Collaboration and Virtualization in Large Information Systems Projects

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A project is evolving through different phases from idea and conception until the experiments, implementation and maintenance. The globalization, the Internet, the Web and the mobile computing changed many human activities, and in this respect, the realization of the Information System (IS) projects. The projects are growing, the teams are geographically distributed, and the users are heterogeneous. In this respect, the realization of the large Information Technology (IT) projects needs to use collaborative technologies. The distribution of the team, the users' heterogeneity and the project complexity determines the virtualization. This paper is an overview of these aspects for large IT projects. It shortly present a general framework developed by the authors for collaborative systems in general and adapted to collaborative project management. The general considerations are illustrated on the case of a large IT project in which the authors were involved.
Keywords: *large IT projects, collaborative systems, virtualization, framework for collaborative virtual systems*

1 Introduction

As results of the globalization, developments of the Internet, World Wide and Mobile Computing many activities were changed. The projects are growing and have many users with a heterogeneous profile. The developers are geographically distributed in different locations, with different profiles and heterogeneous knowledge.
In this respect, the large IT projects development and usage where transformed from individual or local team activities to distributed, cooperative ones, making from the real world a virtual one. The cooperation involves communication and a new kind of coordination. These elements emerge to the development of a new paradigm of the collaborative activities and also to the virtualization.
The projects can be classified by different criteria, such as the number of locations, the number of projects and the number of the stakeholders. Each one of these criteria could be single or multiple. In this respect, we have a cube that can be described by a table analogous with Desouza [1].
The present paper will consider the case of the single large IT project, with multiple locations and multiple stakeholders. The theoretic concepts are illustrated on the Students Register Project. This project involves as beneficiaries the Ministry of Education and Innovation, National Agency of the Academic Finances, National Institute of Statistics etc. The main objective is to have a National Student Clearing Systems that is necessary for different decisions and analysis. The data are given by Romanian Universities. Each student would have his trajectory described in this system.

2 Distributed systems and large IS projects

Martin [2] defines a distributed system as *a network of computers (nodes), each having parts of network-wide data and functions, which work cooperatively to solve a problem.*
One of the first characteristic of large projects is that there are geographical distributed. In our case study this characteristics is obvious because the 71 universities are in different parts of Romania and consequently the users are in different locations. Moreover each student needs to know his data even on cell phone that involve a cloud computing paradigm. It is clear that this system will aggregate the different computing entities to collaborate as a single collaborative task in a transparent or more exactly in a virtual way, so that they appear a as a single, natural system.
The main actors in a distributed system can be considered the human or artificial actors such as managers, operators, robots, knowledge based software agents, and other software or hardware entities. As it can see in a large IS project, as our, all these can appear.
Koening [3] defines the distributed information systems as *"when coordinated work of different actors in socio-technical organizations (for example a company, or a public administration) takes place, we call this organization a distri-*

buted information system".
These mutations from IS generate modifications in the organizations strategies, in their management, but also in their information systems [4] [5]. Finally, as result, were appeared the distributed virtual organizations.
The management of these organizations needs a new generation of DSS. The first step was represented by the usage of distributed databases [6]. The distribution the processes and also the IS were considered after.
From this point of view the IS coordinates the activities of these actors from the organization-wide network. Incorporated in different organizations or individuals establish a *"virtual organization"* or an "*interaction group"*.
Concluding, the large IS projects are based on huge distributed information systems.

3 Coordination in large IS projects

Because in large projects many people are involved, and also different heterogeneous issues have to be considered, the coordination is a very important.
The coordination is not a new problem. Concepts concerning the coordination were presented by [7], who defines it as *the organization of a group effort for a unitary action for a common objective.*
The coordination represents a huge domain from simple problems as time, or human activities scheduling to more complicate ones such as the consensus or complex marketing planning and researches etc. In coordination different tools are used such as hierarchies, divisions, organizational matrixes, standards, project management, indoctrinations, motivations, education, negotiations, information and many others.
In our cases, the system is based on data and information developed in different universities. In universities where the coordination was assured by an important person, as for example, the rector, in the case of Technical University of Timisoara, the things were developed well. In other universities where the coordination was not assured by an authority, the projects, if started, are stagnated in different phases.

