cost, schedule, customer satisfaction, and service process performance and improvement for the service projects. |
| SP 1.5-1 – Establish and maintain the organization's process asset library. | Build a library to contain organizational policies, standard processes, training material, lessons learned, service planning data, models, guidebooks, and validation results. |

6.2 Implementing Processes to Support the Staff – Organizational Process Focus PA

Implementing resources and process assets developed by implementing the practices in the Organizational Process Definition PA should be performed in stages. First, the organization should develop a list of process needs and then inventory the current process assets. The shortfalls identified by conducting the inventory, including the need for CMMI training, should be turned into an action plan. This action plan contains the necessary resources, schedule, and milestones to fill the gaps in the relevant process assets. Milestone completion should be tracked and reviewed by service managers like any other project.

The practices in the Organizational Process Focus PA start with identifying process improvement areas in the current organization. Next, designated and CMMI-trained service staff conducts a gap analysis to determine the current status of service processes. The practices in the Organizational Process Definition PA also include development and execution of an action plan to close these gaps. Table 23 provides interpretations of the specific practices of the Organizational Process Focus PA for service organizations.

Table 23: Interpretation of the Organizational Process Focus (OPF) PA

SG1: Strengths, weaknesses, and improvement opportunities for the organization's processes are identified periodically and as needed.	
Specific Practice	**Interpretation**
SP 1.1-1 – Establish and maintain the description of the process needs and objectives for the organization.	Define service organization and service function process needs and objectives that support the organizations business objectives.
SP 1.2-1 – Appraise the processes of the organization periodically and as needed to maintain an understanding of their strengths and weaknesses.	Assess the organization's processes to determine if organizational needs and objectives are being met and to identify gaps and improvement opportunities. If possible and appropriate, include representatives from the customers, in the appraisal process.
SP 1.3-1 – Identify improvements to the organization's processes and process assets.	Use the service organization's current and future objectives to solicit, prioritize, analyze, and select process improvements that will be implemented.

SG2: Improvements are planned and implemented, organizational process assets are deployed, and process-related experiences are incorporated into the organizational process assets.	
Specific Practice	**Interpretation**
SP 2.1-1 – Establish and maintain process action plans to address improvements to the organization's processes and process assets.	Use the service organization's current and future objectives as leverage to obtain commitment from the appropriate senior organizational sponsor and plan the implementation and role out of selected process improvements.
SP 2.2-1 – Implement process action plans across the organization.	Implement the action plans, considering the customer base in prioritizing and tailoring service process changes.
SP 2.3-1 – Deploy organizational process assets across the organization.	Deploy the service process assets to selected service projects and sites.
SP 2.4-1 – Incorporate process-related work products, measures, and improvement information derived from planning and performing the process into the organizational process assets.	Geographically distributed service organizations should consider incorporating lessons learned experiences, exemplar project plans, and other process artifacts into a conveniently accessible process asset library.

6.3 Training Staff Members – Organizational Training PA

As every service organization realizes, maintaining a well-trained staff is essential to achieving high levels of customer satisfaction. Selection of service contractors typically is significantly weighted toward filling labor categories that are closely linked to specific skills and levels at the lowest costs.

This staffing challenge is made more formidable by the dynamic support environments of current and future customers. Service organizations should focus not only on near term training requirements, but also take a more strategic view of the changing marketplace.

The practices in the Organizational Training PA cover both strategic and tactical training needs for service organizations. Table 24 provides interpretations of the specific practices of the Organizational Training PA for service organizations.

Table 24:   Interpretation of the Organizational Training (OT) PA

SG1: A training capability that supports the organization's management and technical roles is established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 Establish and maintain the strategic training needs of the organization.	Determine the training needs of the entire service organization for near and far term business objectives.

SP 1.2-1 – Determine which training needs are the responsibility of the organization and which will be left to the individual project or support group.	Decide which needs are the responsibilities of the larger organization and which are the responsibility of a specific project. Determine if any training to be provided by the service organization to the customer as part of a service contract is to be the responsibility of the training organization.
SP 1.3-1 – Establish and maintain an organizational training tactical plan.	Plan the service organization training identified as near term training.
SP 1.4-1 – Establish and maintain training capability to address organizational training needs.	Allocate resources, develop or obtain training materials, and assign roles and responsibilities. Geographically distributed service organizations should consider mentoring and virtual courses (online and distance training).

SG2: Training necessary for individuals to perform their roles effectively is provided.	
Specific Practice	**Interpretation**
SP 2.1-1 – Deliver the training following the organizational training tactical plan.	Deliver service training according to the tactical training plan, implementing cross training to provide redundancy in service functions.
SP 2.2-1 – Establish and maintain records of the organizational training.	Keep training records and use this information to evaluate the effectiveness of the training program.
SP 2.3-1 – Assess the effectiveness of the organization's training program.	Assess the effectiveness of training and use this information to revise training artifact, revise the training plan, and improve the training processes.

6.4 Measuring the Effectiveness of Functions - Organizational Process Performance PA

The decision to develop and maintain organizations' service processes is an investment decision that should be directly related to specific business objectives. Like all investments, there should be techniques of calculating return on investment based on the measured performance of selected service functions. From the knowledge of future return on investment on improvements to specific processes in service functions, service organizations can gain a competitive edge.

The practices in the Organizational Process Performance PA cover the selection of specific service function processes that correspond to measurement activities needed to obtain values of return on investment. Table 25 provides interpretations of the specific practices of the Organizational Process Performance PA for service organizations.

Table 25: Interpretation of the Organizational Process Performance (OPP) PA

SG1: Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.	
Specific Practice	**Interpretation**
SP 1.1-1 – Select the processes or process elements in the organization's set of standard processes that are to be included in the organization's process performance analysis.	Identify the specific service processes or process elements from the organization's standard processes that are to be included in the process performance analysis. These service processes should be candidates to help gain competitive advantage.
SP 1.2-1 – Establish and maintain definitions of the measures that are to be included in the organization's process performance analyses.	NFI
SP 1.3-1 – Establish and maintain quantitative objectives for quality and process performance for the organization.	NFI
SP 1.4-1 – Establish and maintain the organization's process performance baselines.	NFI
SP 1.5-1 - Establish and maintain the process performance models for the organization's set of standard processes.	Develop and implement service process performance models for estimation of future work as well as changes in current requirements.

6.5 Introducing New Functions to Customers – Organizational Innovation and Deployment PA

Both the changing support environments as well as the highly competitive nature of the service marketplace strongly encourage development of "better ways" to provide services. The "better ways" should offer customers opportunities to implement new technologies, introduce more efficient operations, and control costs, and offer service organizations opportunities to reduce service times.

Introducing change into the practices of any organization is risky. Introducing innovation is kept low risk by first understanding the statistical performance of the current processes and then carefully selecting pilot projects to implement the new processes.

The practices in the Organizational Innovation and Deployment PA build upon the practices in other PAs, such as Quantitative Project Management and Organizational Process Performance to cover piloting and evaluating "better ways" that can be incorporated into organizations with minimal impact to daily routines. Table 26 provides interpretations of the specific practices of the Organizational Innovation and Deployment PA for service organizations.

Table 26: Interpretation of the Organizational Innovation and Deployment (OID) PA

SG1: Process and technology improvements that contribute to meeting quality and process-performance objectives are selected.	
Specific Practice	**Interpretation**
SP 1.1-1 – Collect and analyze process- and technology-improvement proposals.	Socialize the recognition of the need for organizational improvements. Collect and analyze service process and technology improvement proposals and incentivize participation by the service staff.
SP 1.2-1 – Identify and analyze innovative improvements that could increase the organization's quality and process performance.	Actively search for innovative improvements to the organization's quality and process performance.
SP 1.3-1 – Pilot process and technology improvements to select which ones to implement.	Pilot selected improvement proposals to decide which ones to implement across the organization, recognizing that improvements may be short lived.
SP 1.4-1 – Select process- and technology-improvement proposals for deployment across the organization.	Re-evaluate benefits of pilot projects to see if customer requirement or environment changes are still valid. Then, select improvement proposals for deployment across the service organization.
SG2: Measurable improvements to the organization's processes and technologies are continually and systematically deployed.	
Specific Practice	**Interpretation**
SP 2.1-1 – Establish and maintain the plans for deploying the selected process and technology improvements.	Plan the resources, schedule, and staff required for the deployment of the improvements.
SP 2.2-1 – Manage the deployment of the selected process and technology improvements.	Consider possible impacts from changing customer requirements and environments when managing the deployment of the improvements.
SP 2.3-1 – Measure the effects of the deployed process and technology improvements.	Measure the effectiveness of the deployed improvements.

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ABSTRACT (MAXIMUM 200 WORDS)

Capability Maturity Model® Integration (CMMI®) provides a framework for improving the processes organizations use to develop, deliver, and maintain products and services. This technical note presents one organization's interpretation of CMMI best practices for organizations that primarily provide services. Service organizations can use this example interpretation of CMMI practices to inform management and staff about how CMMI practices apply to their work. The interpretation will also help appraisal team members ensure that implemented practices provide the business value necessary to satisfy the goals for quality process improvement that are stated in the CMMI models.

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