Software Engineering Institute

TSP Performance and Capability Evaluation (PACE): Customer Guide

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September 2013

SPECIAL REPORT
CMU/SEI-2013-SR-031

Team Software Process (TSP) Initiative

http://www.sei.cmu.edu

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Abstract

The Team Software Process (TSP) Performance and Capability Evaluation (PACE) process provides an objective way to evaluate software development organizations using data collected during TSP projects. This guide describes the evaluation process and lists the steps organizations and programs must complete to earn a TSP-PACE certification. It also describes how data gathered during the evaluation is used to generate a five-dimensional profile summarizing the results of the evaluation.

1 Overview

The Team Software Process (TSP) Performance and Capability Evaluation (PACE) process provides an objective way to evaluate software development organizations by using data collected during TSP projects. Certification is useful to organizations seeking to acquire software products from suppliers because it provides an independently and factually demonstrated evaluation of the organization's ability to develop and deliver software.

The TSP-PACE process can also be used to evaluate programs. A program may consist of individual or multiple development projects. This type of certification can be used by supplier management or acquisition authorities as assurance that specific programs are using sound methods and can be expected to produce timely and high-quality work. Certification can also be used by software development and service organizations to distinguish themselves from their less capable competitors.

Once an organization has been TSP certified, the Software Engineering Institute (SEI)will maintain a record of the certification and will make it available upon request.

1.1 Overview of Certification

To acquire software, whether as a product or a service, acquiring organizations must select suppliers. Unfortunately few organizations have the expertise, time, or money to make informed evaluations of suppliers. Certification by a credible and independent organization can fill this need. A good certification process must

- be objective, repeatable, and consistently applied
- consistently certify capable organizations
- consistently identify and reject poor performers

To satisfy this need, the SEI has developed a certification approach for organizations that use TSP.

1.2 TSP Certification Principles

TSP is a disciplined development method that stresses realistic planning, process definition, disciplined execution of the process, commitment to quality, precise measurement, and individual commitment to continuous improvement. Organizations using TSP have reliably produced high-quality software at reasonable cost. Evaluations using TSP rely upon the following assertions:

- The quality of an organization's work is determined by the quality of the processes its people use.
- The TSP process, when properly used, produces superior work outcomes.
- If the organization has adopted the TSP process and the people are using it properly, it will do superior work.

Therefore, the evaluation tasks are to determine (1) if the organization has actually adopted the TSP process, (2) that its people are actually using the TSP process properly, and (3) if they have reported the data and results to the SEI.

1.3 Approaches to Certification

Traditionally, certifications have been granted at different levels: individuals, processes, or products can be certified. Each approach has strengths and weaknesses.

Individuals are certified as meeting defined criteria for skills, knowledge, and experience through training, testing, references, and demonstrated experience. Various professional certifications are available at the individual level, such as the Microsoft Certified Developer and the Red Hat Certified Engineer. Providing certification at this level has some advantages: the scope and criteria can be clearly defined and administration is easy and economical. However, disadvantages also exist. There is no assurance that individuals will use certified practices or that the practices they use will actually produce the desired results.

Similarly, processes can be certified to be compliant with a standard (e.g., ISO-9000). In this way an organization is certified as meeting defined criteria–usually through some form of assessment. Advantages to this include clearly defined scope and criteria and flexibility in implementation and technology. Disadvantages include the lack of assurance that the process will be properly used, appropriate, or produce the desired results. Comprehensive assessments can also be expensive.

Products or outcomes can also be certified. For example, the U.S. Food and Drug Administration certifies products as safe, effective, sanitary, and so forth. This has the obvious advantage that the certification directly certifies that specific products meet defined criteria for functionality, performance, and quality.

However, this approach also has disadvantages: results are only available after the product has been developed, which is often too late, and rely on testing that can be expensive and time consuming.

