Validation of Metrics for Collaborative Systems

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This paper describes the new concepts of collaborative systems metrics validation. The paper defines the quality characteristics of collaborative systems. There are proposed a metric to estimate the quality level of collaborative systems. There are performed measurements of collaborative systems quality using specially designed software.

Keywords*: collaborative systems, metrics, quality characteristics, quality indicators.*

1 Collaborative systems

A collaborative system is one where mutiple users or agents are engaged in a shared activity, usually from remote locations. In the large family of distributed applications, collaborative systems are distinguished by the fact that the agents from the system are working together towards a common goal and have a critical need to interact closely with each other [1].

Collaborative systems represent a new interdisciplinary domain at the intersection of economics, computer science, management, sociology, etc. Using IT technologies new collaboration opportunities were developed on the electronic products and services market. Collaboration involves organizations with same goals that are uniting in order to form a new structure. A collaboration example it is a strategic alliance [2]. Implementing a collaborative system is accomplished using software instruments that allow the development of distributed software applications.

Science has great impact on the development of different types of collaborative systems from various activity fields. The medical field in which modern communication technologies allow doctors from around the world to work on the same patient gives one important domain that was one of the first fields presenting great interest in implementing complex collaborative systems. In a chirurgical operation each person from the group of doctors has distinct roles. In [3] it is analyzed a collaborative system model representing a training on different chirurgical activities that is done in a virtual medium. The training is based on the scenario in which the instructor and the trainee are on different locations. The instructor and the trainee share a common virtual space that contains various three-dimensional anatomical models. Each person interacts with the other one through the virtual space and a medical simulation engine describes the physical and logical behavior of objects present on the virtual scene. The interaction is maintained by a multi-modal interface that uses visual 2D and 3D data, voices and audio simulation. Each person is in front of a working table that has a monitor and stereo active pair of glasses. All of these generate a three-dimensional desktop. For collaborative use, it has been implemented a mini broadband system that allows creating a videoconference between persons. The interaction between the instructor and the trainee is based on voice, gestures, chirurgical demonstrative actions, step by step tutorial and simultaneous actions.

People working collaboratively must establish and maintain awareness of one another's intentions, actions and results [4].

2. Quality characteristics of collaborative systems

The quality characteristics of collaborative systems are an important subject of our days and an important part of the human activities is involved in this problem. The need to study the quality characteristics is done by fixing, at the beginning, the performance of a system which will be designed. The complexity of this subject, but also the huge number of the applications makes impossible to have a large presentation in a note, but we

would underline some of the main aspects.
The quality is a main characteristic of a collaborative system and contains the followings properties: complexity, reliability, maintainability, functionality and stability.
The *complexity* is a measure for the interdependencies between components and their links and also for the diversity of different types of input and output constructions. This characteristic describes the density of fluxes between the components of the system. The complexity of the collaborative system generates a large number of various components. Based on that, a proper approach of the system quality is to analyze every component separately.
The system *reliability* is determined by analyzing the number of problems solved by the system and the total number of specified problems.
The *maintainability* is a process particular to software products that have a complex development process and that are intended to be used for a long time, meaning more than three years. In this category are included also products like the collaborative systems. Maintainability measures the effort needed to make modifications on the collaborative system in order to make it suited for current needs. This effort can be described as consumed time, number of modules modified, number of added modules and number of deleted modules.
The system *functionality* describes a set of functions and their specified properties. The functions are those that satisfy stated or implied needs.

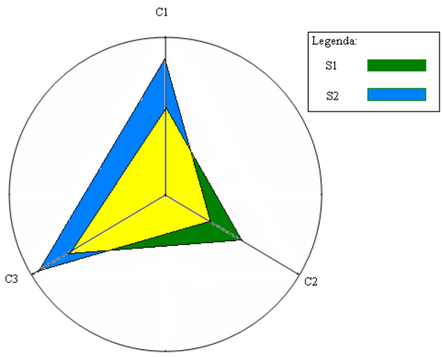

Fig.1. Functionality nomogram [5]

When for each quality characteristic C_1, C_2, ..., C_n are established the normal areas in which are enclosed, delimited like subintervals $[b_i, 1]$ with $0 < b_i < 1$, $i=1..n$, on represent on the nomogram the standard diagram of the collaborative system *functionality*.
Is defined the aggregate indicator of functionality, *IF*:

$$IF = \frac{\min\{S_1, S_2\}}{\max\{S_1, S_2\}},$$ where:

S_1 and S_2 are the surfaces delimited in the figure 1, C_1 is the complexity, C_2 is the reliability, C_3 is the maintainability.
If $HS = 0$, then the collaborative system is working properly and very well and if $HS = 1$, the collaborative system is working very bad.
A collaborative system is defined through some form of construction like:
$<\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7>$, where:
α_1 – activity, α_2 – location, α_3 – resources, α_4 – people, α_5 – energy resources, α_6 – procedures, α_7 – flows.
Starting from such a construction, the collaborative system *stability* is defined as a relationship between the elements $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7$.
The development of collaborative systems is accelerated, along with the wireless networks and, the quality characteristics become strictly related to the security characteristics [6].

