A Study of an SOA-based Collaborative Project Management

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ABSTRACT
The formation of transnational enterprises had driven the needs of collaborative project management (CPM) in which project teams often have different background of organizational culture and language thus making CPM difficult. A collaborative technology may be the most significant change in the way projects are managed that future PM will be more concerned with project work and processes, and collaboration will become essential for success. Thus, the integration of the project process becomes the critical success factor for realizing collaborative business. In this study, we use the concept and method of Service Oriented Architecture (SOA) and Web services to design and integrate a CPM process based on the newest Project Management Body of Knowledge, including five main processes and nine knowledge areas, established by PMI. We have implemented two main project service management modules of the Initiating process with two knowledge areas, one is “Develop Project Charter Service Module” belonging to the Project Integration Management, and the other is “Identify Stakeholders Service Module” belonging to Project Communication Management. The result of this study presents a prototype of collaborative project management with a process service for the orchestration of the two service modules. The prototype system demonstrates a good starting point to establish more intact CPM models with SOA style so that individual project teams in the distributed environment can have better coordination and collaboration under a standard CPM platform by eliminating from management and communication problems.

Keywords: Collaborative Project Management, SOA, Web Services, Orchestration, Process Integration.

1. INTRODUCTION
As the development and advance of various communication products, project management will not be restricted to conduct in the same environment. The mode of cross-territorial project will be the future trend. But the increasing complexity and globalization of new product exploitation makes it difficult to plan and manage the project of new product development process. On the other hand, the development time of a large project often covers seventy percent in the collaborations [7, 11]. So when focusing on the management of a large project, more experiences and efforts are needed [3].

Besides, with the internet maturation cross-boundary cooperation was formed that changes the trend of project management (PM). The formation of transnational enterprises had driven the needs of collaborative project management (CPM for short in this paper) which involves project teams of diversified character across regions. These project teams have different background of organizational culture and language that makes the task of collaborative project management intricate [11]. Issues include, for example, how to integrate businesses between different enterprises, how to schedule the project, how project members can handle each other’s message state and project progress, and even the problem of resource allocation, task assignment, communication and coordination under different language, culture, and regulation. These factors are all involving different members in different locations. Helbrough [6] had described earlier that the significant change of project management will be the collaboration. Romano et al [11] also advocated that the collaboration would be the basis for project succession that makes the PM transforming from the traditional style to the collaborative style and even needs to integrate the business cultural, human resources, documents and information between project partners. Obviously, a collaborative technology may be the most significant change in the way projects are managed that future PM will be more concerned with project work and processes, and collaboration will become essential for success. Thus, the integration of the project process becomes the critical success factor for realizing collaborative business.

The collaboration at CPM is very different as traditional PM emphasizes scheduling, planning and tracking but members of CPM have to handle the progress of project effectively in different places. PM team usually uses the MS Office Project, Excel or any project management tools provided by a third party to manage, control or monitor project members and their progress, etc. However, the project members always have their own preference for PM tools and are always not satisfied with the tools they selected in order to meet their business process requirement. In other words, most traditional off-the-shelf project management software tools usually focus on such functionalities as the project schedule and progress control management and are short of advanced support for the integration management of collaborative project business process. Consequently such kinds of software cannot really satisfy the demand of collaborative project management.

Web technology has developed to support traditional window application to represent a web-based application. The web-based application software can be a convenient way for CPM. However, although it can reduce communication problem and the difficulty of project management between project members, enterprise always has to invest more to set up such kind of project management system. There are few CPM system in current market can actually satisfy the versatile needs. With the company growth and expansion, there may have more and more legacy project management systems owned by an enterprise. These legacy systems cannot cater for the new demand of project management. Thus, enterprise may renew some PM software for new big project whereas the existing old PM system is tantamount to a waste. For CPM, a project member in different location may have a variety of legacy PM systems used in past project. These legacy PM systems are all assets that belong to enterprise which cannot be effectively reused. Therefore, if a collaborative project is required, the team members must find suitable PM software for using to achieve the goal of CPM.
Currently the commercial available PM software, whether web-based application or not, is provided with tightly coupled software function components. It means that there has high dependency between each software module. Enterprise can hardly reuse them once a project was complete and a new PM process with different features begins. In this case, PM team may need to have a new function of PM software to support well management. Enterprise may have to waste time and cost to find new PM software for CPM. As a result, current and future project management will more focus on the team work and project process. An agile CPM system that can accommodate the change of project task and process to recompose the internal or external PM system or other service functions for enterprise is essential to success.