1.4 The TSP Certification Strategy

Because each certification approach has strengths and weaknesses, TSP-PACE combines the three to assure that the capabilities exist, are properly applied, and are producing good results. A TSP certification is the SEI's assurance that the organization or program has properly used the TSP process, meaning

- team members know proper methods
- team members know how to gather and use data
- an effective process was defined and followed faithfully
- the reported data accurately represents the process used and the product produced
- quality products were produced and the customers were satisfied with the results

TSP-PACE generates a profile that portrays the capabilities and performance of the organization or program. While this does not guarantee future performance, it demonstrates that the organization has successfully performed in the past and can provide accurate status reports.

1.5 Overview of the TSP-PACE Process

TSP is a comprehensive method that includes training, coaching, work practices, measurement, and project planning and tracking. Because TSP-PACE evaluates all of these aspects, it provides a comprehensive picture of performance at the individual, process, and product levels. It verifies that organizations have the skills they need to do the work, that they enact those skills in a disciplined execution of the process, and that the results are accurately tracked and reported.

A TSP certification is based on a professional evaluation of an organization's performance in doing software engineering work, including the predictability of project costs and schedules and the quality of the delivered products. A certification is only issued to organizations that have demonstrated proper and effective use of the TSP process and have supplied the data required to verify that performance. Once an organization is certified, the record will be kept by the SEI and made available on request.

The scope of an evaluation can be the organization, a sub-set of the organization, or a specific program within the organization. A program may consist of a single project or multiple projects. A TSP-PACE evaluation is intended for organizations that have achieved at least a basic level of TSP use and seek to have their capabilities professionally evaluated and recognized by the SEI. The evaluation provides assurance that a program has properly followed the TSP process to launch and perform its work.

When the SEI awards a certification, it is stating that the certified program or organization has used the TSP process properly and has demonstrated the ability to continue producing work of the quality typically produced by TSP groups. This certification is based on multiple analyses of data about the performance of the program or organization. TSP-PACE applies to that segment of the development organization that is within the certification scope, and it is valid only for a specified period. As a result, all certifications must be renewed periodically.

2 Obtaining a TSP Certification

Organizations and programs must be evaluated to earn a TSP certification. The evaluation process has the following four steps:

1. applying for a certification
2. conducting the on-site evaluation
3. making the certification decision
4. recertification

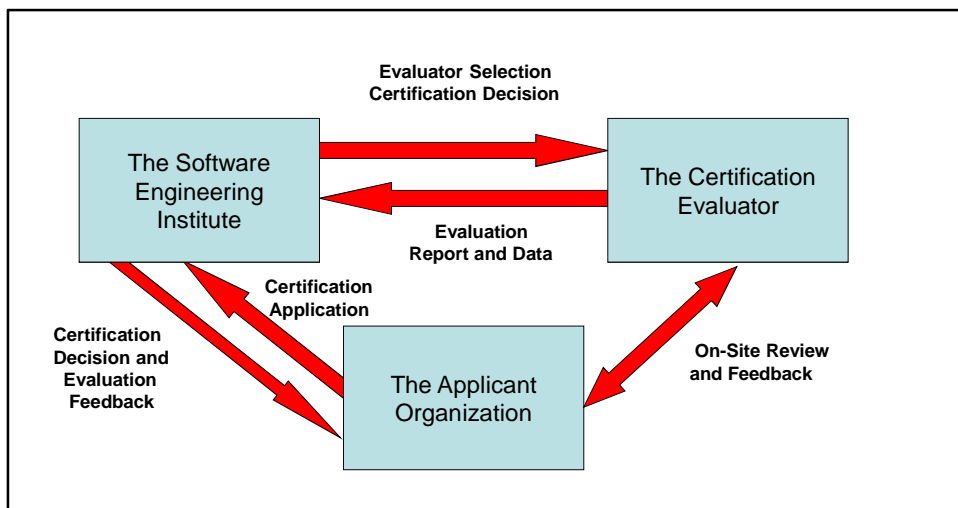The organizations and their roles in the certification process are shown in Figure 1.

