SPICE – International Standard for Software Process Assessment

Marko Pyhäjärvi

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Marko Pyhäjärvi

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Abstract

While software projects have became large, industrial production processes, it has been noticed that process assessment can be a strong and effective driver for process improvement. Based on this, acquirers of large, critical software-intensive systems have impeded for the use of international standard for process assessment.

High-quality software is tightly connected to the process used to produce the software. To build high-quality software, organizations have to improve their production processes continuously. SPICE is an international standard for software process assessment and it can be used in process improvement and process capability determination.

Contents

1 Introduction

SPICE is a major international initiative to support the development of an International Standard for Software Process Assessment. The project has three principal goals [SQI 2004]:

- To develop a working draft for a standard for software process assessment
- To conduct industry trials of the emerging standard
- To promote the technology transfer of software process assessment into the software industry world-wide

The first goal was achieved on June 1995 when the version 1 (draft standard) was released. By the normal process of development of international standards, the SPICE documents have been published as ISO/IEC TR 15504:1998 - Software Process Assessment. WG10 is continuing the work to the ultimate goal, full international standard [SQI 2004].

The main focus of SPICE project is now on SPICE trials, which are independent trials of SPICE in various organizations. Companies and organizations can apply to register as SPICE trial via SPICE website. These trials provide a lot of information of practical execution of SPICE in various organizations [SQI 2004].

There are a lot of people involved in SPICE development from over 20 countries. The international efforts are coordinated by five international technical centers. This arrangement has brought together software, standards, process and many other developers and academics around the world. The ultimate goal of this international community is to develop a consistent and validated framework for software process assessment [SQI 2004].

Why an international standard is needed? To improve quality and productivity, management needs to somehow measure the process used in development. Process assessment can be a strong and effective driver for process improvement. An international standard will provide the following benefits to software industry [SQI 2004]:

- Software suppliers will submit to just one process assessment scheme (presently numerous schemes are used)
- Software development organizations will have a tool to initiate and sustain a continuous process improvement
- Program managers will have a means to ensure that their software development is aligned with, and supports, the business needs of the organization

Practically it means that companies can get much better situation in the competitive world-wide markets when they use internationally standardized

software process assessment framework. Companies participating the SPICE development ensure that they are at the forefront of this technology when it will reach the international standard.

This paper introduces the SPICE concept with its documents for software process assessment. All documents will be presented shortly, describing their purpose and the most important contents, in the subchapter of the chapter 2.

2   SPICE document suite

SPICE provides a set of documents, which are used as a framework for the assessment of software process. Organizations can use these documents in various phases of production, for example in planning, managing, monitoring, controlling and improving acquisition, supply, development, operation, evolution and support of software [Sp1 v1.0].

Basically software process assessment examines the selected processes whether they are effective in achieving their goals, which is done by determining the capability of the selected processes. This structured approach for software process assessment helps an organization to improve its processes or to determine its capability for certain requirement, or to determine supplier's capability for certain requirement [Sp1 v1.0].

Process assessment provides information of the capability of the selected processes. Analysis results, from business point of view, identify strengths, weakness and risks inherent in the processes. By this, analysers are able to determine whether the processes are effective, and to identify significant causes of poor quality, or over runs in time or cost. After recognizing these kinds of issues, managers can prioritise improvements to processes [SQI 2004].

Process capability determination analyses the proposed capability of selected processes against a target process capability profile. By this, it tries to find out the risks involved in a project, if the project is run with the analysed processes [SQI 2004].

The document suite of SPICE contains nine different documents, which can be used in process assessment. These documents will be shortly described in the following subchapters.

