World of Computer Science and Information Technology Journal (WCSIT)
ISSN: 2221-0741
Vol. 1, No. 7, 317-322, 2011

Quality Requirements Optimization with Architectural Styles

Marwan AL-Abed Abu-Zanona
Department of Computer Information System
Jerash University
Amman, Jordan

Yosef Hasan Jbara
Department of Computer Technology
Yanbu College of Technology
Yanbu, Saudi Arabia

Farah Hanna AL-Zawaideh
Department of Computer Information System
Irbid National University
Irbid, Jordan

Abstract— Small and large scale business and financial corporations are becoming more and more vital in our everyday life. These organizations are faced with increasing pressures to provide high quality services, especially in an increasing competitive environment. To stay competitive, adaptations and enhancements of service operations and the associated business processes need to take place continuously. A growing concern for such business corporations and the structure of its business processes is their functional and non-functional quality requirements. Current approaches often fail to explicitly specify the organizational business structure, objects, rules, constraints, etc. upon which any improvements of quality of business services or the evolution of an existing one must be based. In this paper and based on modeling and simulation we proposes a simple method using architectural styles to predict these quality requirements. Simulation results show that functional and non-functional quality requirements can be achieved.

Keywords-quality requirements; architectural style; simulation.

I. INTRODUCTION

In today's competitive business environment intensive competition in the commercial aviation industry is placing increasing pressure on management for looking closely at ways to increase their efficiency by reducing time and cost, while providing the products and services that customers want, when they want them. To compete effectively in today's global marketplace, innovative approaches to reducing time and cost are needed. One important approach to improve services quality and make it more flexible, efficient, productive and competitive is managing its staff. The staffs working in a company are its greatest asset. They represent intellectual capital and it is up to the management to ensure that the company gets the best possible return on its investment in staff. In successful business environment, this can be achieved when staff are managed and used in the most effective way possible. Managing staff is one of the most successful approaches used by the company to generate new and better ways to run a business. Looking at business structure from a modeling viewpoint, it involves the movement of entities within the organization. Entities could be staff member or customer. In fact, managing staff is presented in BPR as a necessity that organizations must introduce in order to survive and gain competitive advantage in an increasingly and more demanding and competitive economic market [1]. Business modeling is the representation of entity movement, so that the complete business process network and the position of each entity on the process network can be represented in a simulation. Therefore, BPR writers argue that organizing teams is a mechanism that will make companies more flexible, efficient, productive and competitive [2, 3]. These are reasonable and rational arguments from a management perspective. As it is clearly impossible for every one in a large team to work together effectively, this large team is usually divided into a number of groups. Each group is responsible for a number of tasks. Putting together groups of entities and within a group putting individual entities in the most suitable position and deciding what their task (s) are in order to work effectively is therefore a critical management task. Furthermore, the representation should be flexible to allow reconfiguration of the business structure in different ways. In addition, managers have to solve technical and non-technical issues by using their staff in the most effective way possible. They have to plan and organize their

work, their staff and ensure that the work is being done properly. Poor management of staff is one of the most significant contributors to organization failure.

The variety of subjects and disciplines covered by organizational sciences has given rise to several models and theories of organizations. Models that describe ways of organizing groups to achieve shared goals and predict effects of these structures on work and workers. Multi-agent systems (MAS) can also be of some use as it is widely applied for enterprise modeling. Multi-agent systems can be considered structured societies of coordinated autonomous components (agents) that interact with one another to achieve specific aims. Agent is a member of a group, for example an accountant that assigned a set of responsibilities [4].

Lucia Bastos and Jaelson Castro [5] introduced an approach for the integration of requirements and multi-agent architectures based on organizational concepts. Their approach advocates that a multi-agent system corresponds to the organizational structure, in which agents are members of a group in order to perform specific tasks. An organization comprises groups, goals, members, roles and interactions. More details can be found in [5]. Hence, any business organization environment can be viewed as a multi-agent system that corresponds to the organizational structure, a situation that is easily mapped into multi-agent system.