Figure 1: TSP Organizational Certification

2.1 Step 1: Applying for a Certification

To initiate a certification evaluation, an organization should submit a TSP-PACE application to the SEI.[1] Acquirers that contract with suppliers may want the suppliers to obtain a TSP-PACE certification as evidence of their capability. When focused on a single program, the TSP-PACE will assure the acquirer that the certified program has implemented the TSP process correctly for that given program. In its application for a TSP-PACE, the applicant organization must specify which type of certification it seeks: a TSP-PACE Organizational Certification or a TSP-PACE Program Certification.

2.2 Step 2: Conducting the On-Site Evaluation

Once the SEI is satisfied that the organization's application contains sufficient information, it will select a qualified TSP-PACE evaluator. That evaluator will obtain a copy of the application and all associated data required for TSP-PACE. The evaluator will conduct an on-site evaluation to

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[1] Submit to: TSP Certification, The Software Engineering Institute, 4500 Fifth Ave. Pittsburgh, PA, 15213 or TSP-OEC@SEI.CMU.EDU.

verify that the data are accurate and represent the work of the group or groups that produced it. The evaluator will then send a report and additional supporting data to the SEI.

2.3 Step 3: Making the Certification Decision

Once the SEI receives the data and on-site evaluation report, it will verify that the data are complete and accurate, check for evidence of misrepresentation, analyze the data, make the certification decision, prepare a final report, and inform the evaluator and the applicant organization of its decision.

If the SEI judges that the organization or program has not provided adequate supporting information but could likely achieve a TSP-PACE with minor corrections, a re-evaluation will be recommended. A re-evaluation would likely be conducted by the original evaluator and be used in cases where a modest amount of data was missing or some data was not adequately described.

2.4 Step 4: Recertification

A TSP-PACE certification granted by the SEI is valid for a fixed period (initially set at one year and renewable for two additional one-year periods with data review). Thereafter, the original certification will expire and a recertification including on-site evaluation will be required.

3 The TSP-PACE Evaluation Process

When an organization submits a TSP-PACE application, the SEI will designate a qualified evaluator to conduct the on-site evaluation and to obtain the supporting data required to make a certification decision. The evaluator will then contact the organization, identify an official contact point, and inform that contact of the data required for the certification evaluation. After the organization's contact assures the evaluator that all of the required data have been gathered and provided, the evaluator will conduct the on-site evaluation.

3.1 TSP-PACE Program Certifications

As part of a TSP-PACE **Program** Certification, the evaluator will complete the steps below.

- **Assess the quality of the TSP data**
  Did all of the program's TSP teams gather accurate and complete data on their work, and are the data sufficiently accurate and complete to make a TSP-PACE decision?

- **Assess the quality of TSP training**
  Were authorized instructors used to train executives, managers, team leaders, and team members in TSP?

- **Assess the quality of the TSP coaching**
  Were SEI-certified TSP coaches used during launch preparation, team launches, and team operation? Did the coaches guide all of the team members and team leaders in following the TSP process and in conducting and reporting on the required launch, cycle, and project postmortems?

- **Assess the quality of the TSP launches and relaunches**
  For each TSP team, did all involved team members and team leaders participate in the entire launch? Did the appropriate executives or senior managers participate in launch meetings 1 and 9? Did they establish specific team goals and negotiate and approve a team-developed plan? Was a launch record produced and is it available?

- **Assess the quality of the post-launch coaching**
  For first-time TSP teams, was a coach available following the launch to resolve questions, issues, and concerns? For all of the program's TSP teams, was a coach available to consult with the teams? Did the coaches meet with every team at least monthly during the project? Did this ongoing coaching result in acceptable fidelity to the TSP process?

- **Assess the quality of the TSP project cycle postmortem reports**
  For every project cycle of every TSP project team, was a postmortem conducted and are the results available?