SPICE documents (see figure 1) from 1 to 6 mainly concentrate in addressing various aspects related to process assessment. Other documents, 7 and 8, address the use of process assessment for process improvement or for process capability determination. Document 9 acts as a vocabulary [SQI 2004].
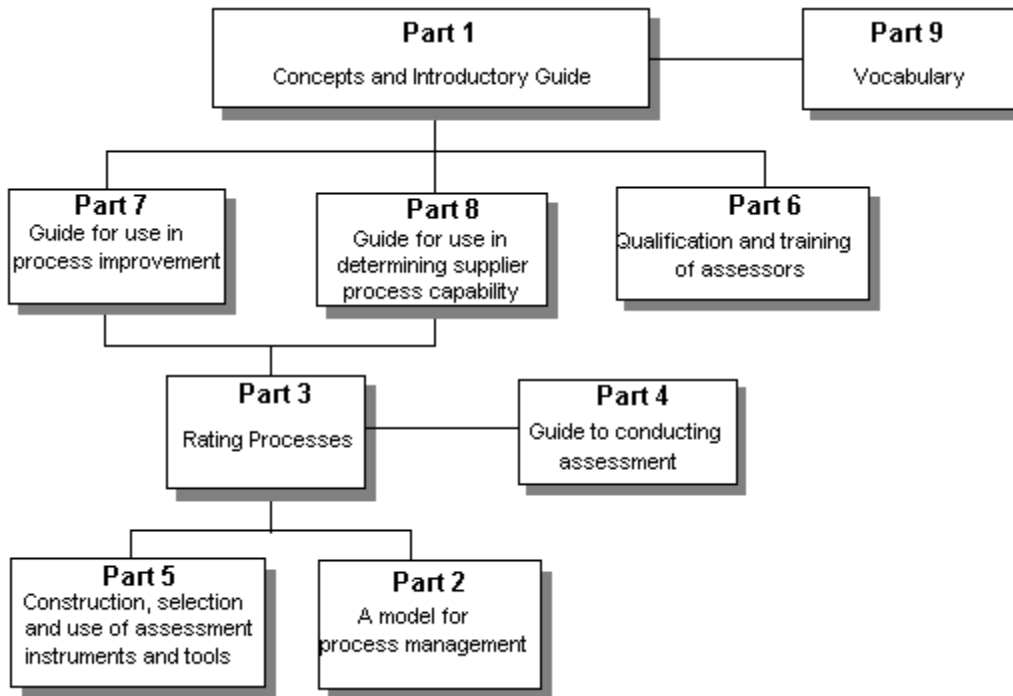
Figure 1: SPICE document suite

2.1   Part 1 – Concepts and introductory guide

The purpose of the first document is to provide overall information of software process assessment and its use in two contexts, process improvement and process capability determination. It also describes how various parts of the suite fit together, and it provides guidance for the selection and usage of the documents [Sp1 v1.0].

Figure 2 shows how process assessment and process capability determination affects to process improvement. Basically a process is examined with an assessment, which leads to process capability determination and process improvement.   Capability determination identifies the capability and risks of a process, and process improvement identifies the changes, which should be made to the process. Software capability determination generally motivates an organization to do process improvement.
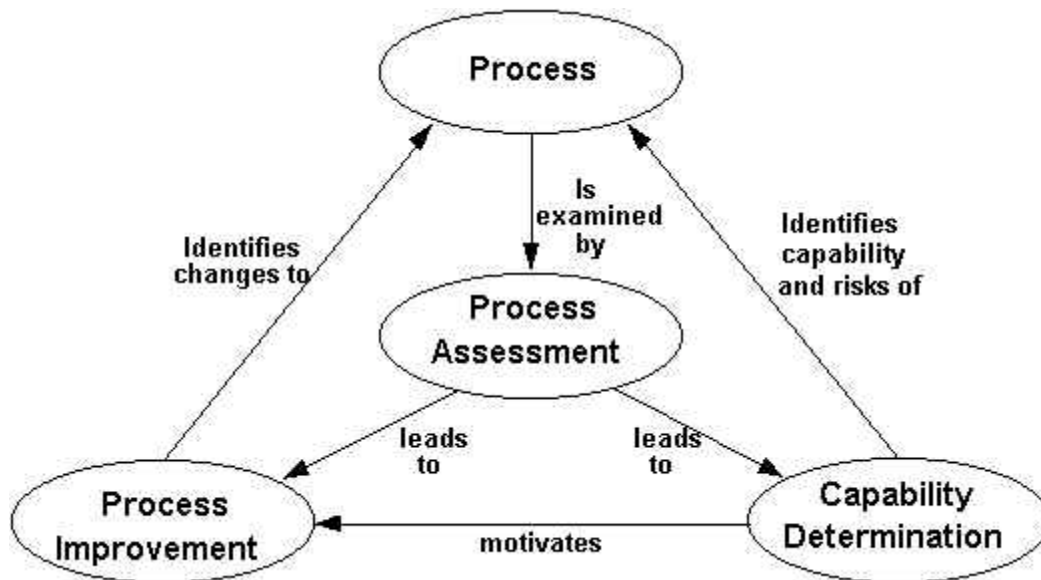
Figure 2: Process assessment on high level [Sp1 v1.0]

