

Quality characteristics of collaborative systems

Ion IVAN, Cristian CIUREA

Computer Science Department

University of Economics, ASE

Bucharest, Romania

ionivan@ase.ro, cristian.ciurea@ie.ase.ro

Abstract – This paper describe the new concepts of collaborative systems quality evaluation. There are identified structures of collaborative systems. The paper define 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 a specially designed software.

Keywords – *collaborative systems; quality characteristics; metric.*

I. 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.

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.

When collaborative systems are used in a voluntary way, one of the most important factors that leads to success is the manner in which the users feel their experience with the system: do they enjoyed it, does the system offer what is

expected from it, are they capable of freely and natural communicate with other participants and do they want to recommended to other persons.

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].

II. STRUCTURES OF COLLABORATIVE SYSTEMS

There are many criteria for collaborative systems classification. After the criterion of the organisation, collaborative systems are [5]:

- linear;

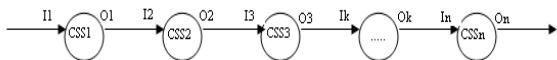


Figure 1. Linear structure

In the linear collaborative system shown in figure 1, initial entries are I_1 and final outputs are O_n . At intermediate levels, the outputs of $k-1$ subsystem are the entries for k subsystem. These types of collaborative systems are encountered in the field of education, each subsystem representing a graduate school.

- arborescent;

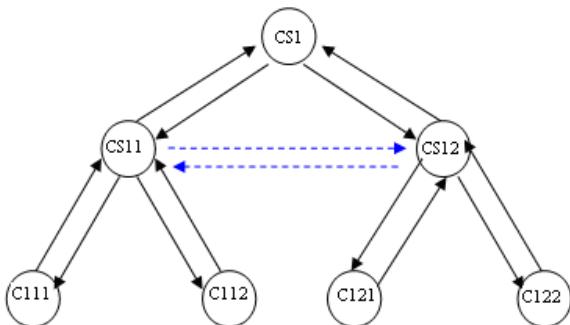


Figure 2. Arborescent structure

In the arborescent collaborative system the messages move between subsystems in hierarchical sense, that means a message from the level two will reach the top level only if it passes first to the level one. In the example shown in figure 2, each subsystem has many entries and many outputs and the information flows move in both directions. The information flows exchange can be done also on the same hierarchical level, in the given example between $CS11$ and $CS12$.

Considering the collaborative system as a tree structure, there are taking into consideration:

- the degree of vertical collaboration as the number of links between components from level k to the ones on level $k+1$;
- the degree of horizontal collaboration as the number of links between components on same level.

Systems of this kind meet in organizational management and public administration.

- network.

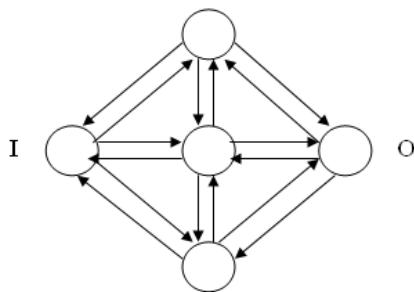


Figure 3. Network structure

In the case of a collaborative system, network type, subsystems are all interconnected, that all transfers are interrelated. In such a system, messages circulate between all components without any restriction. Network type collaborative systems meet in the field of production and banking.

The business collaborative system works under the black box principle set out by Zadeh, the entries being given by raw materials and information and the outputs being materialized in finished products, services and other information which turns into costs for that business.

III. QUALITY CHARACTERISTICS OF COLLABORATIVE SYSTEMS

The collaborative systems represent, from the implementation viewpoint, software entities that are developed during a life cycle process that starts with the problem analysis and ends with the implementation of a fully functional software system [6].

The quality is a main characteristic of a collaborative system and contains the followings properties: complexity, reliability, maintainability, functionality, usability and stability.

This characteristic may be analyzed also from the viewpoint of the length of the track the message is taking from the source component to the destination one. On this way, the system must take care the messages are not lost in the system or they aren't altered.

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.

When for each quality characteristic C_1, C_2, \dots, 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*:

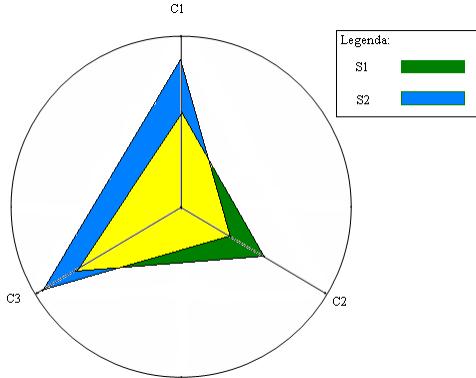


Figure 4. Functionality nomogram

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 4;
 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.