This approach is a way of describing how the organizational structure may be split into architectural components on the basis of their patterns of relations with one another. Roles can be used both as an intuitive concept in order to analyze requirements in multi-agent systems as well as a behavioral structure in order to assign responsibilities for these architectural components[5, 6].

In this paper, we introduce our architectural style, show how architectural styles can be used to estimate quality requirements as well as the use of simulation to study the efficiency and performance of each style and we apply this method in real life business situations.

II. PREPARE YOUR PAPER BEFORE STYLING

Herein, in this section we describe Organizational theory in multi-agent system as introduced in the literature [1]. The variety of subjects and disciplines covered by organizational sciences has given rise to several models and theories of organizations. Role theory can also be of some use as it is widely applied for enterprise modeling, postulating that individuals occupy positions in an organization [3]. In every organization, members play various roles to realize their functions. Roles might be ´manager´, credit officer or ´treasury´. Internal organizational structures evolve by the social and functional differentiation of roles in complex organizations. This leads to the formation of groups, where these roles can appear temporary as well as long-lasting. Groups are defined by the roles they involve and vice versa [7]. A group consists of a number of actors which occupy various roles inside the group.

Organizations are social groups that are goal-driven and have a set of structured activities to achieve their goal [8]. Organizational concepts are described in terms of the actor members and the roles that they play:

- Actor is an entity that plays one or more roles, and may be individual members, s.w agents or organizational units (group or sub group).
- Group is an organization unit (e.g., ‘finance’) with a set of organized members, pursuing common goals for a period of time in identifiable domain.
- Agent is a member of a group (e.g., ‘accountant’) that plays roles.
- Role is defined in terms of the specific task(s) that the agent has to accomplish in the context of the overall organization, for example, the ‘manager’ role involves the tasks ‘to manage’ and ‘to supervise’. Roles are assigned to actors and are separate from the actor that plays the role.
- Task specifies a particular way of doing something. Tasks can be operations, processes.

Multi-agent systems approaches use role concepts for modeling social actors in organizational structure [8].

III. BASIC ARCHITECTURAL CONCEPTS

According to Shaw and Garlan [10], architectural constituents are conceptually categorized as follows:

1) Component: An object (entity) with independent existence.

2) Connector: A typed object relating interface points, components, or both. In other words, an interaction among the components.

3) Interface: An interaction point between components and connectors or external environments.

4) Configuration: A collection of constraints that wire objects into a specific architecture.

5) Architectural style: An architectural style defines patterns and semantic constraints on a configuration of components and connectors.

The architecture describes the overall organization of the system in terms of its constituent elements, and their interrelationships [11].

IV. DEVELOPED ARCHITECTURAL STYLE

When considering staff allocation problem in any business organizational unit, and based on satisfying the business and user requirements and some other requirements, several questions arise such as, how groups are structured, organized and managed. How and where members are managed, and based on what they allocated. How responsibilities and jobs assigned to groups or its members. When answering these questions two general performance criteria are considered, i.e. minimizing cost and providing high quality services. An architectural style represents a typical configuration of

organization elements and intercommunication among them. The architectural styles represent a typical configuration of organizing members in multi-agent system and can be used as a kernel reference for improving the way in which an organization manages and control its human assets.

The architectural styles are used to provide a classification of organizing and managing staff in multi-agent system while considering lowering cost and providing high quality services, and to implement staff allocation system in each style. In fact, this can be used as a framework for improving the way in which an organization manages its human assets and a guide to improve the capabilities of any business firm to provide high quality services and allows the effective use of resources within minimum operational cost.