New information technology, framework and architecture were continuously brought up. Enterprise usually hopes to integrate heterogeneous systems without changing any existing system architecture to get best benefit with less cost. In the early time, distributed computing systems were based on Remote Procedure Call (RPC) to communicate with remote applications, such as CORBA, JAVA RMI and DCOM. But this tightly coupled nature forces the use of a homogeneous infrastructure on both service endpoints and thus distributed component platforms cannot interoperate easily [9]. On the other hand, Web services do not bind each other using application-specific interfaces. By focusing on XML-based messages, Web services are completely language, platform, and object model agnostic. Web services hold the promise of moving beyond the simple information exchange. Key to this concept is the service-oriented architecture (SOA). In SOA, business-aligned services are used as the basis for constructing flexible and dynamic business process. Another important characteristic of an SOA is that services are implemented with standard ways for invoking and are loosely coupled [5, 9].

Before implementing SOA, we must clearly define and analyze current business process in enterprise. Thus, the BPM (business process management) and SOA are closely related. Sophisticated process orchestration can be combined with stateless itinerary-based routing to create SOA that solves complex integration problems. An Enterprise Service Bus (ESB) uses the concept for process orchestration that supports BPEL (Business Process Execution Language) or other process definition language [9]. ESB is a framework for connecting heterogeneous systems built in different programming languages, e.g., .net or Java EE, to realize SOA. It is a flexible connectivity infrastructure for integrating applications and services by performing message routing between services, converting transport protocols between requestor and service, transforming message formats between requestor and service, and handling business events from disparate sources.

In this study we apply the concept and method of service-oriented architecture attempting to design and construct a collaborative project management system based on the main knowledge domain of project management process. Under the developed platform, we expect to efficiently integrate the processes for multiple project teams utilizing the nature supported by the system architecture. Furthermore, we have designed an Enterprise Service Bus for Project Management and taken advantage of the loose coupling feature of Web service to support the composition of services that will make the project process, legacy data and legacy application systems reusable, extensible, automated and agile to different project goals.

Besides SOA, we based on the newest Project Management Body of Knowledge [10], including five main processes (Initiating Process, Planning Process, Executing Process, Monitoring Process, and Closing Process) and nine knowledge areas, established by Project Management Institute (PMI) to develop those function modules. We have implemented two main project service management modules of the Initiating process with two knowledge areas. First one is called “Develop Project Charter Service Module” belonging to the Project Integration Management, and the second is called “Identify Stakeholders Service Module” belonging to Project Communication Management. They are based on JMS (Java Message Service) [12] and SOAP transmission and all have subservice modules to compose complete function of our prototype system. These subservice modules all utilize OPEN ESB to connect each other and also can be called by other business process. In order to demonstrate the service modules we developed, we designed a collaborative project management scenario which uses Business Process Execute Language (BPEL) [5, 9, 12] to realize a business process operation model with the two subservice modules.

The rest of this paper is organized as follows. Section 2 will briefly review the concept of SOA and Enterprise Service Bus (ESB). In Section 3, we will give an overview of the past, present, and future of collaborative project management. Section 4 presents the design and implementation detail of our SOA-based CPM. Finally, conclusions and the future work are given in Section 5.

2. REVIEW OF SOA AND ESB

Erl [5] mentioned that service-oriented architecture (SOA) has become the focal point of the IT industry, yet few fully understand it. So far, many people still think to achieve SOA was implementing Web services. Erl [5] indicated that a common but dangerous assumption that leads to the number one mistake made by organizations intending to adopt SOA is thinking a technical service-oriented architecture as simply one comprised of Web services. In effect, SOA is a concept or method that even can represent a software architecture but not a specific structure or technology, and the point of SOA on the software engineering is to design and build service model or components following the principles of SOA. So we cannot only rely on recent IT technologies to achieve the goal SOA like Web services do. Web service is a function that can be called by service consumers. If we only implement web service to be an SOA, the enterprise cannot get any benefit from it because it just makes some services to be called. To achieve SOA, the first important thing is to conduct the business process analysis. Before importing SOA, enterprise must utilize this chance to examine the business process and find out main part for the business process reengineering in the organization. But many companies all think SOA a system like other enterprise applications, e.g., ERP, CRM, etc., so that this is why they always failed in their SOA projects. As long as people can break the misunderstanding of SOA, they will bring the benefit into their enterprise SOA projects. When applied to IT architecture, service-orientation establishes a universal model in which automation logic and even business logic conform to a vision in which resources are cleanly partitioned and consistently represented. By adhering to this vision, past technical and philosophical disparities are blanketed by layers of abstraction that introduce a globally accepted standard for representing logic and information [5].
Enterprises also hope to try to use new technologies, framework and methods to achieve a better benefit at lower cost. They also hope to allow heterogeneous systems to connect with each other without changing their system architectures. Since the introduction of SOA, the most-written-about technology is the Enterprise Service Bus (ESB). It is a framework for connecting heterogeneous systems built using different programming languages, for example, .Net and Java EE, to realize SOA. Carter [2] stated that ESB can help achieve the goal of SOA and is a flexible connectivity infrastructure for integrating applications and services. The ESB is at the heart of an SOA, powering it by reducing the number, size, and complexity of interfaces. In this study, we will adopt it as our main methodology to establish our SOA-based collaborative project management system.

3. COLLABORATIVE PROJECT MANAGEMENT

Traditional Collaborative Project Management
When project operated in a collaborative environment, the difference to traditional project is that traditional project focuses on the management in the same place and emphasizes the schedule planning and tracking, but for collaborative project the collaboration team members must control project status with each other [6, 11]. Under this condition, team members always use Microsoft Office Project, Excel or the third party project management software tools to control project progress and monitor their project tasks. However, the tools we described above are not sufficient for dealing business process of CPM. Because each team has its own favorite project management application software and often cannot make their project processes and states synchronized. The advanced web technology led the windows application to present as web and browser-based application. For collaborative environment, it’s very convenient that project management using the web-based applications can handle the progress and resources of project in different locations. Although using this kind of web project management tools can reduce bottleneck of communication, enterprise usually must cost expensively to incorporate such kind of PM systems and even cannot know clearly the process of collaborative project.

Present Collaborative Project Management
In recent years, the main significant change of project management was using computer and new method for project management [6, 11]. In the past, with low-level IT framework enterprise only can rely on traditional communication tools for data exchange and transformation with their external partners. With the advance of the Web technology, every kind of application software based on the WWW was developed to assist the collaborative project management. So a popular way of CPM is a software style developed on the collaboration for the Web. The external collaboration partner of the enterprises can exchange the information, control the time, arrange the schedule, and do the relative pursuing for the project operation via the interface of the Web-based application. Some other relative researches use the web service, agent and semantic technology to monitor project [8, 13, 14].

Lots of advanced software products had helped the enterprise to eliminate the gap between the virtual and traditional PM works, but the virtual teams are still with limited working efficiency and their work ability is restricted. The main reason is that the virtual team members are not seated at the same table at the same time [4] and by only utilizing the software with limited collaborative capability it is hard to complete their task with maxima efficiency.

Future Collaborative Project Management
In the future, project management will more concern about task and process of collaboration project. It would be a great break-through if we can have the style of PM software that will recompose and reallocate the PM modules or existing legacy systems in or outside the enterprise for CPM to accommodate the change of project process. No matter it is complicated or not, project process is a critical success factor of a project. It is very important to enhance the reusability of and reduce communication bottleneck of project process.

4. SYSTEM DESIGN AND IMPLEMENTATION

Although some commercial CPM tools have brought benefits for project teams, their communication styles were basically tightly coupled. To archive a better CPM, this study based on SOA style and adopted Web Service technology to construct the WEB-based CPM software. So every main function module on the system is composed by many subservice modules which are loosely coupled. Every subservice module can be reused by the business process that needs it to achieve the business goal. This will make the enterprise business process more agile and flexible. The service modules also can be composed to a new system to accommodate the new business requirements that will maximize the flexibility of the software architecture.

Figure 1 shows our research framework in which the mapping of the PM layers and SOA layers is illustrated. As can be seen, IBM SOMA [1] is applied to analyze the PM process.

The System Architecture
In this paper we design and implement an SOA style CPM system (SCPMS) model (as shown in Figure 2) that based on the newest Project Management Body of Knowledge, including five main processes (Initiating Process, Planning Process, Executing Process, Monitoring Process, and Closing Process) and nine knowledge areas described by PMI’s PMBOK 2008 [10]. Web service is the basic technique to make our service modules come to alive. Through the use of SOA’s basic framework—ESB, which is the center of service components, we can make these components interactive along with the change of project process. In the future, these modules will be orchestrated with enterprise process immediately if the goal of project changes. Thus, the system style we present will make project process more flexible and agile to recompose and orchestrate the service modules.
IBM service-oriented Modeling and architecture (SOMA)

**Service identification**
1. Domain Decomposition (Top-down)
2. Existing Asset Analysis (Bottom-up)
3. Goal-Service Modeling

**Service specification**
1. Business Alignment
2. Composability
3. Feasibility of implementation
4. Redundancy elimination

**Service realization**
1. Component Allocation to Layers
2. Technical Feasibility Analysis
3. Realization Decisions

**Project Management Process (PMBOK 2008)**
1. Initiating
2. Planning
3. Executing
4. Monitoring & Controlling
5. Closing

**Project Management Knowledge Area**
1. Integration Management
2. Communications Management
3. Scope Management
4. Risk Management
5. Cost Management
6. Quality Management
8. Time Management
9. Procurement Management

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**Figure 1.** Research Framework with PM and SOA Layers Mapping.

**Figure 2.** The SCPM Model.
**Function Modules of Our Prototype**

To realize SOA style software architecture and make the whole system loosely coupled, service modules must be integrated with other heterogeneous systems and be able to be composed easily to support the project process. Service modules can be reused and composed through WSDL port by using common standard language between them. Thus, in this study we utilize Java EE technology to develop a prototype system of CPM for project Initiating Process. As has been indicated, we based on the PMBOK’s five main processes and nine knowledge areas (as shown in the top 2 layers of Figure 2) to develop those function modules based on SOA. We have implemented two main project service management modules of the Initiating process with two knowledge areas. One is called “Develop Project Charter Service Module” belonging to the Project Integration Management knowledge area, and the other is called “Identify Stakeholders Service Module” belonging to Project Communication Management knowledge area. Figure 3 illustrates their corresponding service modules.

The prototype is based on JMS and SOAP transmission for the two main project service management modules and all subservice modules to communicate and exchange data. These subservice modules all utilize OPEN ESB (supported by the NetBeans Platform [12]) to connect each other (Figure 4) and also can be called by other business process. In order to demonstrate the service modules we developed, we design a collaborative project management scenario which uses Business Process Execute Language (BPEL) to realize a business process operation model with the two subservice modules.

![Figure 3. Service Modules of the System Prototype.](image)

![Figure 4. Service Modules Connected by ESB.](image)
Prototype implementation

According to the design described above, this study realizes the main function modules including Service Index, Building Contract JMS Service Modules, and Reviewing Contract SOAP Service Modules. Building Contract JMS Service Modules allow builders to enter contract details to establish a new contract. After that other PM team members can query to view the contract content. JMS is used to send contract data to the message queue allowing Web service client to call this message later from the queue. On the other hand, calling contract data is implemented using EJB Session Bean based on the JAX-WS Web Service to select data from the database. In this way, the modules we realize are loosely coupled that will make it easy for other heterogeneous systems to be integrated with our system modules. Thus, these two submodules can be composed by the ESB and call each other or even be reused by any other project process when required. All service modules will be composed to a service assembly deployed on the application server we adopt. Finally it can achieve the SOA spirit and goal of integration without application clients to change their user experiences.

5. CONCLUSIONS

In this study, we have implemented a prototype of SOA-based collaborative project management system which takes advantage of the SOA concept to convert the CPM business process to several individual Web services with no dependencies to each other and these services can be recomposed to accommodate change of the business process due to project modification. In every stage of CPM the characteristics of service composability, reusability, extensibility, and agility can be achieved with this service-oriented support. In addition, the process of project management can be integrated and reused efficiently at different organizations. The entire project process will also be suitably analyzed and designed into individual services to coordinate projects of different features. In other words, once there is a change in the project process, the function modules of SOA style can be easily composed and used even that the collaborative project involves teams with different industry domains and located in disparate places. The CPM project should be able to progress smoothly and its success degree will be increased with better coordination and collaboration obviating management and communication problems. With the help of our system, individual project teams in the distributed environment should be able to efficiently handle each other’s status and all the resources that comply with the standard procedures in collaborative project management allowing project members to achieve in time the expected goal.

Further research is underway striving for the establishment of other knowledge areas and service modules of other project management processes. We hope members of the project management may proceed under a standard CPM environment and obtain a well managed and controlled project in every stage of the process. We also expect to establish an intact CPM model with SOA style based on the five main processes and nine knowledge areas. A practical performance evaluation and service test also should be done so as to provide better operating experiences for the users.

REFERENCES