4 Cooperative systems

The domain was studied by many authors [8], [9] etc.
The cooperative systems consist essentially in:
- actions for a common scope;
- common benefit of the actors;
- work division;
- factual coordination;
- social coordination etc.

The first direction in the cooperative systems was the extension of DSS to the group DSS (GDSS) or Groupware [10]. These mutations have also effects on the Executive Information Systems (ESS) by changing the solving mode of the top management problems. In this respect, we can consider the cooperative DSS as first generation in collaborative systems. This generation use a large IT&C support as hardware media (videoconferences, voice, paper, fax, videotext, telephone, computer nets, etc.), but mainly a huge software support. In this respect, in the last 20 years were developed many well known specialized software products, the most important being the IBM Lotus.
It is worthy of note that some authors [11] consider that the cooperation problem is an organizational conglomerate of a hard, soft and human conglomerate.
After this first generation, we can consider a second generation based on the classical applied AI. At the beginning the expert systems or the knowledge based intelligent information systems were used. Today, are used extensively the expert systems, but also the neural nets, genetic algorithms, or different hybrid intelligent systems.
A new era in management represents, the intelligent organizations epoch. This new approach imposed a new generation IS because the classical applied AI supports these problems very difficult. This implied, a new generation of collaborative systems based on distributed artificial intelligence [12], namely the era of the intelligent multiagent supports.
In a large IS project the cooperation is one of the most important issue. Without this cooperation IS cannot achieve the objectives. The cooperation need to be realized horizontally, between the team members from different phases, but also vertically between the phases. In our case we have three phases with three workgroups:
- The first phase is the semantic analysis realized by the first workgroup (wk1). It is formed by different managers of the beneficiaries that know the information necessary for their decisions and analysis. The members cooperated to establish the requirements and also to set up a questionnaire containing the data used by Romanian Universities for the students' administration and management. The result of this phase is a document that specifies this information.
- The second phase represents the logical project

development by the work group 2 (wk2). In this group are involved specialists in IS and databases that cooperate to develop the conceptual and logical project and the document containing the implementation requirements. The authors worked in this phase.

- The third phase is the implementation realized by wk3. For this phase an auction will be organized in order to select an IT company to implement the project. This company will cooperate with some academic members of wk3.

From the precedent description it can be seen that the cooperation needs to be realized at the workgroup level but also between the workgroups.

5 Collaboration in the large IS projects

The synergy between the human and artificial, named as socio-technique [12] imposed mainly the collaborative support systems.

The collaborative systems represents a new interdisciplinary research field, analogous with the cooperative systems, but if the first category correspond to the horizontal structure, the second represent the vertical one [13].

In the literature are known many definitions for the collaborative systems, but one of the most simple is [14]: *a collaborative system is a collection of dynamic objects which communicate and cooperate for a common and partitioned target.*

Other authors consider these collaborative systems as *complex information systems for a large area of activities based on sophisticated technological standards and on complex Internet, Intranet and Multimedia applications* [15].

Snoyer [11] and Marakas [16] considers the problem to be more complex, namely as a conglomerate of hard, soft organization, people and many other.

There are some similarities between the cooperative system generations and the collaborative systems history because the last category is based on the first.

Concluding, we can consider that the collaborative systems are based on 3C (Communication, Coordination and Cooperation).

The collaborative systems domain is an important subject of our days, and an important part of the human activities is involved in this problem. The complexity of the subject, but also the huge number of the applications makes impossible to have a large presentation in a note, but we will underline some of the main aspects:

- The European Information Society Portal [17] designs the New Working Environments, as first point in their strategy for 2005-2006, the subject of the collaborative systems. The project started with a 40 million Euro and one of the main objectives was "*...the development of new generations of collaborative work environments, developing in this way the creativity, the innovation and productivity*".
- The collaborative systems need new educational standards. One of standards is Information Technology for Learning, Education and Training ISO/IEC JTC1 SC36 WG2, Revised NP for: Collaborative Technology – Learner to Learner Interaction Scheme, din 31.01.2002 [18].
- The research cannot be made without collaboration. In this respect, we present some initiatives:
  - The Australian Government initiated the startup of some cooperative research centers in the Commonwealth. These were based on the Changing Research Practices in the Digital Information and Communication Environment Program developed by the Department of Education, Research and Training, by the project "National Collaborative Research Infrastructure" [19].
  - The governmental and military organizations organize specialized centers and laboratories. In this respect, the American Air force settled up in 2002 a laboratory for the collaborative systems [20].
- The Nederland Institute for Telematique started up the project Context Aware Collaborative Environments for Next Generation Business Networks (Project IST-2001-37460), [21] for the new generations of the environment based on the collaborative nets. In this project a huge consortium was establish from 10 universities and research institutes from different countries.
- Another important project, BRICS (Basic Research in Informatics for Creating Knowledge Society - from 2003), was settled up by a 6 University consortium from Nederland [22].
- Well known universities organize and founds these kind of research centers. In this respect University of North Texas started up in 1992, Center for Collaborative Organizations [23].
- On the World and European level there exist a huge number of Workshops and conferences for this field.

Among the different problems concerning the collaborative systems studied actually we can mention:

- modeling and developing conceptual frameworks
- collaborative DSS [24] [25]
- consortiums as collaborative systems [26]

- collaborative development environments [27] [28]
- federative databases [29] and their transaction systems, as extension of the distributed databases, [30] collaborative data warehouses, [31] collaborative data mining techniques [32]
- collaborative knowledge bases
- portals as collaborative systems, actually a very much studied field
- the collaborative programming is studied in the literature under different aspects:
  - there exists a specialized portal [33]
  - PhD Thesis in this field [34]
  - pair team programming [35]
  - case studies for collaborative programming [36]
  - extreme programming [37]
  - collaborative education in programming [38]
- collaborative activities simulation [39]
- collaborative projects management [40]
- the interface with the knowledge management in the collaborative systems [41]
- the relations between the collaborative systems and organizations [42]
- research projects in collaborative games [43]
- metrics for evaluation of the collaborative systems [44].

Concluding, it can underline that the collaborative systems comprise the distribution, coordination, and cooperation. To these it adds a very important component namely the communication.

One of the main sources of the failing of large IS projects is the lack of communication. Generally the communication at the horizontal levels, in work groups works, but in many cases the collaboration between different phases is felt and by this the project is damaged. One of the examples in our case is that many universities develop or buy IS for students' administration and management but the lack of the communications between the developers and implementers make the systems to not work properly.

6 The virtualization in large IS projects

The virtualization is also a huge problem studied in the literature. There are many studies in philosophy, in ontology, epistemology or computer sciences on this subject.

The initial meaning of virtual was used to represent "virtual computers". Today are many different interpretations. Through the developing of the Internet, WWW and mobile computing, the concept was extended and the virtual world overlaps now the real one. In this respect the virtualization can be considered as an important tool. "End users don't want or need to know that virtualization is being used; they want access to their applications, and they want the very rich media experiences that modern applications offer" [45].

In large IS projects, like our case, the virtualization has different meanings:

- The first one is the virtual team. This team is formed by different developers and users that cooperate through the WWW or videoconferences.
- The virtual community is formed by the people that collaborate in the system development, the users, students and many other people interested in this subject.
- The virtual consortium formed by the beneficiaries but also by universities that are members in the project.
- Finally, but not at last, the end user interface, which represents, may be, the most important virtualization of the project.

7 The collaborative framework in large IS projects

The authors applied the DARPA Intelligent Collaboration and Visualization program (IC&V) results [46] for the collaborative systems in project management [47] and extended this framework [48].

Considering the project management (PM) the main differences between traditional and the collaborative PM can be underlined by "Traditional PM focuses on a single project at a single location and is more concerned with project inputs and outputs than with project process" [46]. In this respect, the traditional PM is not concerned on the workflow development because it has a poor communication system based mainly on the organization reporting, and generally is located in a single place and it is reactive. The collaborative PM paradigm assures a better knowledge share, the distribution of the tasks and information. The PM teams are based mainly on a Web Community and consequently, a heterogeneous workflow. We can remark similarities between the evolutions from the traditional PM to collaborative PM with the evolution of DSS to collaborative DGSS.