The organization Staff is organized as single group and multiple groups of staff members. Tasks distribution is classified as single task, subset of tasks, and all tasks. This classification, based on staff grouping and tasks distribution, led us to develop seven architectural styles. Note that the developed styles are characterized by the need to allocate staff members with varying skills and to handle a stream of arriving clients, in which each client with varying sub-tasks routings requirements.

The following are the meanings of the symbols used in this paper:

- O-T: One task.
- OG: One group.
- MG: Multiple groups.
- Sub-T: Subset of Tasks.
- All-T: All Tasks.
- All-Sub-T: Each client with all subset of tasks.
- Queue number 1.
- Qn: Number of queues equal to n.

Sometimes it is obviously important that all the groups should have the right balance of technical skills, experience and responsibilities. In the following sections we present a description of each style.

A. OG_Sub-T_O-T Style

The model represents multiple queues of clients (requesters) served by a number of staff members (providers) in which they belong to only one same group. In this style the group is associated with a subset of tasks and only one specific task is associated to each member of the group. In this case, clients have to round through some or all the group members to get their job done. The typical structure of this style is shown in Figure 1.

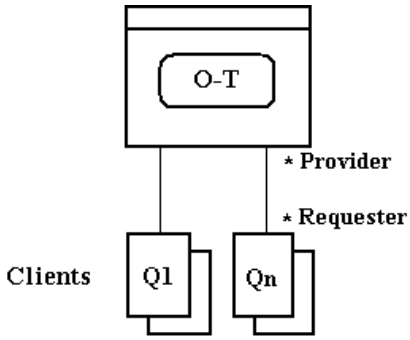

Figure 1. One group one task style

B. OG_Sub-T_Sub-T Style

The model represents multiple queues of clients served by a number of staff members (providers) in which they belong to only one group. Herein, a subset of selected tasks is associated to the group and further a sub-subset of the selected subset is associated to each member of the group. This means that the group agent can provide more than one task to the requester. In this case, clients have to round through one (maybe) or more than one member of the group to get their job done. The typical structure of this style is shown in Figure 2.

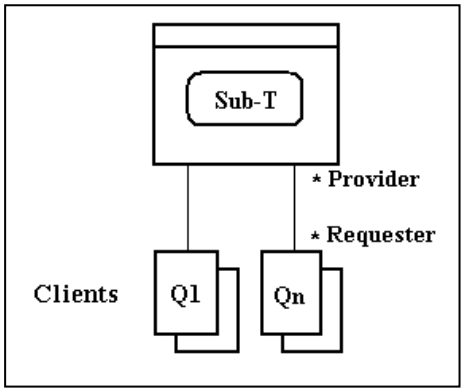

Figure 2. OG_Sub-T_Sub-T Style

C. OG_All-T_Sub-T Style

The model represents multiple queues of clients served by a number of staff members (providers) in which they belong to only one group. All available tasks are associated to the group and a selected subset of the tasks is associated to each member of the group. This means that the group agent can provide more than one task to the requester. The typical structure of this style is shown in Figure 3.

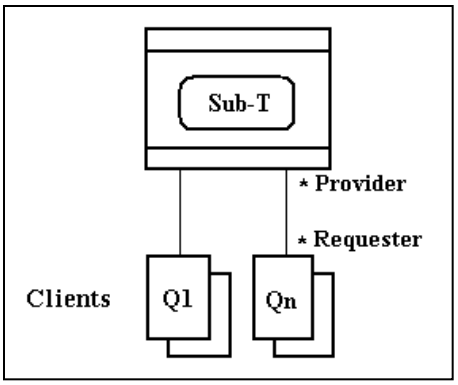

Figure 3. OG_All-T_Sub-T Style

D. OG_All-T_All-T Style

The model represents multiple queues of clients served by a number of staff members (providers) in which they belong to only one group. All available tasks are associated to the group and the tasks are associated to each member of the group. This means that the group agent can provide any requested task to the requester. The typical structure of this style is shown in Figure 4.