- **Assess the quality of the TSP project postmortem reports**
  For every completed project for every TSP team in the program, was a project postmortem report produced and is it available?

3.2 TSP-PACE Organizational Certifications

During the on-site evaluation for a TSP **Organizational** Certification, the evaluator will performs all the TSP-PACE program certification assessment steps listed above for multiple teams within the certification scope, along with the additional steps listed below.

- **Assess the certification scope**
  Is the certification scope defined clearly? Are the required data available for all of the teams within the certification scope? Are data available on a sufficient number of TSP teams within the certification scope to warrant conducting a certification evaluation?

- **Assess the customer satisfaction data**
  Has the organization gathered sufficient data from its customers and are the customers satisfied with the work the organization's TSP teams have performed?

At the end of the on-site evaluation, the evaluator will conduct an exit briefing with the organization's management. The evaluator will then prepare a report and submit it and all of the supporting data to the SEI.

After receiving the evaluation report and the supporting materials the SEI will analyze the data and make the final certification decision. It will then inform the evaluator and the organization's management of the result. If, in this review, the SEI finds that required data are missing, it may request that the evaluator or the organization supply these missing data or that a reevaluation be conducted.

4 The TSP-PACE Evaluation Profile

The TSP-PACE process uses data gathered during the evaluation to generate a five-dimensional profile summarizing the results of the evaluation. The five dimensions are

1. coverage
2. process fidelity
3. performance
4. customer satisfaction
5. overall

The data is presented as a Kiviat diagram (sometimes called a radar plot). This type of chart is useful for displaying multivariate quantitative data on a two-dimensional surface by using multiple axes.

The data listed for each profile dimension is scaled in percentages, typically with 100% being best and 0% being worst. There are some exceptions where the axis is permitted to exceed 100% by a modest margin, usually less than 25%. A specific axis or the scale of an axis may change over time as the SEI updates the approach. A general description of the content of each profile dimension and examples are provided in this section.

4.1 The Coverage Profile Dimension

The coverage dimension provides indications that the organization has proper training, certifications, and depth of coverage to perform the work. The coverage profile includes

- PSP training provided to the organization's TSP team members
- PSP training delivered to the entire development staff
- TSP training of managers
- TSP-related certifications obtained
- percentage of the organization's development work within the certification scope that uses the TSP process
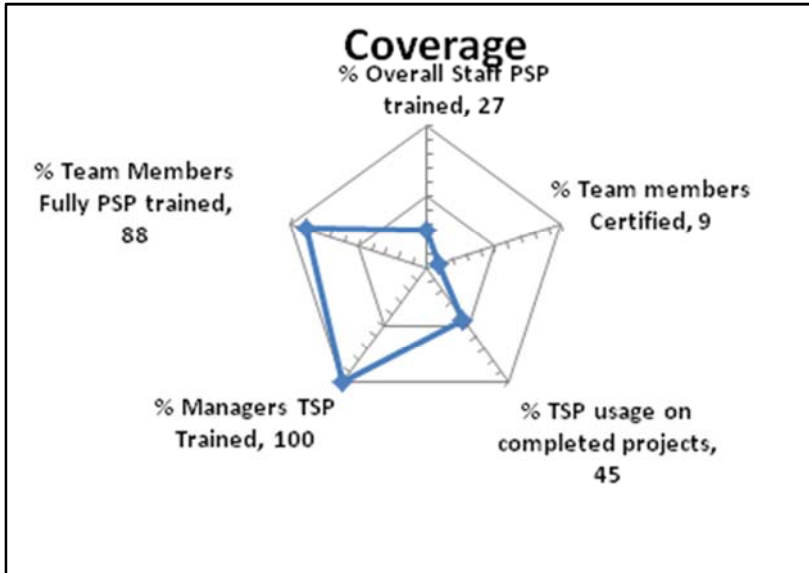
Figure 2: Coverage Dimension

In the example above, the data are consistent with a small organization that has completed the pilot phase but has not yet rolled out TSP to broad usage. The axes indicate the following:

- TSP was used on several projects that represented 45% of the total organizational projects completed during that time.
- All managers had been trained.
- 88% of the team members had been fully and formally trained.
- 27% of the total staff had been trained.
- 9% of the team members were PSP-certified developers.

