Service agents based collaborative workflow management implementation

Leo Pudhota, Elizabeth Chang
PudhotaL@cbs.curtin.edu.au
School of Information Systems, Curtin University of Technology PO Box U1987, Perth WA 6845, Australia

Abstract: W*orkflow management systems in collaborative logistic companies require strong information systems to support in a distributed environment. These IT integration requirements have expanded considerably with the advent of collaborative e-business; utilizing B2B (Business to Business) and P2P (Partner to Partner) e-commerce. This paper deals with adaptation management of collaborative workflow changes in such consortia and proposes architecture for implementation of these changes through the process of component integration and agent based workflow management system where by existing workflow systems adapt to the changes. This paper describes conceptual framework required for prototype implementation resulting in new collaborative workflow adaptation.*

Introduction

In this paper we aim to prototype adaptation management for dynamic business processes of large logistic consortia, often we see that the business processes are composed of several parts, a structured operational part and an unstructured operational part, or they could be composed of semi-structured parts with some given and some unknown details. Unpredictable situations may occur as a result of changes in decisions made by the management. The inability to deal with various changes greatly limits the applicability of workflow systems in real industrial and commercial operations. This situation raises problems in workflow design and workflow systems development. We propose workflow implementation methodology through the process of component integration techniques for development of new workflow using existing workflow components.

Collaborative Workflow for an Extended Enterprise

Collaborative workflow is a new type of workflow that allows an organisation or enterprise to be added to the existing workflow model and be used in the extended organisation or enterprise.The advent of the internet has provided mechanisms for binding organisations to work together as they need collaborative workflow management for carrying out sales over great distances and at any time. Collaborative workflow is important for marketing and enabled partnerships, previously inconceivable within a wide array of business, as well as other human activities. Management of collaborative workflow helps the connectivity and information richness that one is faced with in an increasingly dynamic business environment and workflow. Collaborative workflow management helps the shift from old business paradigms to new business paradigms. New collaborative organisation workflow systems that *transcend* the *previous static, closed, competitive models* and *move* to *dynamic open re-configurable, often collaborative models* that are able to respond to the business environment dynamics inherent within the networked economy [13]. Several factors characterise collaborative workflow management for extended enterprise; namely:

(a) A strong information infrastructure that extends beyond the original closed walls of the *individual enterprise*.

(b) High connectivity and electronic handling of information, of all sorts including data and documents.

(c) An increasingly *collaborative approach* between what were more traditional *individual enterprises*.

(d) Utilisation of new forms of electronic interaction, provision of services and utilisation of services.

(e) Ability to self organise and reconfigure the business of the organisation, perhaps even the organisation as a whole.

(f) Use of multiple channels for sales and marketing.

(g) Capture and utilisation of business intelligence from data and *smart information use*.

These features are increasingly exhibited by successful modern business organisations, for instance, in collaborative supply chains, collaborative consortia for marketing, strategic partnerships, alliances and selling services, utilisation of web sales, marketing and customer service and creation of multiple modes of user interaction with the business.

A key factor in the success of such collaborative workflow management for Extended Enterprise is the creation of the underpinning *information infrastructure* to carry out the required services and development to enable and support the creation and the strengthening of small-medium enterprises (SMEs) to achieve some of the characteristics of collaboration. However current workflow techniques do not address the collaborative workflow issues and management.

Challenges of collaborative workflow

Activities and artefacts do not quite constitute a process. We need a way to describe meaningful sequences of activities that produce some valuable result, and to show interactions between processes. Changes in collaborative workflow have to be incorporated into the integrated enterprise system; we have proposed a prototype of its working in our previous papers [8, 9, 10, 11].

In this paper we are concentrating on,

1. Implementation aspects of integrating and adaptation of changes in the new workflow into an already existing workflow.

2. Information systems can change at run time so that new workflow can synchronize with existing workflow to adapt quickly.

Other issues like

3.1 Management of data scattered over multiple origin systems/legacy systems, for example, a company will have consolidate data in one logical view with a unified architecture, thereby enabling data-source independence. Because application data continues to live and change in the origin systems, the new software layer must be able to retrieve origin data on the fly and also propagate changes back to the origin systems.