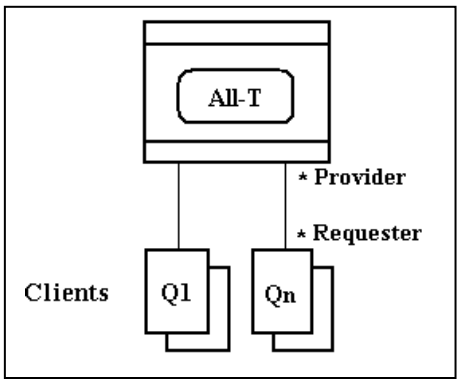

Figure 4. OG_All-T_All-T Style

E. MG_Sub-T_Sub-T Style

The model represents multiple queues of clients served by a number of staff members (providers) in which they belong to more than one group. Different subsets of chosen tasks are associated to the groups. The group members are associated with sub-subset tasks of the subset tasks associated to the group they belong to. The typical structure of this style is shown in Figure 5.

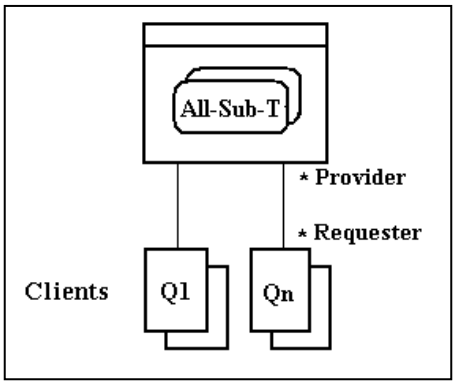

Figure 5. MG_Sub-T_Sub-T Style

F. MG_All-T_Sub-T Style

The model represents multiple queues of clients served by a number of staff members in which they belong to more than one group. All available tasks are associated to each group and within each group a chosen subset of the tasks is associated to each member of the group. This means that the group agent can provide more than one task to the requester. The typical structure of this style is shown in Figure 6.

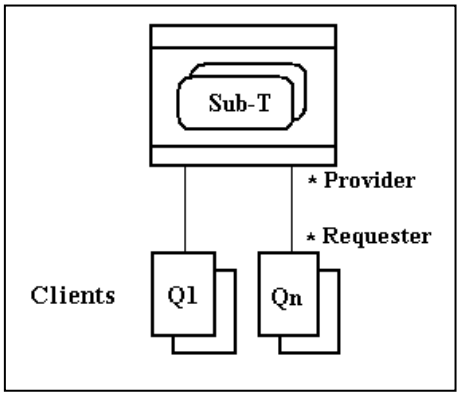

Figure 6. MG_All-T_Sub_T Style

G. MG_All-T_All-T Style

The model represents multiple queues of clients served by a number of staff members (providers) in which they belong to more than one group. All available tasks are associated to each group and within each group all the tasks associated to the group are associated to each member of the group. This means that the group agent can provide any requested task (s), that are given to the group, to the requester. The typical structure of this style is shown in Figure 7.

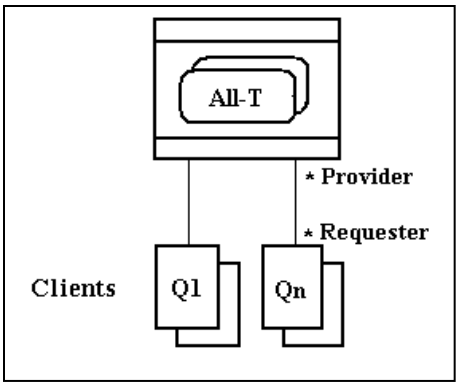

Figure 7. MG_All-T_All-T Style

V. SELECTING SUITABLE STYLE

In this section, we propose a simple method to help decide the selection of an appropriate architectural style.