The projects contain operational tasks or activities, each of them having a start and an end that means temporary attributes. It has a unique and specific goal and requires a diverse set of human resources that suppose some skills and knowledge. According with PMBOK [49] project tasks

include initiating, planning, executing, controlling, documenting, and managing cost, time, people, risk, quality, and procurement.
Concluding, in large IS the collaboration is very important, because in the actual world, the decisions and the workflow in projects are distributed, and generally the team is working as a Web Community.
In our framework we have a pyramidal structure. The main tiers are:

- requirements
- conceptual
- logical
- middleware
- technological

Our last model divided some tiers in two subtiers, the global (high level) and the local ones (low level).

7.1 The requirement tier contains [48] the general objects that represent the group, tasks being performed by the group and the support necessitated by the characteristics of the group. The tasks described in the framework include work tasks and transition tasks. At this level we have also requirements concerning the social interactions based on social protocols of the group as well as some requirements concerning the group characteristics. At this level we need to represent the group structure, the group process and different protocols and behavior issues.
The work tasks in our project are, for example, the realization of multiple allocations of resources to different activities. As transition tasks we can consider different functional or multivalued dependences between data and information. This tier, as it was mentioned is realized by the wk1.
7.2 The conceptual tier represents the image of the requirement tier objects and relations by conceptualization. More exactly at this tier is described the functionality that is needed to support the different requirements, that means, it describes the work and transition tasks, social protocols, and group characteristics from the requirement tier.
The functionality can be obtained from different services as for example text chat services, telephone services and many other different conceptual services describing the scenarios.
7.3 The logical tier is represented by different ontologies from those based on the formal logics or heterogeneous structures theories to WordNet or SUMO (Suggested Upper Merged Ontology) etc.
In IS projects this tier is represented by the logical project of the system. This tier is assured by the wk2. It is implemented by the logical project.
7.4 The middleware tier contains different types of services that can be used in developing Computer Support Collaborative Work Systems (CSCW), meeting support systems, visualization tools or other collaborative or virtualization tools. At this level we can use the functionality of various types of services to understand how a given conceptual objects and scenarios would be supported. Services can be compared to determine which service is more appropriate given the characteristics of a group of tasks or members. Services also assure the robustness and the scalability of the system and also can prove the correctness of the CSCW. Some of these are: E-mail, chat, Internet connections, Web services, telephone conversation, multicast audio and video, half and full duplex audio, duplex audio, white and black boards, shared workspace and applications, encryption, recording, history mechanism, lists of objects, participants, possible collaborators, version control, simultaneous sessions, collaborative space management and navigation, object repository, object control, import/ export facilities, semantic web facilities, data warehouse and data mart systems etc.
As it was specified this tier is specific in our project to wk3.
7.5 The technology tier is based on various implementations of the services with a description of their performance, concerning different characteristics as for example, the image resolution, communications and networks, the expected image quality, and the compression factor, etc. User interface components and different technological elements of CSCW can be determinant in the collaborative systems.

8 Our proposal for the architecture of Students Register Project (RMU)

The structure of the project is represented in Figure 1. The system is a dual one. The main function is assured by a data warehouse system. As it can see in Figure 1 we have four levels.
The first level contains the operational data bases at the universities. At this level are used the students' administration and management systems. This level is the OLTP level.
The second level is formed by data stores that contain the information necessary for the beneficiaries' decisions and analysis. These data stores (SRMU) are located at universities and contains operational information necessary to collect in

the data warehouse (RMU). Between them and the operational data bases are gateways that assure the interface, data cleaning, and conversions, aggregate and summarize the data.
The third level is the data warehouse that contains the historical information used in decisions and analysis at the central level. In this warehouse are aggregate and store in cubes the data information prepared at SRMU level. The periodicity of the maintenance is generally one month. This level assures also the OLAP functions of the system. Between this level and the second one we have the main grid (Figure 1).
Finally the fourth level is beneficiaries' level. At this level we have different reports resulting from the multidimensional analysis at third level but also different data marts asked by some users.
The data and information streams are in the both directions from level 1 to level 4 and reverse.