Another quality characteristic is the *usability* of collaborative systems, defined by the ability of a system to be useful for his agents. Usability of a collaborative system is reflected through the effective interactions between its agents and the successful achievement of proposed objectives.

The collaborative system is developed based on a set of specifications that were defined in the analysis stage in order to define objectives for the development process. The system must behave and must give the results the users want and that they have stated at the start.

IV. THE ESTIMATION OF COLLABORATIVE SYSTEMS QUALITY

For a quality characteristic, a lot of estimation indicators are built depending of work hypothesis and data gathering capability necessary for computation making. The indicator has an analytical expression easier or more complex depending of influence factors, influence intensity and

reused structured of indicators with the behavior already known.

Also, the indicators for quantification of characteristic levels for maintainability, reliability, portability, complexity has a variety of analytical expressions, from homogeneous expressions to reports of homogeneous expressions, leading to constructions in which logarithmic and exponential function appear.

The analytical forms of the indicators must be built such as the indicators simultaneously assure the following conditions [7]. They must be:

- *sensitive*, that is at small variations of the influence factors the result variable has small variations; at big variations of the influence factors the result variable has big variations;

- *non-compensatory*, that is at different variation sets of the factors, small values of the result variable are not obtained;

- *non-catastrophic*, that is at small variations of the factors, big variations of the result variable have not to obtain;

- *representative*, it represents the quality to be accepted by users in analysis making assuring the significance of the results.

The analytical form of an indicator used to measured quantitative levels for collaborative systems qualitative characteristics is based on:

$$y = f(x_1, x_2, \dots, x_{nfc}),$$

where:

nfc – number of identified factors which have impact on the evolution of analyzed phenomena;

x_i – measured level for the i^{th} influence factor of the case study;

$f(\cdot)$ – an analytical real form used to represent the dependency between the influence factors and result variables; it is used to describe and to study the phenomenon;

y – result variable that describe an existing situation in the phenomenon evolution.

A collaborative system is defined through some form of construction like:

$$\langle \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6, \alpha_7 \rangle,$$

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. The extensions to metrics should include, in the future, indicators of collaborative systems security.

V. SOFTWARE STRUCTURE FOR THE QUALITY METRIC IMPLEMENTATION OF COLLABORATIVE SYSTEMS

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:

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

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 calculation of this indicator was implemented in a software available to the internet address: <http://collaborative.brinkster.net>. Some experimental results are presented in the figure 5:

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

Figure 5. Experimental results table

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

Collaborative recommendation applications update their datasets when users enter new ratings, but, in these applications, is no guarantee that the ratings reflect the user's true preferences [8].

Collaborative filters help people make choices based on the opinions of other people. Users can protect their privacy by entering ratings under pseudonyms, without reducing the effectiveness of the score prediction [9].

The diagram of experimental results is presented in the figure 6:

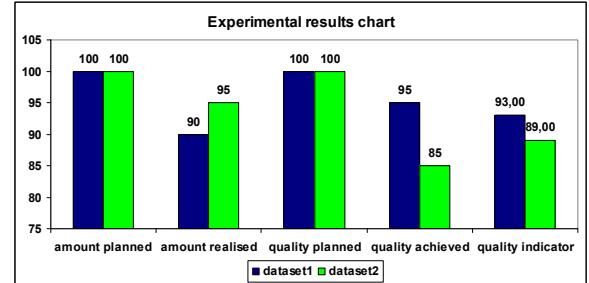


Figure 6. Experimental results chart

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.

These results led to the development and employment of numerous collaborative filtering systems [10].

This quality is achieved at the end of the developing process of collaborative systems, if, during the development, are built those internal properties that determine the level of quality characteristics.

If are considered the collaborative systems S_1, S_2, \dots, S_n , we can build and other indicators for the implementation of quality metric of collaborative systems. For each system S_i are collected the data $d_{i1}, d_{i2}, \dots, d_{im}$ regarding its dynamics. Through the intersection of $d_{i1}, d_{i2}, \dots, d_{im}$ values are obtained some data, which is common to all collaborative systems. These informations are necessary to create new indicators I_1, I_2, \dots, I_h . It selects from these indicators some of them which must be sensitive, stable, representative. With the new indicators we evaluate what is unique in collaborative systems.

VI. 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 quality characteristics of collaborative systems have 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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