4.2 The Process Fidelity Profile Dimension

The process fidelity dimension reflects the degree to which the organization defines and follows defined processes, including the TSP process. It includes using the TSP launch process, the degree to which the TSP teams properly gathered and used their data, the degree to which these teams followed their defined development processes, and the quality of TSP coaching. Each dimension has an upper bound of 100 to indicate ideal fidelity to the defined process. The scale approximates a percentage of high-fidelity process execution from the available opportunities.
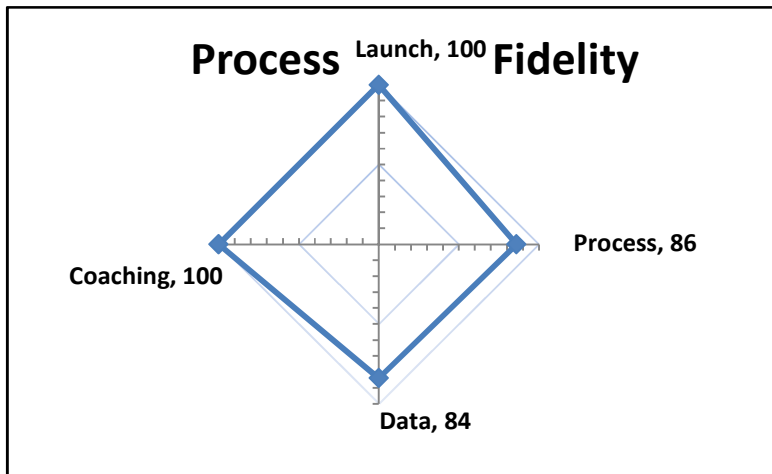
Figure 3*: Process Fidelity*

4.3 The Performance Profile Dimension

The performance profile dimension addresses cost, schedule, and quality. For schedule and cost, the measures are indicators of predictability—that is, the ability to accurately predict cost and schedule. These dimensions may sometimes exceed 100 by a modest amount. However, for scaling purposes, the axis is bounded by 1.25. Schedule uses a composite from the schedule performance index (SPI). Cost uses the ratio of estimated and actual effort applied to the work from task hour estimates to approximate the cost performance index (CPI). The functional scale is defined by the portion of the estimated product actually delivered: the functional process index (FPI). The calculation is similar to that of the SPI using estimated size committed in the denominator and the estimated size of delivered components in the numerator. Quality is a composite measure of defect density in test and ratio of time in the testing activities to total development effort.
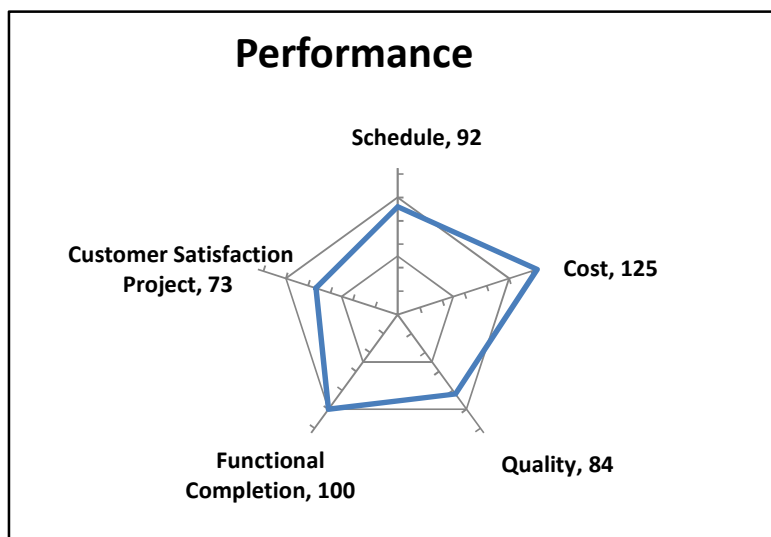