3. The quality indicators

The McCabe complexity was implemented with the following indicator:
$CC = n_a - n_n + 2$, where:
n_a is the number of relations between the components of the collaborative system, n_n is the number of collaborative system components.
The reliability for the software component of a collaborative system is defined like:

$$I\ fiab = \frac{r\ succes}{r\ total},$$ where:

I fiab is the reliability indicator, *r succes* is the number of successfully executions of the program, *r total* is the total number of program executions.
System reliability is a very important quality indicator because:
- it value is directly determined by the num-

ber of processes and activities that give correct and complete results;

- allows particular approaches for determining models of quality estimation; taking into consideration the hypothesis that once the causes that generates unwanted errors and system failures are eliminated it is possible to increase its levels and directly the system quality;
- its value influences the entire collaborative system project;

The portability for the software component of a collaborative system is:

$$\text{G portab} = 1 - \frac{\text{LA} + \text{LM} + \text{LE}}{\text{LI}}, \text{ where:}$$

G portab is the portability degree indicator, *LA* represents the number of added instructions, *LM* represents the number of modified instructions, *LE* represents the number of instructions eliminated from the program, *LI* represent the total number of program instructions;

The maintainability of a collaborative system is defined like:

$$\text{I ment} = \frac{\text{T modif}}{\text{T dezv}}, \text{ where:}$$

I ment is the maintainability indicator, *T modif* represent the necessary time for the realization of the modifications in the system in order to keep them in current use, *T dezv* is the necessary time for the system development.

4. The quality estimation of collaborative systems metrics

The quality of a collaborative system is defined as all features and characteristics, bearing ability to meet the needs specified or implied. To measure the quality of a collaborative system and assess its performance is used the indicator:

$$I_{calit} = \frac{\min(A,B)}{\max(A,B)} * p + \frac{\min(X,Y)}{\max(X,Y)} * q, \text{ where:}$$

A – the amount planned, B – the amount realised, X – the quality planned, Y – the quality achieved, p – represents the share of the quantitative characteristics (generally amount 0.4), q – represents the share of the qualitative characteristics (generally amount 0.6).

The function was implemented in a software available to the internet address: http://collaborative.brinkster.net. Some experimental results are presented in the figure 2:

a	b	x	y	I_calit	set
100	90	100	95	0.93	Dataset1
100	95	100	85	0.89	Dataset2

Fig.2. Experimental results table

The current database contains a representative number of records relating to the behavior of a banking system and accept extensions for other collaborative systems.

The diagram of experimental results is presented in the figure 3:

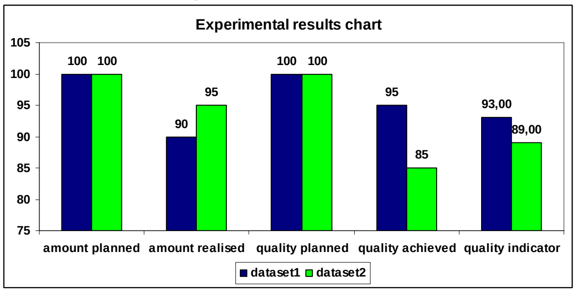

Fig.3. Experimental results chart

For the same amount and quality planned in the first dataset, when the amount realised is 90% and the quality achieved is 95%, the quality indicator is 0.93. In the second dataset, for the same amount and quality planned, when the amount realised is 95% and the quality achieved is 85%, the quality indicator has the value 0.89.

5. Conclusions

The field of collaborative systems is a domain that has many published papers and that has acquired in the last period a great volume of theoretical knowledge. This provides the methods and techniques to analyze the problem, to identify the resulting variables, the influence factors and in the end to define the model.

In this article is achieved widespread use of indicators and is tracked the creation of databases that can be concatenate to increase the volume of necessary data for the analysis of indicators and collaborative systems.

The real problem is to apply the metric and most important to validate it. This will give the confidence that the values are real and the results are reflecting the actual image of the problem. Once the model is defined, it must be implemented in real development or maintenance cases and it must be tested.

The validation of metrics for collaborative systems has great impact on the number of factors and as result on the scale of the model. In the end, it must be reached equilibrium between the model dimension and its capability to give significant results. The metrics must be not too complicated because it will use lots of resources when implemented and also it must be not too simple because the measured levels will loose relevance.

The knowledge-based society evolves only through the high quality of citizen-oriented collaborative systems.

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