A. Vision and Requirements

There are few comparative studies of architectures for multi-agent systems. Of course, this requires that we should have an idea about which are the relevant properties of multi-agent architectures and which architectural alternatives exist for each of those properties. We consider characteristics of an architectural style from the viewpoint of the people who, usually, participated in any business environment. The business management may use various architectural styles according to the requirements of customers, business needs, and the constraints on budgets and quality of service required. Based on this, the architecture is determined by a number of quality requirements including security, availability, response, efficiency, wait time (time in queue), throughput time (delay caused by the work of staff member), number of tasks (services) processed per time period, time spent roaming between staff members allocated at different groups, etc. Due to business need requirements, the authors in [6] suggested that from the viewpoint of clients, availability and waiting time requirements becomes a target of consideration and from the viewpoint of business management, security, efficiency, performance, and cost are a target of consideration. However, in this paper we considered four quality requirements presented below: waiting time; performance; security; and administrative cost. Then, we mapped each quality requirement into corresponding measures that could be used as the basis for comparing the different styles and in the simulation analysis.

1) Waiting time (time in queue): in any business and industry environment, overcome the delays in serving clients is important requirement to gain clients satisfaction. Based on our experience, we have identified two characteristic measures for this requirement. "Exceeding" (greater than the user defined waiting time unit), so that there is delay in serving clients, otherwise "Not exceeding" (less than the user defined waiting time unit).

2) Performance: is a characteristic from a customers' point of view of a term of service quality and efficiency. Providing high quality and satisfied services are important requirements to gain clients satisfaction. Based on our experience, we have identified three characteristic measures for this requirement. "Accepted" (greater than the user defined performance unit), so that quality services are provided to the client; "Reasonable" (between lower and upper limits of the user defined performance unit), so that satisfied quality services are provided to the client; and "not accepted" (less than the user defined performance unit), so that quality services are not provided to the client.

3) Security: changing the position (location) of staff members from one to another at random periods of time, i.e. rotation of duties is one of many important critical security policies needed in any small or large business and industrial environments. Actually, this policy helps deter fraud. Furthermore, staff members are cross-trained to perform each other's duties in case of vacation or termination. Based on our experience, we have identified two characteristic measures for this requirement. "High", so changing the location of staff members from one to another at random periods of time is must, otherwise "Low".

4) Administrative cost: allows the effective use of different types of resources with minimum financial costs. Based on our experience, we have identified two characteristic measures for this requirement. "High", for high budget (greater than the user defined cost unit); "Normal", for normal budget (between lower and upper limits of the user defined cost unit), and "Low", for low budget (less than user defined cost unit).

B. Simulation Experiments

The styles are simulated and experiments on each style carried out. Simulation is based on traditional queuing models. We simulated with respect to all quality requirements by changing the number of clients requesting services. The goals are performance maximization; cost and waiting time minimization. The style which achieves these three goals is chosen. We applied our experiments 100 independent runs to each of the seven styles to avoid any problem due to the choice of initial values. Each run continued until a maximum of 500,000 evaluations (stopping condition) was reached. We begin simulations with a simple approximation of the situation and as our understanding of the process improves we gradually refine the style. Table 2 presents the experimental results of the waiting time (in seconds) quality requirement for each style with respect to whether security and administrative costs requirements are demanded or not.

CONCLUSION

In this paper, we have presented organizational theory in multi-agent system and show how a business environment can be viewed as a multi-agent system that corresponds to the organizational structure, a situation that can be easily mapped

into multi-agent system. We have introduced architectural styles then we have presented derivation of new architectural styles that can enforce the required multi-agent system requirements. We have identified seven architectural styles and introduced a number of quality requirements as characteristics of a style from the viewpoint of the people who participated in the business domains. We have shown, in short, how modeling and simulation can be used as a powerful tool to test different architectural styles; tune it; and select the style best fit a business environment. Finally, we have extensively experimented and tested the developed styles.

