A Model for Measurement and Analysis of the Workflow Processes

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Abstract. This paper presents an approach based on 3-layered model that may be useful for analysis and measurement of workflow processes. The workflow system can evaluate a state of the products or services in each point of processing and is divided into three layers (sources, workflow management system and workflow processes), whereas each layer covers the processing of its specific tasks.

Keywords: workflow, process, metrics, layer, model, analysis.

1 Introduction

There exist two ways of how to manage a the processes in collaborative workflow systems. The first of them is a function management method where main idea of this method is a dividing work among particular function units. These function units are generated on their functions and knowledge. These units perform only their part of the task and they don't take the total result.

The second way of management is a Workflow management. The main differences between both methods can be found in different views to company. The workflow management is focused on result of work produced by employed instrustrial embedded systems. Whole Workflow system is managed by customer requirements, generally by interactions and interfaces. The Workflow system can evaluate a state of the products or services in each point of processing. If the products or services show some abnormal values during the processing, the process method can be adjusted according to the measured values, even the processing can be halted [5].

2 Layered Model

Workflow system appears to be a complex problem for beginner. Therefore we can use the idea from computer network and that is a layered model like a TCP/IP or ISO/OSI. We can divide the complex Workflow system into particular logical layers, whose content is such difficult. The objects from the upper layer can use objects or services from the lower layer.

In our layered model we provide the use of three layered model. The lowest layer is called "*Resources*". This layer includes hardware, operation system and his services, users, data and applications. Second layer is called „*Management system*",

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which take care of synchronization among particular workflow processes and their initiation in proper sequence. In the last layer, there are particular workflow processes. Therefore, this layer is called "*Processes*".

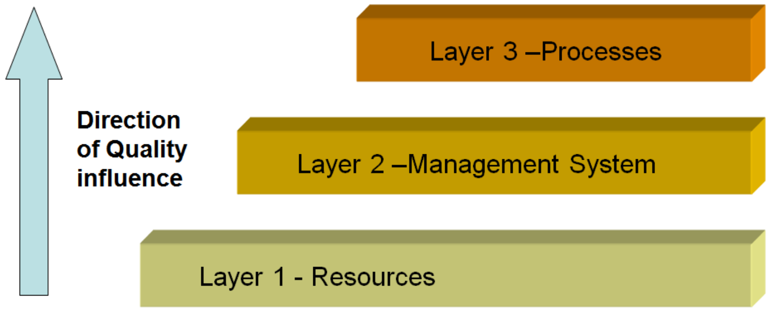

Fig. 1. Layered model

For implementing a high-quality Workflow system, it is necessary to determine chance to monitor running processes. Quantified processes make possible to consider different possibilities and make perfect processes. Quantified processes provide possibilities to compare processes among rival products.

In this case performance metrics for measurements of workflow processes are time, cost and quality.

3 Performance Metrics

3.1 Time

Time is a common and universal measure of performance. For workflow systems, it can be defined as the total time needed by an instance to transform a set of inputs into outputs. The first measure of time is task response time (*T*). Task response time corresponds to the time, which the instance takes to be processed by a task. The task response time can be divided into two major components: delay time and process time. Delay time (*DT*) refers to the non-value-added time needed in order for an instance to be processed by a task:

$$T(t) = DT(t) + PT(t) \quad (1)$$

The delay time can be further divided into the queuing delay and setup delay. Queuing delay is the time, which instances spend with waiting in the task list before the instance is chosen for processing. Setup delay is the time the instance spends with waiting for the task to be set up. Setup activities may correspond to the warming process carried out by a machine before executing any operation, or the execution of self-checking procedures [6].

$$DT(t) = QD(t) + STD(t) \quad (2)$$

3.2 Cost

Task cost represents the cost associated with the execution of workflow tasks. Cost is an important factor, since organizations need to operate according to their financial plan. Task cost (C) is the cost incurred when a task t is executed; it can be divided into two major components: fixed cost and realization cost.

$$C(t) = EC(t) + RC(t) \tag{3}$$

The Cost of task contains a fixed cost (EC) and realization cost (RC). The realization cost includes direct labor cost, machine cost, direct material cost and setup cost.

3.3 Quality

It is possible to interpret the Quality of the product like a set of abnormalities at predefined parameters of the product or service. The Quality consists of two basis items: reliability and fidelity. Task Reliability (R) corresponds to the likelihood that the components will perform for its users on demand; it is a function of the failure rate. The failure rate is given as the ratio of successful executions/scheduled executions.

$$R(t) = 1 - \left(\frac{SuccessfulExecutions}{ScheduledExecutions} \right) \tag{4}$$

We see the fidelity as a function of effective design; it refers to intrinsic properties or characteristics of a good produced or service rendered. Fidelity reflects how well a product is being produced and how well a service is being rendered. Fidelity is often difficult to define and measure because it is subject to judgments and perceptions.

$$\begin{aligned} F(t) = {} & \left| f_1(F(t).a_i) \right| \cdot wi_1 + \ldots + \\ & + \left| f_n(F(t).a_n) \right| \cdot wi_n \end{aligned} \tag{5}$$

Workflow tasks have a fidelity (F) vector dimension composed of a set of fidelity attributes ($F(t).a_i$), that reflect and quantify task operations. Each fidelity attribute refers to a property or characteristic of the product being created, transformed, or analyzed. Fidelity attributes are used by the workflow system to compute how well workflows, instances, and tasks are meeting user specifications.