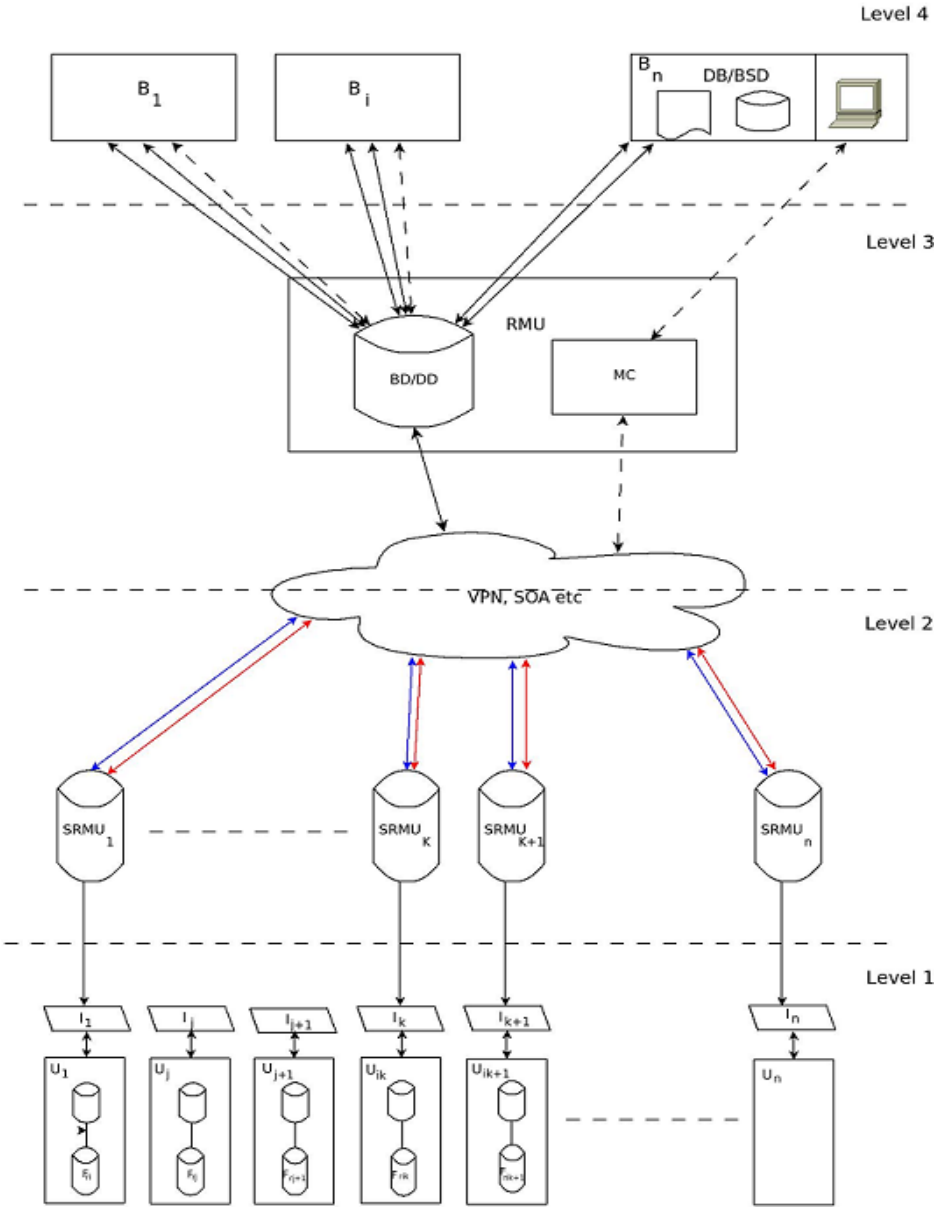

Fig. 1. The RMU proposed architecture

From Figure 1 and from the comments of the paper it can see the collaborative and virtualization attributes of the project.
A second function is assured by a browser that assures the possibility of someone from the fourth level to access the data and information from lower level.

9 Concluding remarks

Large IT projects needs a very complex development and usage. These attributes impose the distribution, collaboration and virtualization. In this paper we analyzed some aspects of these. Because of the limits imposed on the paper length the methodology of the development was

not presented. Trough the complexity of these projects and the time needed for the development of these projects an agile methodology is necessary. Another aspect that is not present in our paper is the utilization of the system by the students and other users from mobile phones, because here is a cloud computing aspect.

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