Figure 4: Performance

4.4 The Customer Satisfaction Profile Dimensions

A TSP-PACE analysis summarizes data provided by customers that expresses their satisfaction with the organization's project performance and product properties. Project performance includes the customer's satisfaction with the team's responsiveness and the project's cost, schedule, and functional-completeness performance. Product properties cover the capability, usability, performance, reliability, install-ability, maintainability, and documentation of the TSP-produced products.

The Customer Satisfaction diagram combines the results from a customer survey and composites the product and project results. The project performance and product properties dimensions are the mean scores (1-5) scaled to 1-100. The product overall and project overall are the mean values of the overall satisfaction results scaled from 1-100.
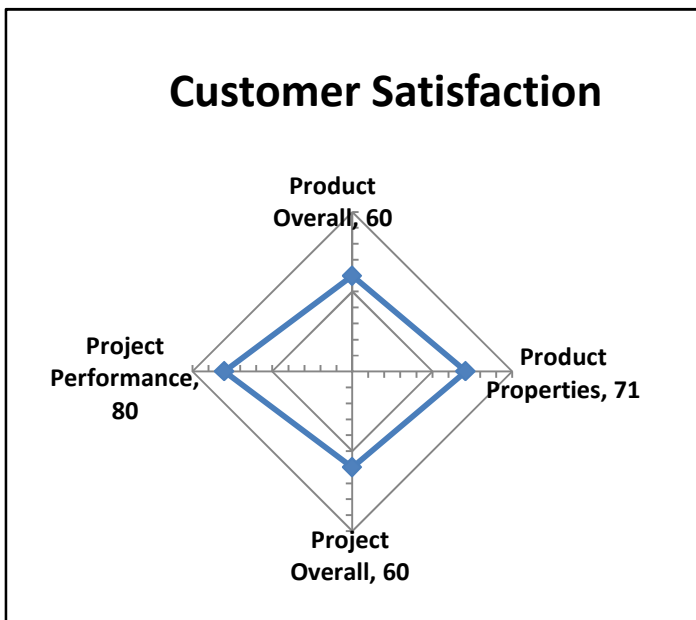

Figure 5: Customer Satisfaction

The project evaluation asks customers to evaluate the results against the cost, schedule, functional completeness, responsiveness, and overall project. The scale is 1-5. The Kiviat shows the median, maximum, and minimum score along each axis.
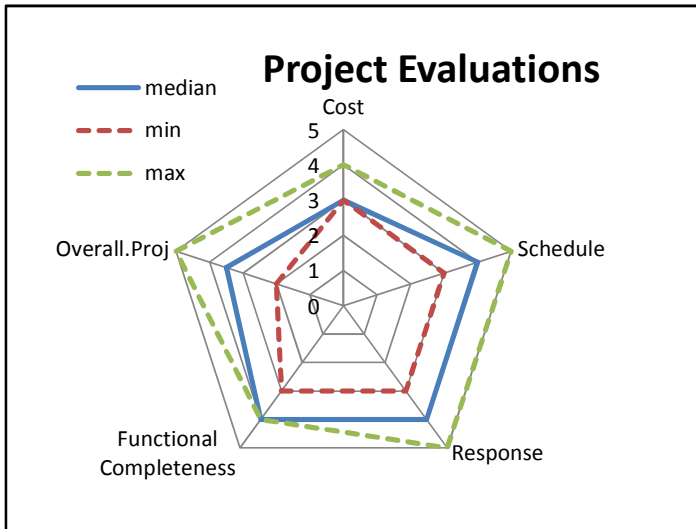
Figure 6: Project Evaluations