After the first results on applying the approach were encouraging, our current work is mainly devoted to refining our proposal. The Key future actions on which we are working including: a) Considering other quality attributes; b) The characteristics establishing different architectural styles introduced will be further refined and formalized to a greater extent. c) Derivation of suitable metrics to assess the quality of test results and to provide deeper insight on the business environment characteristics; and d) applying the proposal to real world case studies.

TABLE I. PERFORMANCE OF STYLES

Style	*Performance*	*Cost*	*# Clients*
OG_Sub-T_O-T	0.52	High	< 2500
	0.41	Low	> 2500
OG_Sub-T_Sub-T	0.59	High	< 2500
	0.46	Low	> 2500
OG_All-T_Sub-T	0.74	High	< 2500
	0.62	Low	> 2500
OG_All-T_All-T	0.85	High	< 2500
	0.69	Low	> 2500
MG_Sub-T_Sub-T	0.89	High	< 2500
	0.74	Low	> 2500
MG_All-T_Sub-T	0.94	High	< 2500
	0.83	Low	> 2500
MG_All-T_All-T	0.97	High	< 2500
	0.87	Low	> 2500

ACKNOWLEDGMENT

This work was made possible by a grant from Jarash National University.

REFERENCES

[1] M. Hammer and J. Champy, "Reengineering the Cooperation: A Manifesto for Business Revolution", HarperCollins Publishers, (1993).

[2] M. Hammer, "Reengineering Work: Don't Automate, Obliterate, Harvard Business Review", (1990) July-August.

[3] H. Thomas and E. James, "The New Industrial Engineering: Information Technology and Business Process Redesign", Sloan Management Review, summer 1990.

[4] M. Fox, M. Barbuceanu, M. Gruninger and J. Lin, "Organization Ontology for Enterprise Modeling".

[5] B. Lucia, C. Jaelson, "From Requirements to Multi-agent Architecture Using Organizational Concepts". ACM, SELMAS'05 at ICSE'05. Louis, Missouri, USA.

[6] J. Yosef and S. Hussam, "Selecting an Architectural Style Satisfying A banking Organization Requirements Using Simulation". The 1st International Conference on Digital Communications and Computer Applications (dcca2007). University of Science And Technology, Jordan.

[7] J. Biddle and J. Thomas, "Role Theory Concepts and Research", New York: Robert E Krieger Publishing Company, 1979.

[8] C. Butler, "The Role of Information Technology in Transforming the Business", Butler Cox plc, (1991) Research Report 79.

[9] M. Fox, , M. Barbuceanu, M. Gruninger and J. Lin, "An Organization Ontology for Enterprise Modelling".

[10] M. Shaw and D. Garlan, "Software Architectures: Per- spectives on an Emerging Discipline". Prentice Hall, 1996.

AUTHORS PROFILE

Marwan Abu-zanona is a lecturer in the Jerash University. He received a Ph.D. in Artificial Intelligence from the Faculty of Computer Information Systems, University of Banking and Financial Sciences. His research interest in neural networks, artificial intelligence and software engineering areas. He has a wealth of expertise gained from his work experiences in Jordan, ranging from web development to network administration.

Yosef Jbara is a lecturer in the Department of Computer Technology at Yanbu College of Technology. He received a Ph.D. in Artificial Intelligence from the Faculty of Computer Information Systems, University of Banking and Financial Sciences. He has published in the areas of artificial intelligence; simulation modeling; data mining and software engineering. His research focuses on artificial intelligence areas as well as simulation and data mining. He has a wealth of expertise gained from his work experiences in Jordan and Saudi Arabia, ranging from systems programming to computer network design and administration.

Farah Al-Zawaideh is the Chairman of Computer Information System in Irbid National University from 2009 until now. He received a Ph.D. in Knowledge based systems from the Faculty of Computer Information Systems, University of Banking and Financial Sciences. His research interest in genetic algorithms, E-learning and software engineering areas. He has a wealth of expertise gained from his work experiences in Jordan, ranging from web development to network administration.