3.2 provide support for transactions/interaction across multiple back-end systems. "The hard part is getting a transaction model wrapped around those back-end systems; so if it didn't work in the third system, it was able to roll back in those first two systems," *[17].*

To keep pace with changing business needs, these systems must be periodically updated. However, modifying such *legacy systems* is in general very difficult: the system's structure and internal operation will become corrupted with the passage of time, designs and documentation are lost, and individuals with an understanding of the software move on. Completely rewriting such software tends to be prohibitively expensive, and is often simply impossible. Therefore, in the long term, the only way to keep such legacy systems useful is to incorporate them into a wider cooperating community, in which they can be exploited by other pieces of software. This can be done, for example, by building an 'agent wrapper' around the software to enable it to interoperate with other systems [23,21]. The process of transforming a software application such as a database into an agent is sometimes referred to as *agentification* [24].

These challenges will help in having a uniform data processing environment for the whole enterprise, which would lead to changes and improvements in customer services, control of receivables and increase efficiency in communication, sales, marketing as well as minimization of warehouse stocks, streamlining inventory and logistics flows.

Provide control to Consortium management to monitor the collaborative enterprise's condition, its stock, order and its general financial condition on a routine basis, this is indispensable to the management processes and enhances decision-making and changes which need to be taken on the short term and long term bases for the consortium to compete in the global market.

Conceptual model of service oriented framework

Conceptual Model provides an architectural separation of business functionality from technology implementation. This separation allowed designers to use business rules defined in a UML model to drive four distinct steps in implementing such systems.

Step1. Create two platform independent models in UML. The first model is a generic domain model, used to build a common understanding and vocabulary among warehouse Logistics domain experts.

Step2. The domain model is then mapped into a second platform independent model (PMI) representing warehouse logistic business. Each of the models includes a detailed set of UML Class Diagrams, Use Cases and associated Activity Diagrams describing the system [12].

Step3. Using this business model, we can create one or more subsystems to represent the logical functions of each of the enterprise systems. This business model contains both the details of the business logic, as well as the mapping of the logic into the major subsystems. The business model forms the basis for managing all changes to the current systems.

Step4. System Integration using Conceptual Model of Platform Specific Models (PSM's), for each of individual systems to form enterprise system. These models were each derived from one or more subsystems in the business model. The relationships are shown in Figure 4. System construction consists of customizing each of the enterprise systems, and creating the business logic. Business logic that spanned systems is constructed using components technology and deployed in the application server [12].

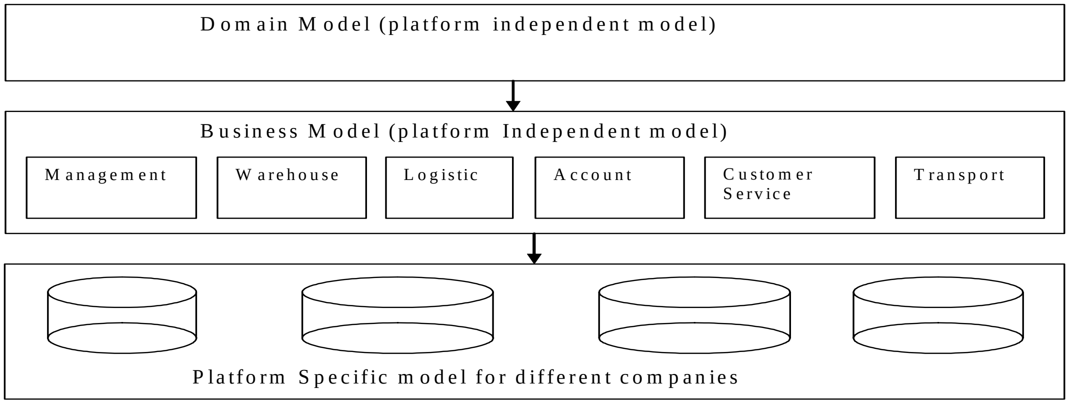

Figure 1: Service Oriented for system integration

Enterprise monitor repository helps by monitoring the front end as well as the back end of the automated enterprise system as shown in figure 3, this frame work helps to balance across one or more application server processes (also called instances) running on one or more machines. Once connected and running, Enterprise component service instances help in monitoring the whole workflow of the logistics enterprise by the scanning process of the goods which takes place at each and every entry and exit process in the industry and they are stored in the database to be reviewed as per user requests; they maintain themselves, their session's state for users, and their database connections. Automated values are derived from each node/sensor at entry and delivery point to know the exact state and they are stored once in 6 hrs any errors or inappropriate data maching is automatically notified by the monitor repostitory. Notify derivatives process helps the logistic industry to keep track of all the items in the enterprise, this also helps handling and transportation of material efficient, fast, and by definition redundant.

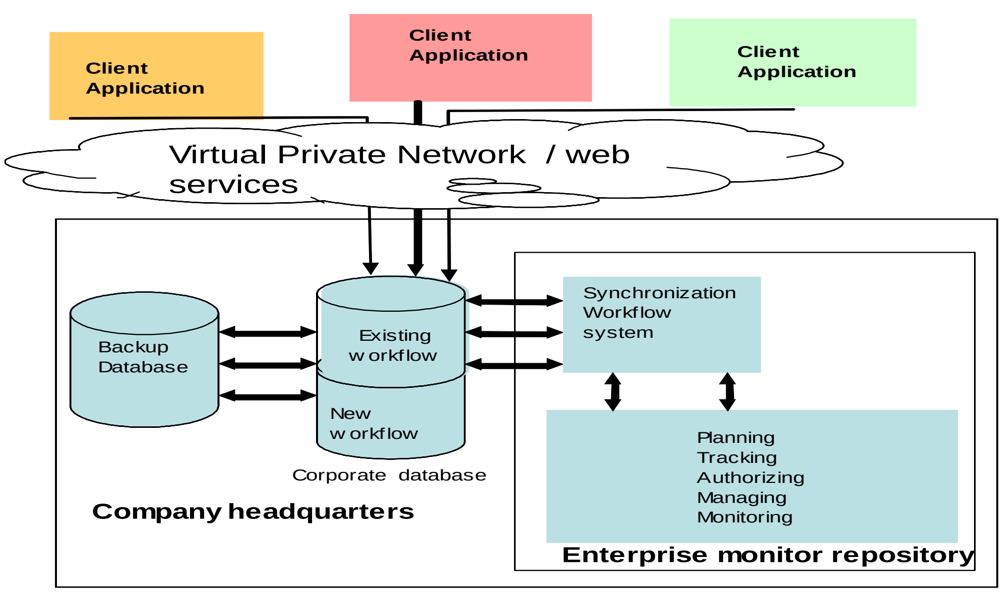

Figure 2. Enterprise monitor repository

Service Components oriented framework.

We represent each agent as a distinct role or department in the enterprise and is capable of providing one or more services. For example, a customer service department provides the services to the customers who are making a booking for the logistic services, a transportation department offers the service of picking up the goods once the payment is made, and the accounting department provides the service of costing and delivering the docket. Agents who require a service from another agent enter into a negotiation for that service to obtain a mutually acceptable time, resources and degree of adjustment for quality implementation of activities. Successful negotiations result in binding agreements between agents. This agent-based approach offers a number of advantages over more typical workflow solutions to this problem. The proactive nature of the agents means services can be scheduled in a just-in-time fashion (rather than pre-specified from the beginning), and the responsive nature of the agents means that service exceptions can be detected and handled in a flexible manner. Project ADEPT [20] tackles similar problem by viewing a business process as a community of negotiating, service providing agents.

Service agent's internal structure: Manager Module Controls all the lower layer modules along with other functions like adaptations to change situation, decision on other services requirements and when required initiating negotiations with other gents and merging with other services agents.

Networking Module deals with connects to processing automation, connection to information system, communication between agents, reasoning and calculations if and when required.

Intelligence module deals with reasoning like how to combine symbolic and numerical processes, assisting other agents proactively providing information they require, and shielding them from information that is not of interest thus acts both as an information provider and filterer and an information gatherer. Terminology is based on genuine automation ontology and process related variables having references, reasoning based on the input from monitor and sensor devices and taking a decision on the changes in the workflow

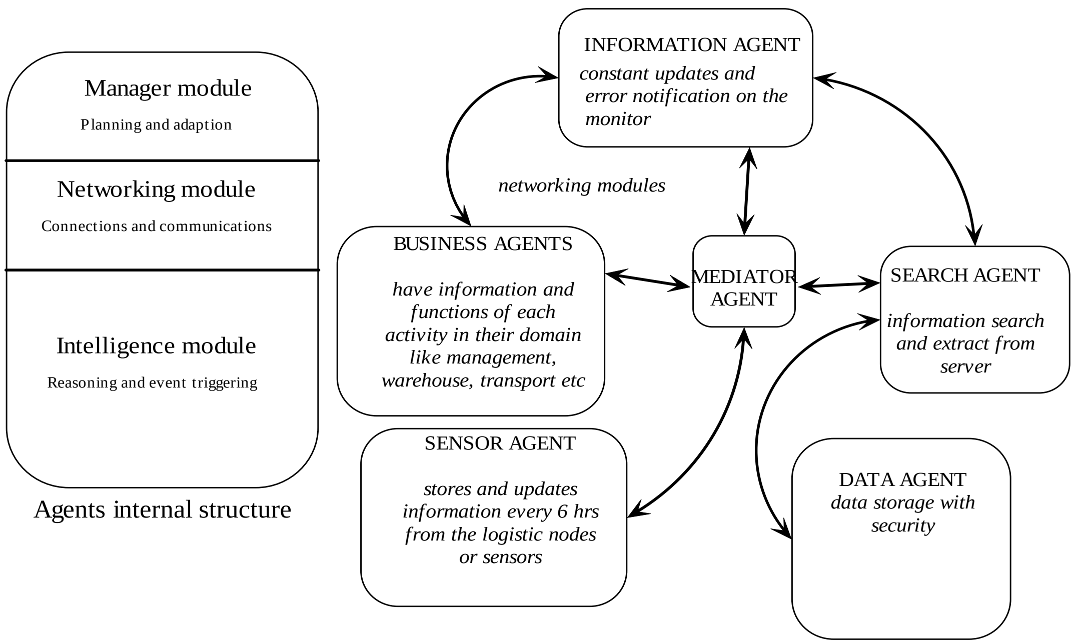

Figure 4. Agents internal structure and their functions

Virtual collaboration via service communication

The method we propose is Dynamic Virtual agent Clustering approach, the dynamic virtual agent clustering pattern plays a crucial role in that it embeds the self-organizing properties of components. The main responsibility of this pattern is to configure the enterprise to minimize cost enabling for flexible, re-configurable agent structures. At all levels of the architecture, task propagation occurs by a process of virtual cluster formation. This implementation (which is suitable for manufacturing and logistic industries) places the control into a mediator agent and by this reduces the degree of autonomy of the individual components.

Agents provide a better means of conceptualizing and/or implementing a given application. Here, three important domain characteristics are often cited as a rationale for adopting agent technology [18]:

- data, control, expertise, or resources are inherently distributed,
- the system is naturally regarded as a society of autonomous cooperating components, or
- the system contains legacy components, which must be made to interact with other, possibly new software components.

Dynamic virtual clustering of synergetic partnerships of collaborative organizations aiming to achieve a common goal, finding and accessing an unknown service that is available on the Web, matching of different templates from different sources to better services of their customers, and time management. Such a dynamic Web synergistically glues different dispersed organizations/resources into an added value enterprise capable to accomplish more then the sum of each individual organization/resource could. The basic architecture is based on different component type's behavior [13, 14] like Product Component (PC), Product Model Component (PMC), Resource Component (RC) business component (BC), transport component (TC) and Mediator Component (MC). Product Component will hold information about process status of various goods during logistics operations, time constraint variables, goods status and decision knowledge relating to the order request; it basically acts as a dual for physical component and information component. Here the physical component develops from its state of order forms to an intermediate form like storage in warehouse to delivery of goods as its final stage, its hold all information relating to logistics of the products life cycle. A resource component holds physical and information components, physical component like transportation mode, path of transport, transport preferences (example cold storage) etc and information component like planning and scheduling. For adaptive architecture to work we need a Mediator Component as an intelligent logical mediator to link the orders, goods data and specific organizational resources dynamically. This mediator component can create a dynamic mediator component if a new task needs to be implemented, such as changes in the workflow. When the task is completed this dynamic component is stored in a work-log for further reuse. This PMC identifies the order related resource cluster, (a cluster can be considered as component grouping) and manages task decomposition associated with their clusters. The life cycle of dynamic virtual cluster has four stages 1.Resource grouping 2.Control component creation 3.Execution processing and 4.Termination/worklog [16, 17]. In resource grouping control, we have schedule controller cluster shown in figure 3, a cluster can be considered as component grouping. The controller cluster is associated with one or more physical control like real time operation system and its hardware devices; it functions as a distributed node transparent resource platform for execution of cluster control tasks at the resource level. The dynamic mediator component records and traces local dynamic information of individual components in its association with virtual cluster community, this mediator component can also pass instance information of the partial resource components to some new virtual cluster communities while assigned tasks are being executed. This is a mathematical model approach which will be dealt in detail in following papers.

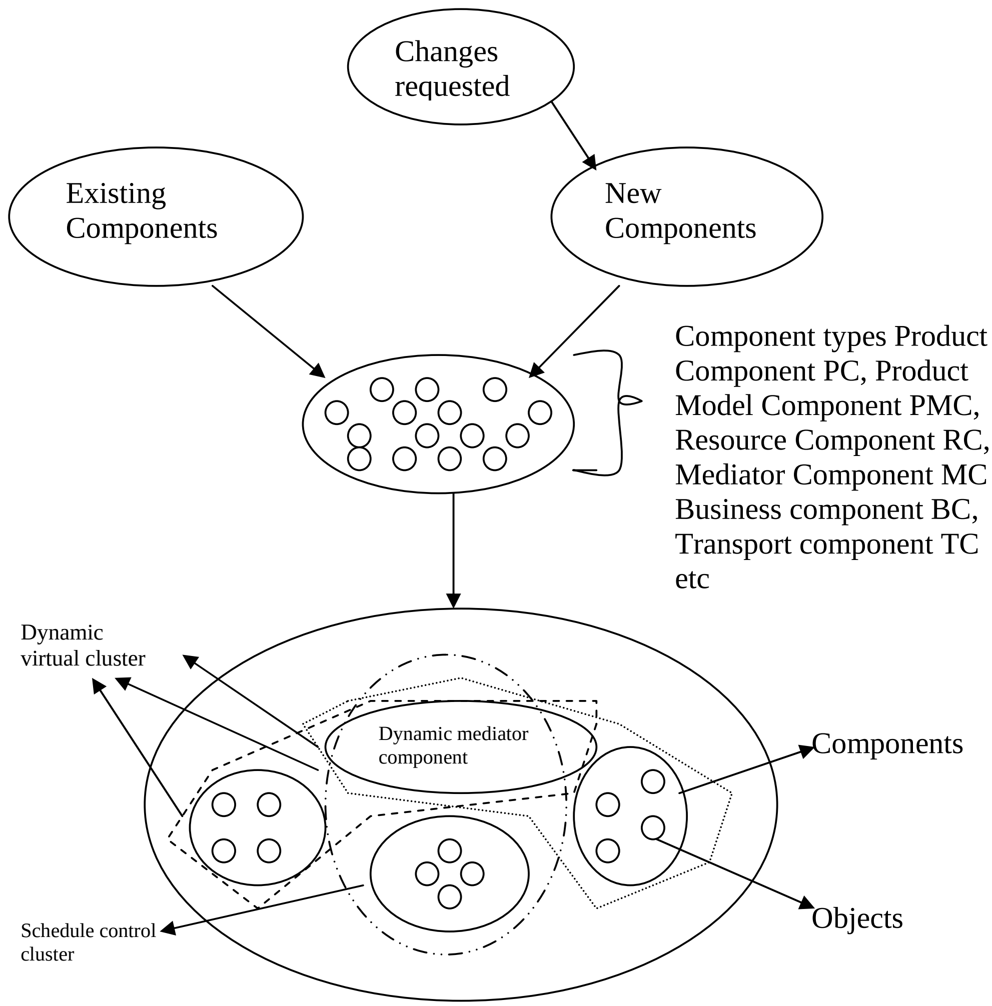

Figure 3: Dynamic virtual agent cluster component framework

System Implementation

An agent system design will both describe the various different roles of each agent that exist within the system and characterize the relationships that exist between these roles. The building process is broadly classified as 1.Workflow logistics automation Ontology 2.Logistics and General monitoring services (Enterprise services) 3.Ontology of reasoning rules (Enterprise rules), having identified the various agent roles in a system, our next step is to determine how each of these roles can be best realized. Agent architecture needs to be devised or adopted for each role, which will deliver the required functional and non-functional characteristics of the agent's role. Many agent architectures have been developed by the intelligent agent's community, with many different properties [21]. At one extreme, there are 'strong AI' systems, which allow users to build agents as knowledge-based systems, or even as logic theorem proves. In order to build agents using such systems, one goes through the standard knowledge-based system process of knowledge elicitation and representation, coding an agent's behavior in terms of rules, frames, or semantic nets. At the other extreme, there are many agent frameworks that simply offer enhanced versions of (for example) the Java Applications of Intelligent Agents programming Selanguage; they include no AI techniques at all. Neither of these extremes is strictly right or wrong: they both have merits and drawbacks [22]. In general, of course, the simplest solution that will effectively solve a problem is often the best. There is little point in using complex reasoning systems where simple Java-like agents will do. Obviously, more detailed guidelines to assist with this decision making process are desirable.

Conclusion:

In this paper, we have discussed logistics e-business development of adaptive workflow systems based on changes made at managerial levels. We have also discussed various approaches for dynamic adaptation of the management workflow system and the frame work for implementation. We propose new models of adaptive systems by the process of dynamic virtual agent clustering; our future research will be to develop a prototype based on this methodology of a working adaptive system.

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