The product evaluations part of the customer survey asks customers to provide an evaluation of the product with respect to the following attributes: capability, usability, performance, reliability, install-ability, maintainability, documentation, and overall product. The scale is 1-5. The Kiviat diagram shows the median, maximum, and minimum score along each axis.
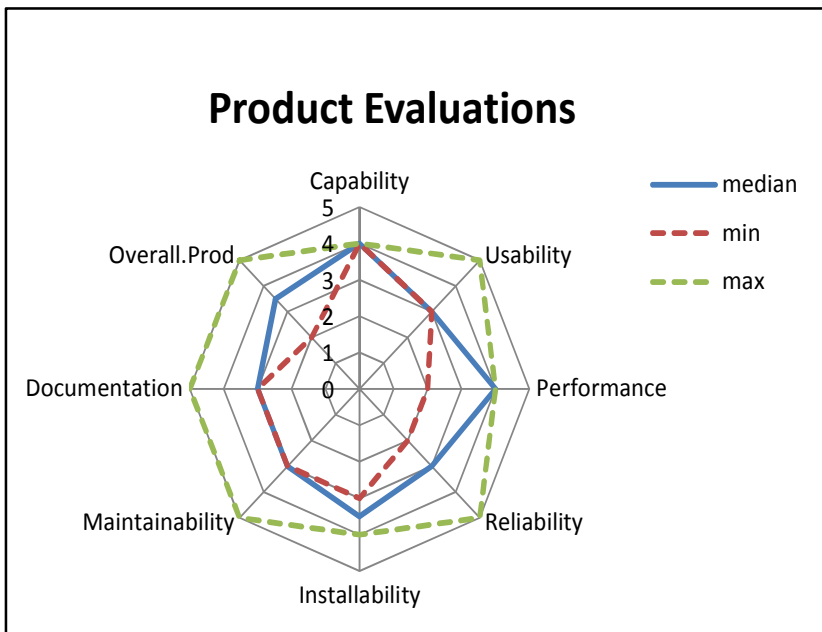

Figure 7: Product Evaluations

4.5 The Overall Profile Dimension

This dimension provides an overall composite rating for each certified organization. The radial axes, coverage, fidelity, performance, and customer satisfaction show a composite from the more detailed plots. This diagram is intended to provide a high-level summary of the evaluation results.
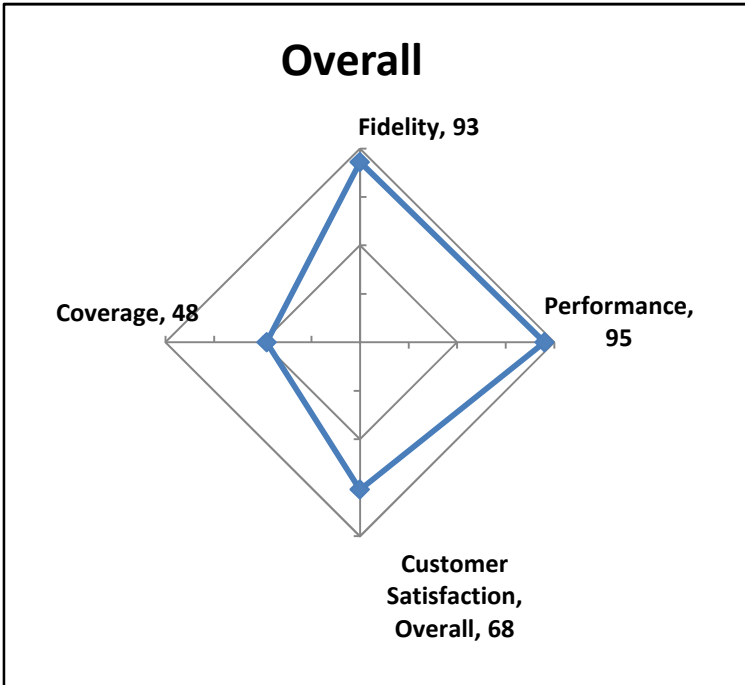
Figure 8: Overall

5   Preparing for a TSP-PACE

To prepare for a TSP-PACE, organizations should focus on collecting the project-based data required for the evaluation as they perform the work. The performance and customer satisfaction data then show how successful the development groups have been in meeting their commitments and producing quality products.