4 Performance of the System

The particular layers of Workflow system are ordered so that lower layers provide elementary services to upper layers. The qualities of services from lower layer are transferred to upper layer. Therefore the lower quality of resources takes effect into quality of workflow process. In ideal workflow system, the quality on workflow process layer is equal to 1. When we use for example hardware of poor quality, than quality of workflow layer goes down. For determination of quality of workflow system we use a function f with n variables $q_1, q_2, \ldots q_n$, where n is a dimension of quality. Vector of total quality layer $Q = [q_1, q_2, \ldots q_n]$ of this dimension is a vector of quality of whole workflow system. Variables of $q_1, q_2, \ldots, q_n$ take the value from 0 to 1. The function of total performance workflow system can be defined as:

$$f(Q)=\frac{\sum_{i=1}^{n} a_i q_i}{n} \tag{6}$$

In our case of three layered workflow model, the function is defined as:

$$f(Q)=\frac{a_1q_1+a_2q_2+a_3q_3}{3} \tag{7}$$

Relevance of participant layer is impressed with a weigh coefficients $a_1, a_2, \ldots a_n$. These coefficients participate in determination of importance each layer. For the coefficients, the following figure should be valid:

$$\sum_{i=1}^{n} a_i = 1 \tag{8}$$

4.1 Total Performance of the Task

The total performance of task (process, activity or service) is a result of factors like time, cost and quality. Though, to calculate the total efficiency of the task, we need a mechanism, which serves for calculating both time and costs. Possible way of this solution is an implementation of conversation coefficient (*CC*) for each task. This conversation coefficient determines the organization or company and it is a rate between costs and spent time during a processing task. Conversation Coefficient *CC(t)* determines costs per unit of time for processing task t. The total cost (*TC*), which is expended to process task t by an organization, can be defined like:

$$TC(t)=CC(t)\cdot ElapsedTime(t)+C(t) \tag{9}$$

where *C(t)* is the cost of task *t*. This cost contains fixed cost (*EC*) and realization cost (*RC*).

Total performance of task *PT* is computed in general as the ratio of quality of process per expended costs. The quality of task *t* can be divided into fidelity *F(t)* and reliability *R(t)*. The total performance of task *PT* is defined like:

$$V(t)=\frac{R(t).\,F(t)}{TC(p)} \tag{10}$$

$$V(t)=\frac{R(t).\,F(t)}{CC(t).\,ElapsedTime(t)+C(t)} \tag{11}$$

With increasing failure rate of task *t*, the performance of the task t goes down even if the quality, namely fidelity has a high level.

4.1 Total Performance of the Layer

The quality of each layer is determined from weight average of total performance of tasks, which are provided by particular layer. The total performance of layer is defined as follows:

$$p_i = \frac{a_1 . V(t_1) + \ldots + a_n . V(t_n)}{n} . (1 - z) \tag{12}$$

For each tasks of $t_1, \ldots, t_n$ there is assigned a coefficient $a_1, \ldots, a_n$ which expresses a weight of services in a layer. The sum of these coefficients is equal to 1. Coefficient z determines a dependence measured layer with lower layer. Vector quality of all layers can be defined in normalized form as:

$$Q = \left(\frac{p_1}{s}; \frac{p_2}{s}; \frac{p_3}{s}; \right) \tag{13}$$

where p_i is total performance of layer and s is defined as:

$$s = \sum_{i=1}^{3} p_i \tag{14}$$

5 Conclusions

This abstract briefly presents a workflow layered model from the view of quality of processes and services. Moreover, the final version of the paper also includes the case study in the area of human processes and the results of the application of the proposed model in the real collaborative environment.

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References

1. Carda, A., Kunstova, R.: WORKFLOW: Nástroj manažera pro řízení podnikových procesů. Grada Publishing, a.s. (2003) ISBN: 80-247-0666-0
2. Cardoso, J., Miller, J., Sheth, A., Arnold, J.: Modeling quality of service for Workflows and Web Service Processes (2002)
3. Fiala, J., Ministr, J.: Průvodce analýzou a modelováním procesů, VŠB – Technická univerzita Ostrava, OFTIS-Ostrava (2003) ISBN: 20-248-0500-6
4. Muehlen, M., Rosemann, M.: Workflow-based Process Monitoring and Controlling - Technical and Organizational Issues, International Conference on System Sciences, Hawaii (2000)
5. Racek, J.: Workflow spravnich procesu v oblasti zivotniho prostredi. FI MU Brno, disertacni prace (2002)
6. Trchalik, R.: Metrics in the Informatics and their using in Workflow Systems. Diploma thesis, Masaryk University, Faculty of Informatics Brno (2005)
7. Ucen, P., et al.: Metriky v informatice. Grada Publishing, Praha (2001)
8. Fisher, L. (ed.): Workflow Management Coalition. Workflow Handbook (2004) ISBN: 0-9703509-6-1
9. Zhao, L.J., Stohr, A.E.: Temporal Workflow in a claim handling system (1999)