There are various benefits from using SPICE in an organization. Most important are listed below:

For acquirers:

- An ability to determine the current and potential capability of a supplier's software processes

For suppliers:

- An ability to determine the current and potential capability of their own software processes
- A ability to define areas and priorities for software process improvement
- A framework that defines a road map for software process improvement

For assessors:

- A framework that defines all aspects of conducting assessments

SPICE can be used in various contexts. Before using SPICE, the organization must first define the key determinant of why SPICE is needed. There are three choices:
- To understand the software process used
- To support process improvement
- To support process capability determination

Document 1 describes shortly all the documents in SPICE document set. This information is not presented in this paper, because all documents will be discussed in the following subchapters.

2.2 Part 2 – A model for process management

Document 2 provides the set of practices fundamental to good software engineering. This document defines various processes which can be used in various phases of production, named acquire, supply, development, support, evolve, and operate [Sp2 v1.0].

The model includes a set of practices, named basic practices and generic practices. Basic practices, grouped into processes and process categories, are essential activities of a specific process, while generic practices, applicable to any process, represent the activities necessary to manage a process and improve its capability to perform [Sp2 v1.0].

Processes, categorized into five process categories in the model, are described below:

- **Customer-Supplier** - processes that directly impact the customer, support development and transition of the software to the customer, and provide for its correct operation and use

- **Engineering** - processes that directly specify, implement, or maintain a system and software product and its user documentation

- **Project** - processes which establish the project, and co-ordinate and manage its resources to produce a product or provide a service which satisfies the customer

- **Support** - processes which enable and support the performance of the other processes on a project

- **Organization** - processes which establish the business goals of the organization and develop process, product, and resource assets which will help the organization achieve its business goals

Proceses in the model are described by base practices, which are their unique software engineering or management activities. Process categories, processes, and base practices provide a grouping by type of activity. [Sp2 v1.0].

Process capability levels, common features, and generic practices are used in evolving process capability. A capability level basically consists of a set of common features (sets of activities), which provide enhancement in the capability

of performing a process. Compared to the predecessors, each level provide a major enhancement in capability of the performance of a process [Sp2 v1.0].

Capability levels provide two benefits:

1. Acknowledging dependencies among the practices of a process
2. Help an organization to identify which improvements it might perform first

Capability levels are named as followed[Sp2 v1.0]

- Level 0 – Not performed
- Level 1 – Performed informally
- Level 2 – Planned and tracked
- Level 3 – Well defined
- Level 4 – Quantitatively controlled
- Level 5 – Continuously improving

2.3   Part 3 – Rating process

Document 3 of SPICE document suite is used in defining the minimum set of requirements for conducting a software process assessment. These requirements are used to ensure that the outputs of the assessment are consistent, repeatable and representative of the process instances assessed [Sp3 v1.0].

A process assessment is practically done by assessing selected processes against the process model defined in document 2. The output of the assessment provides a set of capability level ratings for each process instance assessed [Sp3 v1.0].

This document is primarily addressed to the qualified assessor and other people, such as the sponsor of the assessment, who need to assure themselves that the requirements have been met. It may also be very valuable for developers of assessment methods and tools [Sp3 v1.0].

As part of the SPICE, this document establishes the requirements for a software process assessment, for rating, analysing and profiling an assessment, and defines the circumstances under which assessment results are comparable.

This document provides an assessment framework which:

a) Encourages self-assessment

b) Takes into account the context in which the assessed processes operate

c) Produces a set of process ratings (a process profile) rather than a pass/fail result

d) Through the generic practices, addresses the adequacy of the management of the assessed processes

e) Is appropriate across all application domains and sizes of organization

2.4   Part 4 – Guide to conducting assessment

Process assessment basically means just collecting information describing the current capability of an organization's processes. It is initiated if there is a need to determine and/or improve the capability of these processes. SPICE document 4 provides guidance on interpreting the requirements set out in part 3 primarily for the use in a team-based assessment [Sp4 v1.0].

Although this guidance is directed at conducting a team-based assessment, the principles for rating processes can be used in a continuous, tool-based assessment. Nevertheless, in a continuous assessment the data collection is somehow different [Sp4 v1.0].

This document is primarily aimed at:

- The assessment team for preparing the assessment

- The participants in the assessment for understanding the assessment and interpreting the results

- All staff within organizations for understanding the details and benefits of performing process assessment

- Tool and method developers for developing tools or methods supporting the process assessment model

2.4.1 Process assessment

Figure 3 describes how a process assessment can be initiated by the need for process improvement or process capability determination. Assessment input is collected with the help of assessment instrument, and the process model is used in assessment. Finally the output is used for process improvement or process capability determination.
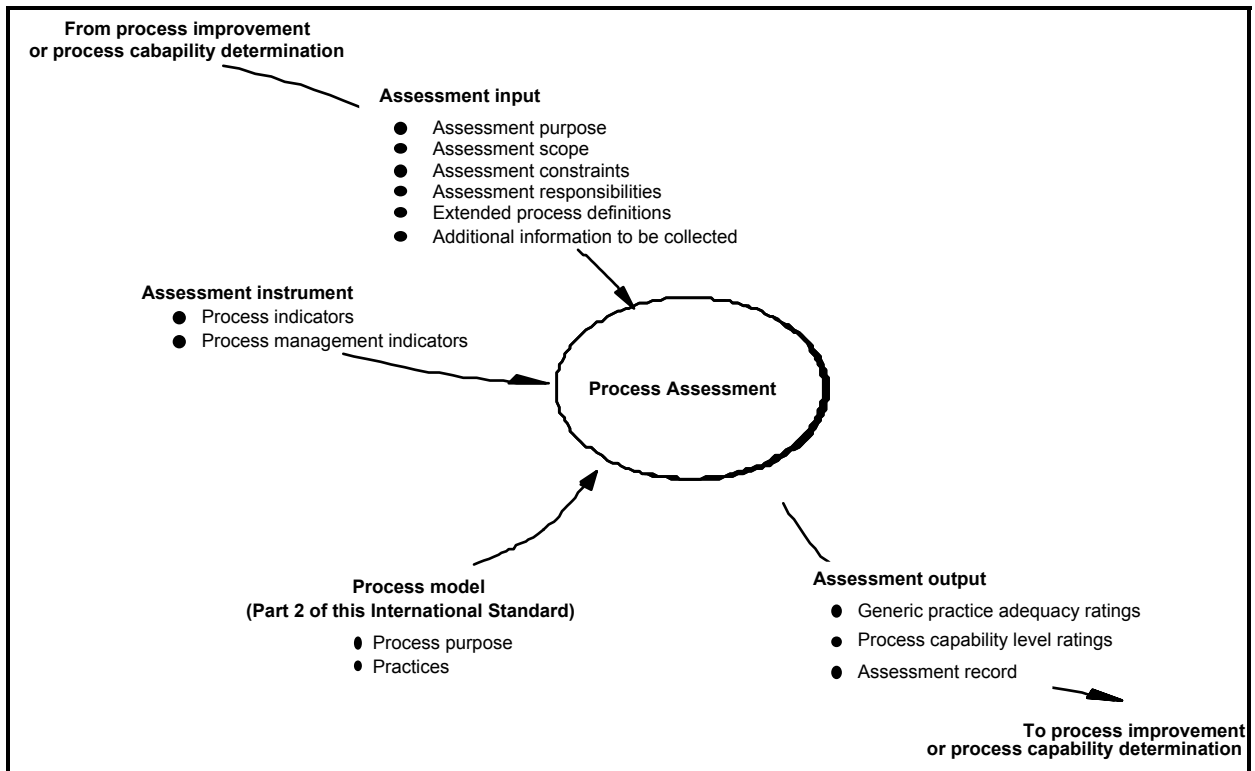

Figure 3: Process assessment context [Sp4 v1.0]

If process improvement is done, the output of the assessment provides the capability level ratings of the selected processes and the basis to plan, prepare, implement and evaluate specific improvement actions. This is described more detailed in part 7[Sp4 v1.0].

If process capability determination is done, the output of the assessment provides information for identifying, analyzing and quantifying the organization's strengths, weaknesses and risks. This is described more detailed in part 8 [Sp4 v1.0].

2.4.2 Assessment guide

The assessment contains eight stages, described in figure 4 below. The stages are:
1. Assessment input review
2. Process instance selection

3. Preparations
4. Information collection and verification
5. Determination of actual ratings
6. Determination of derived ratings
7. Rating validation
8. Presenting the assessment output
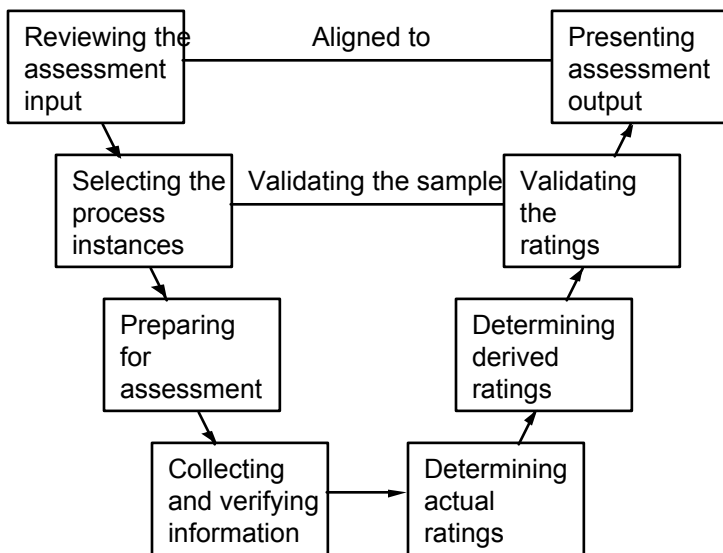
Assessment stages

Figure 4 – Eight assessment stages

2.5 Part 5 – Construction, selection and use of assessment instruments and tools

SPICE document 5 establishes the requirements for constructing an assessment instrument. In addition, it provides guidance on selection and usability characteristics associated with various types of assessment instruments [Sp5 v1.0].

An assessment instrument is defined as a tool (or set of tools) which is basically used in evaluation of the adequacy or existence of practices. An assessment instrument is needed to provide a consistent set of indicators as discriminators to help judge how well the practices have been implemented. An assessment instrument provides also a mechanism for recording the collected information [Sp5 v1.0].

This document [Sp5 v1.0]:

- Sets out the minimum requirements to be met in the construction of an assessment instrument

- Defines a set of indicators to be included in an assessment instrument

- Provides guidance on the selection, construction and usability of assessment instruments

This SPICE document is directed to [Sp5 v1.0]:

- Those responsible for the design and construction of assessment instruments, e.g. methodology providers, tool suppliers, assessors

- Assessors and assessment teams with responsibility for the selection and procurement of appropriate assessment instruments

- Assessors, sponsors or other parties responsible for assessing conformance of an assessment instrument to these requirements

2.5.1 Construction of an assessment instrument

It is not required in this standard that an assessment instrument should take any particular form or format. It can be, for example, a paper-based instrument containing forms, questionnaires or checklists, or it can be, for example, a computer-based instrument such as a spreadsheet, a data base system or an integrated CASE tool [Sp5 v1.0]

"Regardless of the form of the assessment instrument, its main objective is to help an assessor to perform an assessment in a consistent and repeatable manner, reducing assessor subjectivity and ensuring the validity, usability and comparability of the assessment results" [Sp5 v1.0]. To creach this goal, an assessment instrument should be made according to the instructions defined in Annexes A, B, C and D.

"All indicators incorporated into an assessment instrument shall be traceable to a corresponding process, generic practice, or base practice in the process model in part 2 of this international standard, or to a practice in an extended process" [Sp5 v1.0]

Annexes, which provide the actual framework for instrument development, are not described in this paper. They can be found from the actual SPICE document 5.

2.6   Part 6 –Qualification and training of assessors

When SPICE is used in assessment os a software process, the international standard assumes that the assessment team includes at least one qualified assessor. This qualified assessor is in primary responsibility of the assessment, ensuring that the requirements are met during the assessment.

The result of the assessment obviously depends on the skilled judgement of the assessors. *"The achievement of an acceptable level of consistency, repeatability and reliability of results relies on competent assessors with appropriate skills, experience, and knowledge of the software process, of the model for processes described in document 2, and of the conduct of assessment and rating described in parts 3 and 4"* [Sp6 v1.0].

A qualified assessor usually acts as a team leader for the assessment team. This person is in responsibility of ensuring that other team members have the right blend of specialized knowledge and assessment skills. This qualified assessor has to provide the necessary guidance and lead to the team, and help to moderate the judgements and ratings made by other team members to ensure the consistency of the results [Sp6 v1.0].

This document practically describes the assessor competencies and appropriate education, training and experience. The document also introduces mechanisms used in demonstrating the competence and validating the education, training and experience [Sp6 v1.0].

This document is directed to assessors, managers of assessors, and to sponsors of assessments, but it is also useful to organizations offering appropriate assessment training. Figure 5 below describes how a person can become a provisional and/or qualified assessor. Basically becoming a provisional assessor, one needs basic software education and assessor education. To become a qualified assessor, one needs more training and qualifications of education and training.
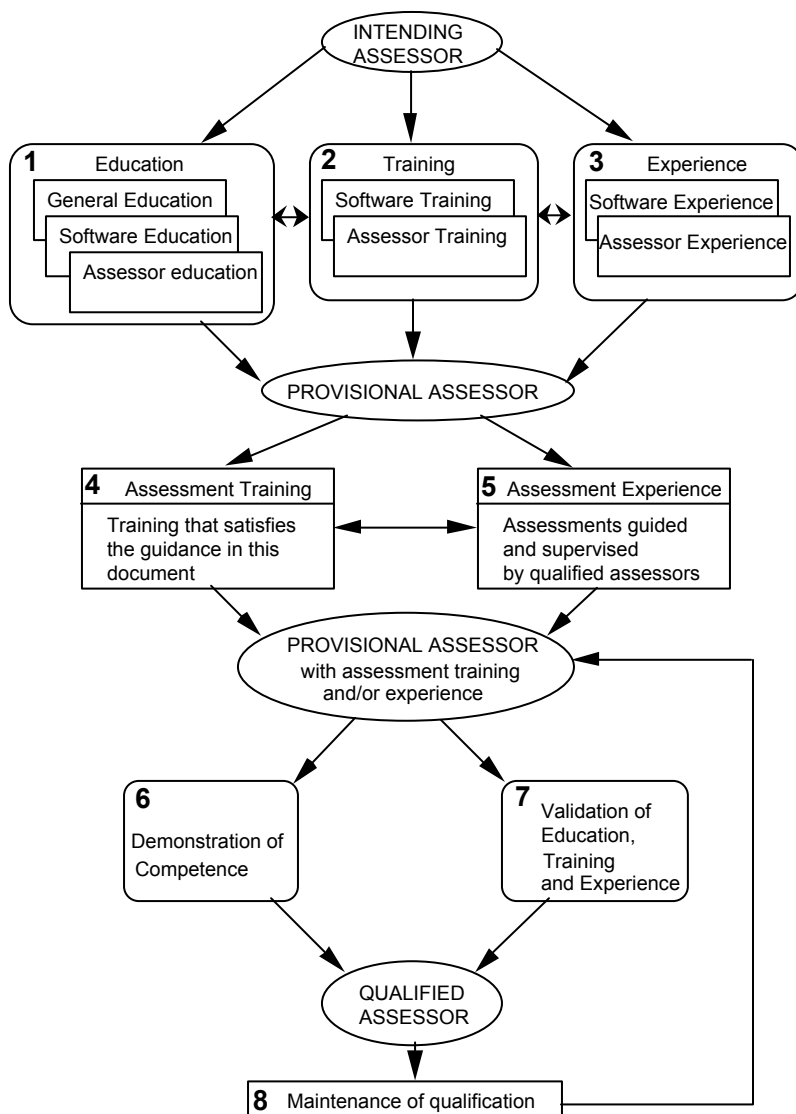
Figure 5 – Becoming a provisional or qualified assessor [Sp6 v1.0]

In addition to technical skills, assessors should have also certain personal skills, like diplomacy, persistence and judgement.

2.7   Part 7 – Guide for use in process improvement

Document 7 acts as a guide on using process assessment to understand the current state of processes, and to create and prioritise the improvement plans. The document is primarily aimed at the management of an organization considering a software process improvement programme, members of improvement teams, software engineers, and external consultants [Sp7 v1.0].

This process improvement guide includes the following [Sp7 v1.0]

– An overview of process improvement – the factors which drive software process improvement and general principles which underpin it

– A methodology for process improvement – an eight step model for improving software processes within a continuous improvement cycle

– Cultural issues – aspects of organizational culture that are critical for successful process improvement

– Management – software process improvement from a management perspective including an overall framework for process measurement

This guidance, used in software assessment for process improvement, covers the following: [Sp7 v1.0]:

– Invoking a software process assessment

– Using the results of a software process assessment

– Measuring software process effectiveness and improvement effectiveness

– Identifying improvement actions aligned to business goals

– Using the process model in document 2 as a route map for improvement

– Cultural issues in the context of software process improvement

– Dealing with management issues for software process improvement

The guidance provided by this document, does not presume specific organizational structures, management philosophies, software life cycle models or software development methods. The guidance and principles are appropriate for different business needs, application domains and sizes of organization, so that they may be used by all types of software organizations to guide their improvement activities [Sp7 v1.0].

Figure 6 illustrates the steps for continuous software process improvement using the components of SPICE. A comprehensive process improvement programme may identify improvement goals to be attained over several iterations of the improvement cycle [Sp7 v1.0].
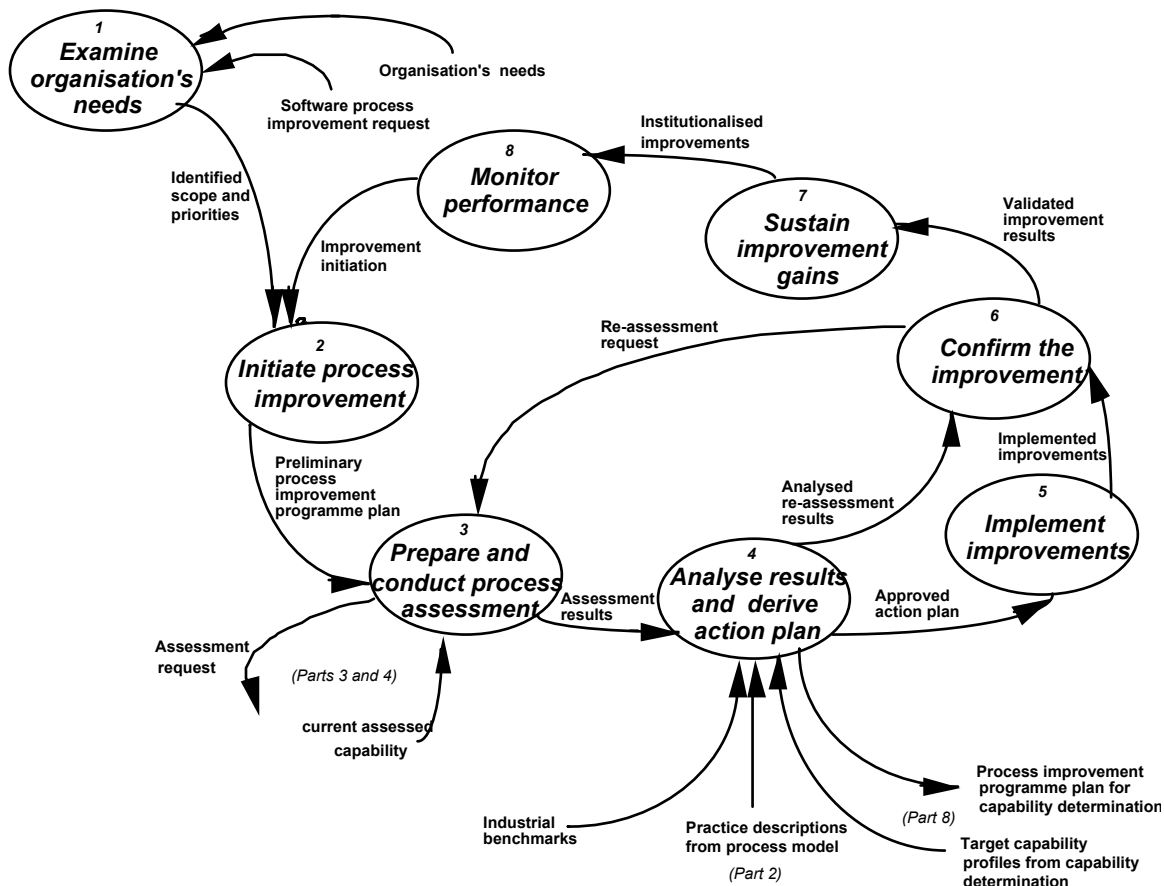
Figure 6 – Software process improvement steps

2.8   Part 8 – Guide for use in determining supplier process capability

Document 8 provides guidance on how to utilize process assessment for the purposes of process capability determination.

"A process capability determination is a systematic assessment and analysis of selected software processes within an organization, carried out with the aim of identifying the strengths, weaknesses and risks associated with deploying the processes to meet a particular specified requirement. This guidance is intended to be applicable across all software application domains, over all software organizational structures, within any software customer-supplier relationship, and to any organization wishing to determine the process capability of its own software processes" [Sp8 v1.0].

This guide is primarily aimed at:

- – The sponsor who initiates the process capability determination
- – The organization whose process capability is to be determined
- – The assessment team
- – Tool and method developers

In this guide, two alternative approaches to process capability determination are presented. **Core process capability determination** is a minimum, streamlined set of activities applicable whenever a single organization needs to identify its current process capability, without any partners or sub-contractors being involved. **Extended process capability determination** is applicable when an enhanced capability is needed to be done, or when consortia or sub-contractors are involved. Which case is ever selected, the conduct of process capability determination is described in three separate stages, named: [Sp8 v1.0]

- - Target definition stage
- - Response stage
- - Verification and Risk Analysis Stage

2.9   Part 9 – Vocabulary

Document nine works as a vocabulary. This document is not described more in this paper. For further information, see reference [Sp9 v1.0].

3   Conclusions

This paper introduced the concept of SPICE, Software Process Improvement and Capability Determination. SPICE is a major international initiative to support the development of an International Standard for Software Process Assessment. It contains nine separated documents, which can be used for process improvement and/or process capability determination. This paper discussed those documents, their purpose and the most important contents.

4   References

[SQI 2004]   Software Quality Institute. "Software Process Improvement and Capability dEtermination". http://www.sqi.gu.edu.au/spice/

[Sp1 v1.0]   SPICE Part 1: Concepts and introductory guide. Version 1.00

[Sp2 v1.0]   SPICE Part 2: A model for process management. Version 1.00

[Sp3 v1.0]   SPICE Part 3: Rating process. Version 1.00

[Sp4 v1.0]   SPICE Part 4: Guide to conducting assessment. Version 1.00

[Sp5 v1.0]   SPICE Part 5: Construction, selection and use of assessment instruments and tools. Version 1.00

[Sp6 v1.0]   SPICE Part 6: Qualification and training of assessors. Version 1.00

[Sp7 v1.0]   SPICE Part 7: Guide for use in process improvement. Version 1.00

[Sp8 v1.0]   SPICE Part 8: Guide for use in determining supplier capability. Version 1.00

[Sp9 v1.0]   SPICE Part 9: Vocabulary. Version 1.00