The data required for a TSP-PACE are specified in the TSP-PACE Application Guide and the TSP-PACE Team Preparedness Guide. A substantial portion of these data are gathered during project execution by TSP teams as they follow the TSP process. The quality of the available data is the key to a successful certification evaluation. Without quality data, organizations cannot expect to satisfy the TSP-PACE criteria. For more information about how TSP teams prepare for a TSP-PACE Organizational or Program Certification, refer to the TSP-PACE Team Preparedness Guide.

6 General TSP-PACE Conditions

The following paragraphs describe the conditions that govern the TSP-PACE Organizational and Program Certification processes. The topics covered in this section include the following:

- certification criteria
- validity period
- certification evaluator

6.1 Certification Criteria

A TSP-PACE Program Certification verifies that one or more teams on a program have been properly prepared, launched, and coached and that they have followed the TSP process. A TSP-PACE Organizational Certification verifies that the organization's development teams followed the TSP process and provides a capability profile of the organization in the form of a set of Kiviat diagrams. The certification is based on an evaluation of the work done by the teams within the organization's certification scope, and it verifies that the TSP process is followed. TSP-PACE cannot provide assurance about the organization's or program's future performance.

6.2 Certification Validity Period

The TSP-PACE is only valid for a limited period. The SEI has initially established this validity period as one year from the date of the certification award, with two one-year renewals. The SEI reserves the right to change this period in the future. However, once a certification has been granted, the time period that the certification is valid cannot be changed, except for cause. The validity period for a TSP-PACE Program Certification is established for each certification.

6.3 The TSP Certification Evaluator

TSP-PACE evaluators are trained and qualified by the SEI to perform the TSP-PACE organizational and program certification evaluations. While performing the evaluations, they are acting as agents of the SEI and are only authorized to perform the duties required by an evaluation.

When selected and retained by the SEI, the evaluator is required to attest that he or she was not employed or otherwise retained by the organization being evaluated in any capacity within the previous five years.

REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave Blank)	2. REPORT DATE September 2013	3. REPORT TYPE AND DATES COVERED Final

4. TITLE AND SUBTITLE	5. FUNDING NUMBERS
TSP Performance and Capability Evaluation (PACE): Customer Guide	FA8721-05-C-0003

6. AUTHOR(S)

William R. Nichols, Mark Kasunic, Timothy A. Chick

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Software Engineering Institute Carnegie Mellon University Pittsburgh, PA 15213	8. PERFORMING ORGANIZATION REPORT NUMBER CMU/SEI-2013-SR-031

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFLCMC/PZE/Hanscom Enterprise Acquisition Division 20 Schilling Circle Building 1305 Hanscom AFB, MA 01731-2116	10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12A DISTRIBUTION/AVAILABILITY STATEMENT Unclassified/Unlimited, DTIC, NTIS	12B DISTRIBUTION CODE

13. ABSTRACT (MAXIMUM 200 WORDS)

The Team Software Process (TSP) Performance and Capability Evaluation (PACE) process provides an objective way to evaluate software development organizations using data collected during TSP projects. This guide describes the evaluation process and lists the steps organizations and programs must complete to earn a TSP-PACE certification. It also describes how data gathered during the evaluation is used to generate a five-dimensional profile summarizing the results of the evaluation.

14. SUBJECT TERMS TSP, pace, performance measurement, data	15. NUMBER OF PAGES 24

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL