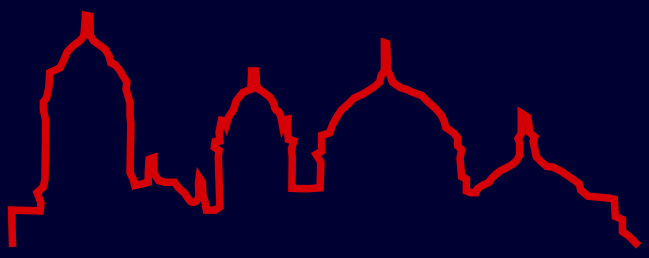
MENSURA 2006

PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SOFTWARE PROCESS AND PRODUCT MEASUREMENT



November, 6-8, 2006
Cádiz, Spain

Alain Abran
Reiner Dumke
Mercedes Ruiz (Eds.)

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Preface

This volume contents the papers presented at the Mensura 2006 conference held at Cádiz, Spain in November 2006 in conjunction with the 16th International Workshop on Software Measurement (IWSM2006) and MetriK Congress (MetriKon2006) hold at Postdam, Germany.

The objective of the International Conference on Software Process and Product Measurement (Mensura 2006) is to bring to light the most recent findings and results in the area of software measurement and to stimulate discussion between researchers and professionals.

The conference included top keynote speakers in the field of software measurement: Dr. Alain Abran from the University of Québec, Dr. Dieter Rombach from Fraunhofer Institute for Experimental Software Engineering and Mark Harman from King's College London.

We would like to thank the many people who have brought this International Conference into being: the Organizing Committee, the International Program Committee and the additional reviewers, particularly for all their hard work in reviewing both the abstracts and the final papers.

The organizers would also like to thank the University of Cádiz, the Research Group for Software Process Improvement and Formal Methods (SPI&FM) and the City Council of Cádiz for supporting the conference.

November 2006

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Technical Papers

Estimating the performance and capacity of software processes according to ISO/IEC 15504

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Abstract. At the moment there is no set of metrics which measures the improvements brought in by efforts to make software processes better. It is often the case that these improvements are measured using informal and subjective processes based on the perception of employees and/or auditors. Bearing all this in mind, this work presents a set of measurements for gauging the performance and capability of software processes, based on the international standard ISO/IEC 15504. This set of metrics aims to lower the level of subjectivity of people when measuring the processes. A more objective and hence more formal evaluation is thus achieved.

1 Introduction

Nowadays, software companies know that success (in terms of time, money, quality, etc.) in delivering a product lies in an effective management of its software processes [6], which involves four key responsibilities [9]: (i) process definition, (ii) process measurement, (iii) process control and (iv) process improvement.

One of the main reasons for the massive increase in the interest in software measurement is the perception that measuring the quality of the improvement process [7] is another crucial activity. This involves carrying out an efficient and effective measurement process, with the following main goals: (i) to help in understanding the development and to maintain tasks, (ii) to allow projects to be controlled, (iii) to enhance our processes and products [8].

However, when dealing with process measurement, it is commonly known that, generally speaking, most measures are defined for products: measures for software processes are scarce. It is therefore important to devote our efforts towards research into software process measurement. This is a key activity for the success of software process management and improvement, as this kind of activity, which gives some

feedback to the process, depends on an appropriate and objective measurement of that process.

The importance of process management justifies many of the standardization initiatives of process improvement, such as CMM, Bootstrap or SPICE. Also, by measuring the capacity of processes we can estimate the maturity of the organization, as stated in current international standards such as CMMI [2] or ISO 15504 [4] [5] which are widely accepted and used.

Currently, process improvement is measured by informal and subjective processes based upon the perception of employees and evaluators. Unfortunately, they are not based on formal measurement processes [11]. In this work, we present a set of measures which are designed to evaluate the performance and capacity of software processes, following the international standard ISO/IEC 15504. With this set of measures we aim to lower the level of subjectivity when measuring processes, increasing the formality and objectivity of the evaluation.

2 Framework for metrics definition

International standards related to evaluation methods present a general framework for evaluating and defining several indicators that must be taken into account when performing an evaluation. However, they do not define explicit measures that help us in calculating the performance or capacity of a process. This value is very important when we are trying to evaluate the maturity of the company, as this is closely related to the capacity of their processes.

The scope of the current work is summarised in the following:

- Regarding the method for measure construction, we will apply the method proposed in [13].
- As framework for the software process evaluation model, our measurement proposal will be based on the ISO/IEC 15504 standard (see figure 1). More specifically, we will focus on levels 1 (performed) and 2 (managed).
- We will use the set of processes defined by Light MECPDS [12] as a reference model, which is based on the international standard ISO/IEC 12207:2004 [3], (see figure 1).
- The measures defined can be directly used by the Light MECPDS evaluation method, but can be adopted by any other model based on ISO/IEC 15504.

As we can observe in figure 1, two kinds of measures are proposed:

- The first kind is related to the capacity dimension, and its goal is to measure the capacity of a process, taking into account the process attributes related to the capacity levels defined by ISO/IEC 15504. For each process attribute, we will define a “capacity measure” based on the measurement of the following indicators: (i) generic practice, (ii) generic resources used and (iii) generic work products obtained in the process. These indicators are based on the ISO/IEC 15504-5Standard.
- The second group of measures is related to the process dimension, and their goal is to measure the process performance by considering the characteristics of the

processes defined in the Process Reference Model of Light MECPDS. For each sub-process, the "performance measure" is based on the following indicators (which have been obtained from the ISO/IEC 15504-5 e ISO/IEC 12207 standards): (i) performed base practices and (ii) obtained work products.

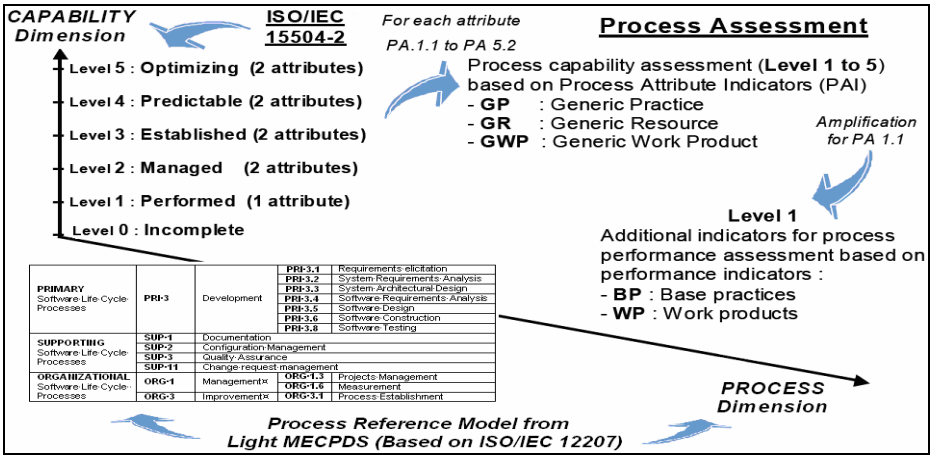

Fig. 1. Structure and indicators for measure definition.

2.1 Need for Information

When carrying out a process evaluation in a company context, we need to follow an evaluation method that generates quantitative results which characterize the performance and capacity of the process (or the organization's maturity) [3, 10]. These results give information that allow us to determine the current state of the software process so we can find the strengths and weaknesses that allow us to define strategies for enhancing the processes.

To obtain the relevant information about a process performance and capacity, it is necessary to provide a set of measures that allow the evaluation processes to work in a way that is both more formal and more objective.

2.2 Goal of Metrics

We have used the GQM method to define clearly the goal that we want to reach by using the proposed metrics. The next table shows the general goal we want to achieve.

Table 1. Goal definition

GOAL	
To analyze	The software process
With the purpose of	Evaluating
With respect to	The performance and capacity
From the point of view of	The improvement process group
In the context of	International Standard ISO/IEC 15504-5:2006(E)

3 Definition of performance process metrics

We have analyzed a standard process from the ISO/IEC 15504-5:2006 standard to define the metrics at level 1 or performance level. As all the processes that follow the standard have the same structure, we can define the metrics for the other processes of the reference model based on the one presented here. Figure 2 shows the structure of the quality assurance process, which we have used as a base for the definition of the metrics for measuring process performance.

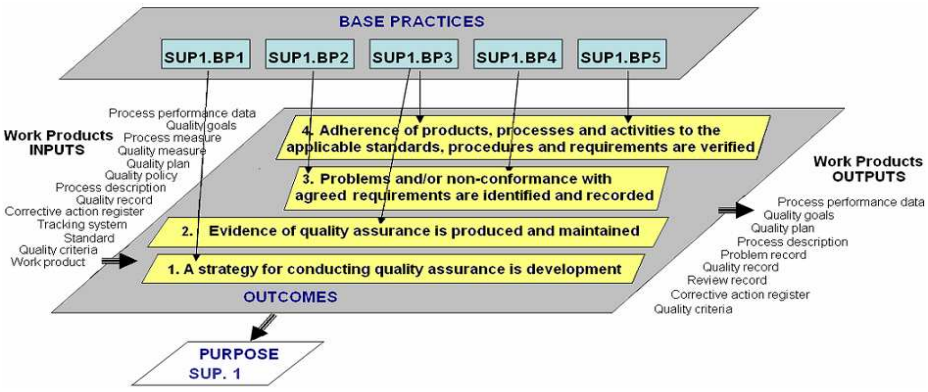

Fig. 2. Structure of the Quality Assurance process in ISO/IEC 15504-5:2006

3.1 Questions

As a starting point in the performance metrics definition process, we have stated a set of hypotheses about the software processes. We have defined these hypotheses as questions we want to answer on the path to getting a valid set of processes metrics.

- Does the achievement of the base practices influence the results of the software process?
- Do the input work products influence the results of the software process?
- Do the output work products influence the results of the software process?
- Do the results of a process influence the performance of a software process?

3.2 Measures Definition

As set out in the schema of the Standard ISO/IEC 15504-5:2006, the process performance can be measured by means of the successful implementation of the results. These results are related to the base practices and work products.

The measures of the level of process performance have been defined, with the aim of evaluating the degree of process fulfillment with respect to the process defined in the process evaluation model. The measure definition is shown in Table 2:

Table 2. Process Performance Measures

Process Performance Measures	
1. Based on Base Practices	
Measure	**Definition**
NRP_std	Number of results (defined in ISO/IEC 15504-5) of the software process being evaluated.
NBPRi_std	Number of base practices (defined in ISO/IEC 15504-5) which contribute to the achievement of the result *i* of the software process being evaluated.
WRP	Weight of each result of the software process being evaluated **WRP = 1 / NRP_std**
VBPRi_ro	Value of the base practices for the result *i* achievement carried out by the organization. ***It is obtained from an information collection tool***.
DFRi (BP)	Degree of fulfillment of the result *i* according to the base practices. **DFRi (BP) = VBPRi_ro / NBPRi_std**
DPP (BP)	Degree of Process Performance based on the base practices. $\mathbf{DPP\ (BP) = WRP * \sum_{i=1}^{n} DFR}i\ \mathbf{(BP)}$
2. Based on Work Products	
Measure	**Definition**
NIWPRi_std	Number of input work products of the software process being evaluated (defined in ISO/IEC 15504-5) related to the result *i*.
NOWPRi_std	Number of output work products of the software process being evaluated(defined in ISO/IEC 15504-5) related to the result *i*.
TNWP_Ri	Total number of work products of the result *i*. **TNWP_Ri = NIWPRi_std + NOWPRi_std**
NWPRi_ro	Number of work products carried out by the organization for the result i achievement. **It is obtained from an information collection tool.**
DFRi (WP)	Degree of fulfillment of the result *i* according to the work products. **DFRi (WP) = NWPRi_ro / TNWP_Ri**
DPP (WP)	Degree of Process Performance based on work products. $\mathbf{DPP\ (WP) = WRP * \sum_{i=1}^{n} DFR}i\ \mathbf{(WP)}$

The process results defined in ISO/IEC 15504-5 are related on the one hand to base practices and on the other to work products. So, in order to obtain a solid measure of process performance, there is an undergirding premise that both the base practices and work products have the same weight.

Table 3. Process Performance Measure

Process Performance Measures	
Based on Base Practices and Work Products	
Measure	**Definition**
GPPM	Global Process Performance Measure **GPPM = DPP (BP) * 0.5 + DPP (WP) * 0.5**

4 Process Capability Measure Definition

We have analyzed a capability level from the ISO/IEC 15504-5:2006 standard for defining the metrics at level 2 or capability level. As all the capability levels of the Standard have the same structure, based on the defined measures for level 2, the measures of upper levels can be obtained. The capability level chosen in the context of this paper has been the level 2, "Managed Process" [4], whose structure is illustrated in Figure 3.

It is important to highlight that every process attribute result has only one generic practice associated, as well as generic resources and generic work products which are related to these results.

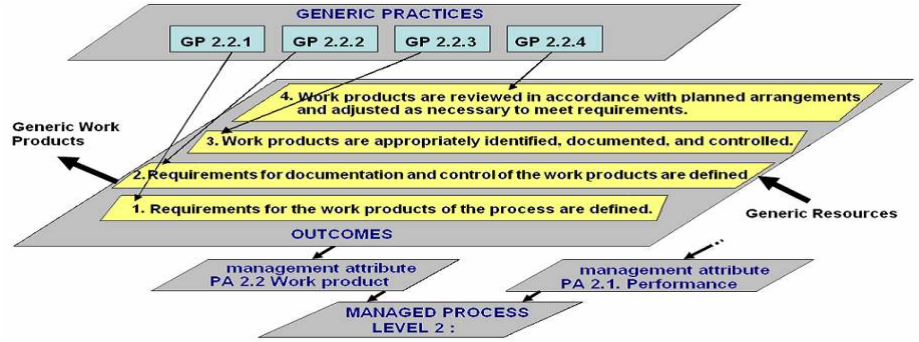

Fig. 3. Capability Level 2 Structure of the ISO/IEC 15504-5:2006

4.1 Questions

As a starting point for the capability metrics definition process, we have stated a set of hypotheses about the software processes. We have defined these hypotheses as questions we want to answer as we go towards getting a valid set of process metrics.

- Do the process attributes affect the obtaining of a capability level?
- Do the results of a process influence the software process capability?
- Do the generic resources affect the software process capability?
- Do the generic work products affect the software process capability?
- Does the achievement of the generic practices have any influence on the results of a software process attribute?

4.2 Measures Definition

According to the schema of the Standard ISO/IEC 15504-5:2006, the process capability can be measured through the successful implementation of the process attributes. These process attributes are related to the generic practices, resources and work products. The measures at the level of the scope of the process capability have been defined with the aim of evaluating the capability level of the process with respect to a capability model. The definition of these measures is provided in Table 4.

Table 4. Measures of the Process Capability Attribute

Measures of the Process Capability Attribute	
1. Based on Generic Practices	
Measure	**Definition**
NARP_std	Number of attribute results (defined in ISO/IEC 15504-5) of the process being evaluated.
NGPRi_std	Number of generic practices (defined in ISO/IEC 15504-5) of the process attribute being evaluated which contribute to the achievement of the result *i*
WRAP	Weight of each result of the attributes of the software process being evaluated **WRAP = 1 / NARP_std**
VGPRi_ro	Value of the generic practices carried out by the organization for the result *i* achievement. ***It is obtained from an information collection tool***.
DFRi (GP)	Degree of fulfillment of the result *i*, according to the generic practices. **DFRi (GP) = VGPRi_ro / NGPRi_std**
DPAF (GP)	Degree of Process Attribute Fulfillment based on generic practices $\mathbf{DPAF\ (GP) = WRAP * \sum_{i=1}^{n} DFR}i\mathbf{\ (GP)}$
2. Based on Generic Resources	
Measure	**Definition**
NGRRi_std	Number of generic resources of the software process attribute being evaluated (defined in ISO/IEC 15504-5) related to the result *i*.
NGRRi_ro	Number of generic resources which are available in the organization for the result *i*. ***It is obtained from an information collection tool***.
DFRi (GR)	Degree of fulfillment of the result *i* according to the generic resources. **DFRi (GR) = NGRRi_ro / NGRRi_std**
DPAF (GR)	Degree of Process Attribute Fulfillment based on generic resources $\mathbf{DPAF\ (GR) = WRAP * \sum_{i=1}^{n} DFR}i\mathbf{\ (GR)}$
3. Based on Generic Work Products	
Measure	**Definition**
NGWPRi_std	Number of generic work products (defined in ISO/IEC 15504-5) of the process attribute to evaluate which contribute to the achievement of the result *i*
NGWPRi_ro	Number of the generic work products for the result *i*, actually carried out by the organization ***It is obtained from an information collection tool***.
DFRi (GWP)	Degree of fulfillment of the result *i* according to the generic work products **DFRi (GWP) = NGWPRi_ro / NGWPRi_std**
DPAF (GWP)	Degree Process Attribute Fulfillment based on generic work products. $\mathbf{DPAF\ (GWP) = WRAP * \sum_{i=1}^{n} DFR}i\mathbf{\ (GWP)}$

The process attribute results defined in ISO/IEC 15504-5 are related to the generic practices, resources and work products. So in order to obtain a solid measure for the process capability, the weight for all these indicators is considered (see Table 5).

Table 5. Process capability measures

Capability Process Measures	
Based on Process Attributes	
Measure	**Definition**
GCPM	Global Capability Process Measure. **GCPM = DPAF (GP) * 0.4 + DPAF (GR) * 0.3 + DPAF (GWP) * 0.3**

5 Measures support tool

Once the measures were defined, a tool based on Bayesian Networks, supported in the Elvira Software Tool [1], for information collection and automatic calculation was developed. The measures had to be collected for all the process attributes in the capacity dimension and for each process in the process dimension. The aim of this tool is to provide companies with a useful instrument to automate the measurement process and to reduce the subjectivity of the evaluation process. The prototype window that supports the calculation of the performance metrics of the quality assurance process is shown in fig. 4.

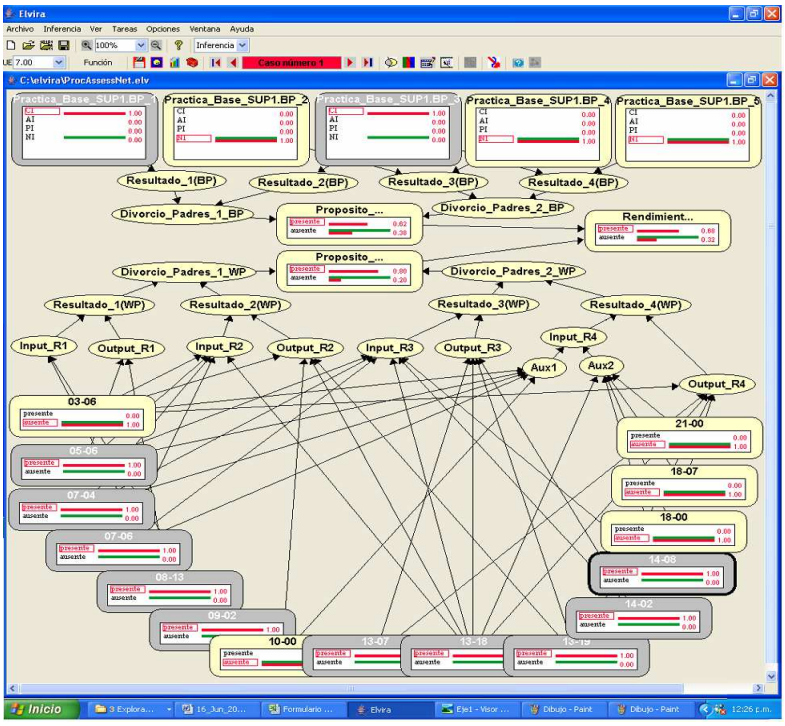

Fig. 4. Bayesian Networks for automatic calculation of the metrics.

6 Conclusions and future work

This work is complementary to the standard. The standard offers a horizontal view of the measurement process, because it provides the main threads in the evaluation of software processes. The work we have presented in this paper is vertical to the measurement process, however, as it provides metrics and forms for information gathering that help us to evaluate a software process in a formal and objective way.

A software company in search of process maturity should be disciplined in software measurement. If we use a process oriented focus, the need is not only to measure the product. It is also necessary to be able to measure the processes for improving the quality of the software product. The goal is to improve the quality of the software product built by the company, by raising the efficiency and effectiveness of the organizational process. Its competitivity in the global market will be heightened correspondingly. To enhance the processes it is crucial to measure appropriately, so in this work we set out to provide companies with easier and more objective processes for measuring and evaluating their processes, and to make the measurement more objective.

We have to take into account that the international standards, as far as evaluation methods are concerned, define a general framework for carrying out the evaluation, but they do not define explicit measures that help in determining the performance value or the process capacity. This value is very important when trying to assess the company's maturity, as organizational maturity is closely linked to the capacity of company processes.

In this work we have also developed some forms for information gathering. These forms are simple and by using them we can obtain valuable information for assessing the performance and capacity of the process being evaluated. We have also built a Bayesian net-based tool to facilitate the collection of information and the calculation of the value of metrics.

Taking this work as a starting point, we have seen several future lines of work:

- To define the weights of the performance metric coefficients for base practices and work products, using studies that have been carried out in this field as a basis.
- To define the weights of the capacity metric coefficients for generic practices, generic resources and generic work products, based on studies that have been carried out in this field.
- To analyze the relationship between base practices and work products in the ISO/IEC 15504:2006 standard.

Currently, these measurements are being used in two software enhancement programs in two small companies from the south-western part of Colombia (named SIDEN Ltda. y Unisoft Colombia Ltda.) the purpose being to validate and refine those metrics.

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