Enterprise Collaboration based on the Internet of Services: Two showcases in Construction and Printing Industries

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1 Introduction

This paper presents the application of the Internet of Services to the development of enterprise collaboration scenarios that take place in two different domains in which choreography and orchestration processes have been modelled: Construction and Printing Industry.

One of the main problems construction companies have to face is the coordination of the different actors in the construction site.

In the printing industry enterprises are usually specialised only in one of the phases of the overall process (i.e. pre-printing, printing, manipulation, …), so the exchange of accurate specifications describing the graphic product represents a key aspect in this collaboration scenario, which is based on the combination of two printing integration standards: JDF and PrintTalk.

Although at first these two enterprise scenarios may seem completely different, they share a common feature: In both scenarios several companies collaborate in the manufacturing of the final product, e.g. a building or a book. This means that the business processes of one company are interconnected to the business processes of the other companies. They are not mere suppliers of raw materials. Therefore, the B2B scenarios are not only the usual ecommerce or trading scenarios.

Furthermore, most of the companies involved in the scenarios are not big enterprises but SMEs, some of them microSMEs.

In this paper, first a brief description of both collaboration scenarios is provided and secondly a mixed BPM-SOA strategy to improve the current scenarios is presented and justified. To end up some conclusions are drawn.

The work presented in this paper is the result of research carried out in two projects: the e-NVISION project (http://www.e-nvision.org), “A New Vision for the participation of European SMEs in the future e-Business scenario”, a STREP project supported by the European Commission under the 6th Framework Programme and the e-JDFB2B project (http://www.in2ca.com/ejdfb2b/ejdfb2b1.asp) supported by the Spanish Ministry of Industry, Tourism and Trade.

2 Construction scenario: collaboration on-site

During the e-NVISION project several B2B scenarios (e-Tendering, e-Procurement and e-Site) were defined and implemented to simplify, speed up or automate some of the construction processes. One of these scenarios was the coordination of all participants in the construction site to efficiently communicate any change in the design documentation or any site incident like a delay, machinery failure, or bad weather conditions, what was called e-Site [1].

When a new construction project starts, the Project Management Company (PMC) prepares the initial project planning (Master Schedule) taking into account the coordination needs of all the participants, including the determination of key positions, interrelations between the planned works, supplies of materials and equipment, and dates of their earliest and latest completion are defined. The main PMC responsibility is to supervise construction and effectively coordinate the activities of all participants as refers to construction and assembly works, services and deliveries of equipment and materials. The main objective of the coordination is the efficient and timely fulfilment of the tasks determined in the Master Schedule. The real situation is that many different unplanned events come up onsite affecting the initial planning and design.

Nowadays, when an event occurs at the construction site (e.g. a delay or a design change), it is very difficult to inform the interested parties (suppliers and sub-contractors) mainly because there is insufficient information sharing among the parties. Event notification is usually human based, via weekly meetings or even worse, by informal conversations on-site. These methods are very prone to errors and they do not take into account the product supplier companies, which are not involved in the work onsite.

Hence, often the affected parties receive the incident notification too late to react accordingly and report the incident to their suppliers. This situation is even more problematic in the case of an SME because they lack the flexibility and recovery capability of big companies.

In order to improve the current situation the coordination onsite (e-Site) scenario's main objective is to coordinate operations on the site in real time taking into account the unexpected events that occur at the building site: breakdown of machinery, unacceptable weather conditions, absence of manpower, change in the documentation, etc.

The following requirements for this scenario were gathered:

- Provide electronic event logging management facilities.
- Update schedules and site documentation according to the incidents and their consequences (reactive scheduling [2]).
- Communicate events to the interested parties automatically by electronic means.
- Gather the response proposal to these incidents by the affected partners.

In order to fulfil those requirements two possible strategies were evaluated: a centralised one and a SOA-BPM based approach.

Traditionally, Project Management Companies (PMC) use centralized construction management applications. This kind of applications cover all the construction phases and provide specific interfaces with which the companies involved in the project have to interact. There exist in the market specific tools for construction project management and collaboration like Primavera [3] or Aconex [4] among others. However, only big construction companies are using those tools due to the big initial investment requirements and the complexity of the solutions. Most construction SMEs uses ad-hoc developments or general purpose tools (like Lotus Notes of ERP products) with limited collaboration capabilities.

Furthermore, these applications are too complex and have several drawbacks for SMEs (subcontractors, product, material and equipment suppliers). As traditional applications are designed to satisfy the PMC's requirements, they force to define the master schedule for the whole building project, whereas supplier SMEs are only interested in one or a few construction stages in which they are involved. Besides, the PMC's main concern is to monitor the schedule of one project, while supplier and subcontracted SMEs that usually provide materials or services to several projects are more interested in optimizing different scheduling constraints.

What we call an e-Business strategy is based on the following assumptions:

- Each company participating in a construction project (regardless of the role it plays, PMC, subcontractor, service provider of supplier) has its own management system, its own processes and schedules.
- Even though a central document repository can exist, event notification and resolution is a distributed and collaborative process. It is not enough to notify an event. Most of the times event resolution leads to a negotiation process among the construction partners.

Next figure shows an example of a construction on-site collaboration scenario:

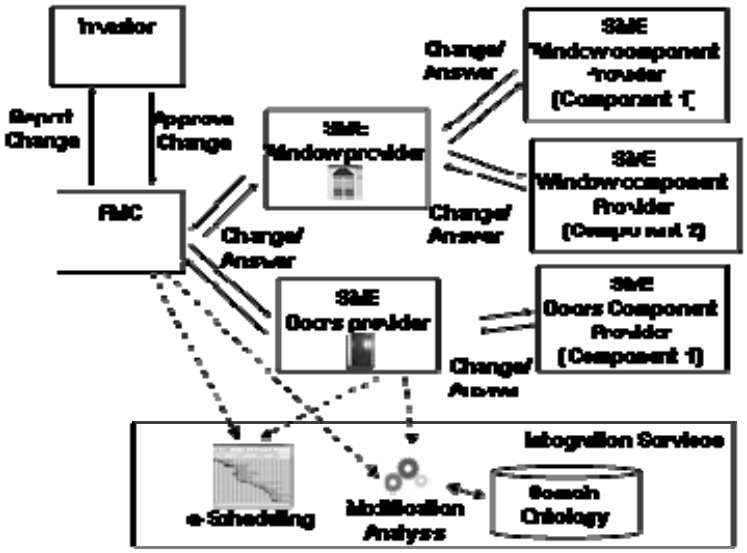

Figure 1 On-site collaboration scenario

An e-Business approach benefits construction SMEs in two ways. Firstly, the e-Business interfaces are independent of the PMC's management system allowing the supplier SME to work with its own application and using the same interface in all construction projects. Secondly, the SME only deals with the information it needs avoiding being aware of the complexity of the whole project.

3 Printing scenario: JDF enterprise integration

Printing overall process is composed by the following sub-processes: product design, pre-press, press and post-press. Nowadays printing companies are usually specialised only in one of these sub-processes. This means that subcontracting activities have to be carried out which involve the transmission of accurate information about the end user requirements among the enterprises participating in the overall process.

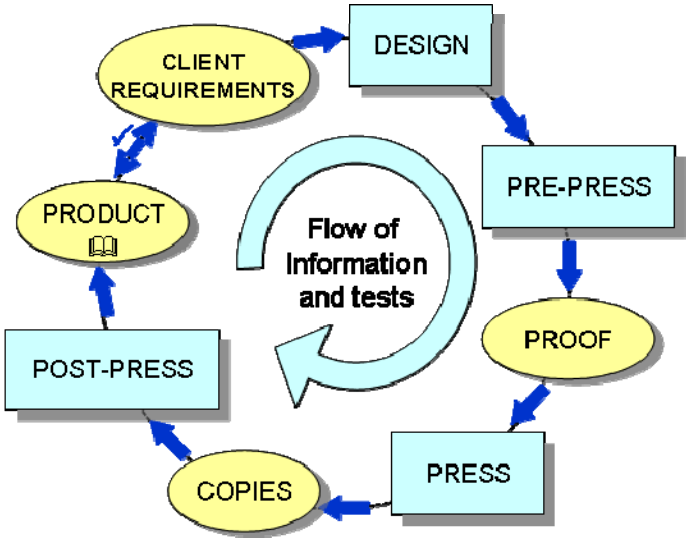

Figure 2Phases of the Graphic Arts process

Figure 2 shows the phases of the Graphic Arts process. Pre-press companies are the first in the production chain. The process starts with the reception of the design and the originals obtained from the client requirements. These originals are basically illustrations and/or text. Next, texts are corrected and composed using computer systems (trapping, imposition, colour correction) and the files that have been generated through various pre-press processes are used to create the plates, which will subsequently be mounted on the press for printing.

In the press phase the inked image is transferred from a plate using different printing techniques such as offset, flexography or serigraphy. Sub processes of this phase include plate-making, ripping, printing...

Finally, the post-press phase covers the cutting, folding and binding processes to obtain the print product ready for distribution.

One of the difficulties which printing companies have to face when doing e-Business transactions, is how to express these requirements in a machine understandable format. This is not an easy task as there is a wide variety of print products (leaflet, brochure, book, label, newspaper, poster, packaging, bag…) and for each product there is a broad range of possibilities. E.g. to print a book it is necessary to define: cover, inside pages, production and finishing of the cover and pages, inks, CMYK colours, layout, digital plate making, binding, etc.

In addition, in this sector there is limited communication between Management Information Systems (MIS), generally responsible for the planning and controlling of a job, and production services, responsible for the operation of a job.

To solve these issues, the e-Business platform used in the printing scenarios is based on two recent standards and all the communication messages exchanged between the potential subcontractors and the printing company are made through a combination of JDF and PrintTalk documents. While JDF describes the piece to be produced, PrintTalk specifies the external communication of business processes between Print Provider and Print Buyer.

JDF allows the description of all the processes needed to complete a print product, from job submission through pre-press, press and post-press. It does this by translating each process step in a job into what is called a node. The entire job is represented by a tree of these nodes. All of the nodes taken together describe the desired printed product and the workflow of its production. The most significant capabilities of JDF can be divided into three principal categories: its ability to complete every part of a job, from start to finish; its ability to link MIS (Management Information System) with production; and its ability to perform both of the first two tasks no matter what tools are used [5, 6].

PrintTalk is an open XML standard to communicate business information used in the Graphic Arts industry. It provides a single format for Print Providers to collaboratively communicate Business Transactions (request for quotation, quotation, order, invoice, etc) and specifications of Print Product both with their Print Buyers and among themselves [7].

The following figure shows the business transactions carried out for subcontracting the binding process to an external company. JDF and PrintTalk facilitate quoting and ordering of print jobs via e-Business applications.

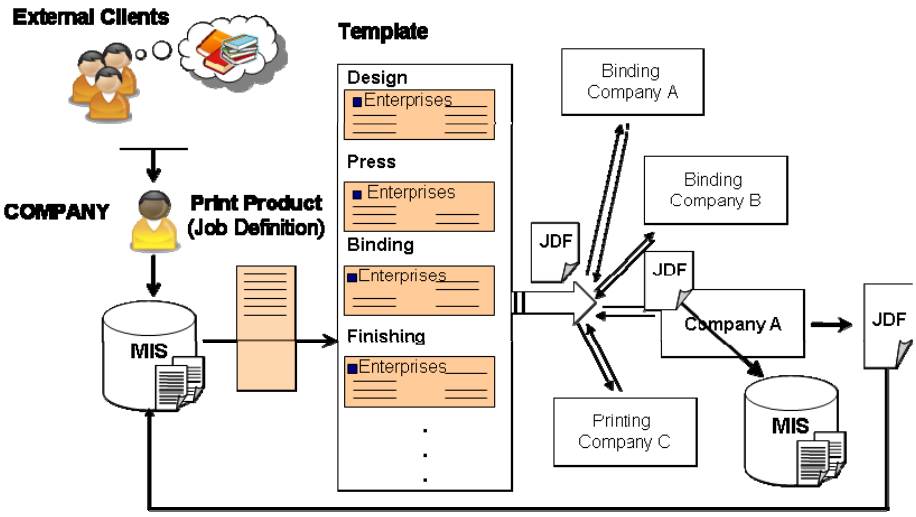

Figure 3Quotation request process

The e-Business platform used for collaboration allows automatic communication between printing companies as well as integration of production services with MIS system in order to avoid or minimize manual procedures to process the job results or to track the job status and information. This platform is the result of the research carried out in the project e-JDFB2B (http://www.in2ca.com/ejdfb2b/ejdfb2b1.asp) that was supported by the Spanish Ministry of Industry, Tourism and Trade.

4 BPM - SOA strategy

The business model follows a BPM-SOA strategy which is based on three pillars: the business messages exchanged among the actors involved in the scenario, internal processes that are executed when one of these messages is received and external services provided by third-party organisations.

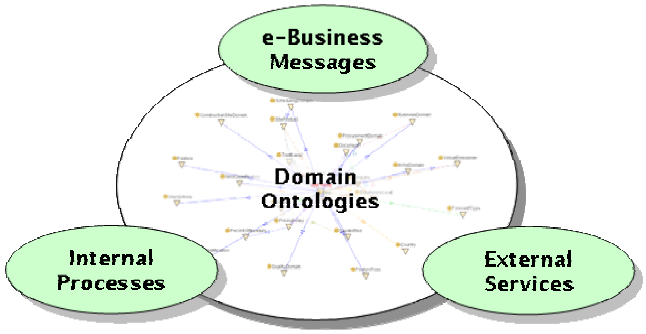

Figure 4 Mixed SOA – BPM business model

Business messages are exchanged between the different actors:

- To notify design changes
- To notify site incidents.
- To provide feedback about the notifications
- To request for quotation for certain process of a print job
- To notify changes in a JDF document

When one of these messages is received, the next step is to define what to do depending on the message and actor and which internal business process (modelled as a BPEL process) needs to be loaded and executed.

The internal process will use both external services and integration services (access to back-end systems) to retrieve the information.

4.1 Services Approach

In the execution of a business process, companies have to make decisions based on information about the process or about partners. Questions come up that have to be answered during the business process: which are the best candidates for a specific task or process of a print job? Do we trust this new partner? Which are the best quotations received for a task or print job? What suppliers are affected by a specific event and how?

To answer these questions, the SME has to consult information previously processed and locally stored by the own SME, ***integration services***, or offered by external organizations, ***external services***. Depending on the type of external organization (association, cluster, public administration, chamber of commerce, consultancy firm) the exploitation model can differ: free access to services, membership fee or fee paid per service and per time the company uses the service.

Both integration and external services have been implemented as Semantic Web services using SAWSDL technology [11, 12]. As Web Services standards did not allow to specify the semantic meaning of the data, specific agreements had to be reached between the provider and the consumer of the Web service. Semantic Web services have been implemented to solve these problems by providing an extension layer that enriches the syntactic information with semantic meaning. They augment Web Service descriptions with annotations, in order to support greater automation in service discovery, selection and invocation, automated translation of message content between heterogeneous interoperating services, service composition and monitoring.

4.2 BPM: Choreography and Orchestration

Above scenarios have been deployed in a service oriented collaboration platform which allows the:

- Definition and execution of choreography processes between enterprises,
- Definition and execution of internal business processes (Orchestration)
- Interaction between business processes and humans
- Semantic integration of back-end services.

- Semantic integration of external services

From the Business Process Management (BPM) perspective, orchestration defines executable processes within a company to respond to an external or internal event. The process can include calling to services, human interaction and some logic (business rules). On the other hand, choreography provides a description of a Multi-party Business Collaboration.

In order to implement the business model, the technical solution depicted in Figure 5 was defined. In this architecture choreography was modelled as ebXML [8, 9] processes whereas internal business processes were modelled using BPEL standard [10]. The integration with back-end applications and external services was solved using a SOA approach based on web services and semantic web services (SAWSDL specification). Finally, to provide interaction between business processes and humans an ad-hoc solution was built as available standards were still under development.

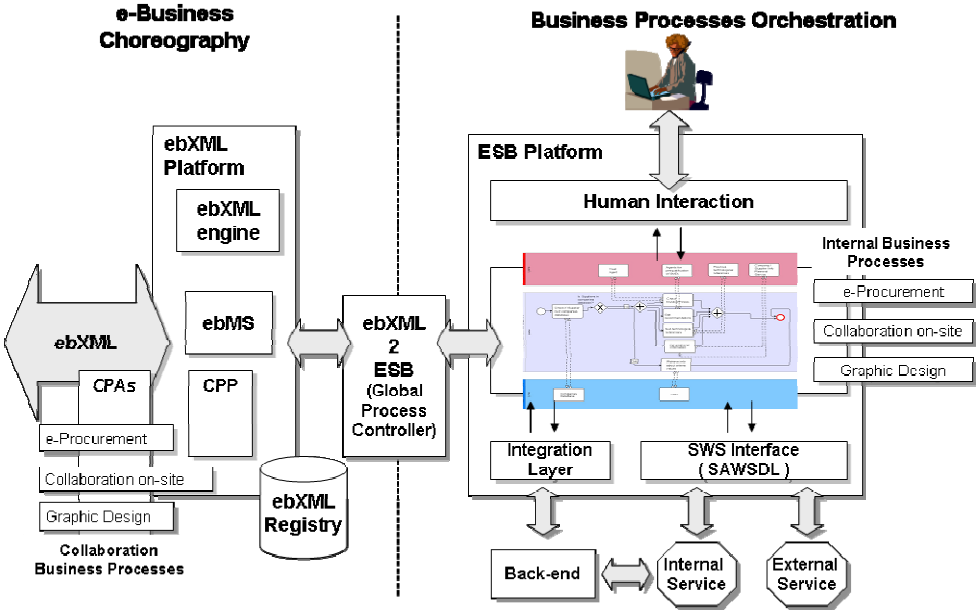

Figure 5 Service and Collaboration Platform Architecture

6 Conclusions and Future Work

Conclusions extracted from the validation of the showcases with the end users showed that in both domains, Construction and Graphic Arts industry, e-Business based collaboration can provide significant benefits.

In the Graphic Arts industry, electronic collaboration facilitates cooperation of different partners like printers and prepress service providers; it can reduce setup times of expensive equipment significantly; it can reduce errors derived from manual job updates that are not correctly communicated to MIS system or to affected partners.

In the Construction industry, electronic on-site collaboration can improve response time to unexpected events; it ensures the communication to all affected partners and facilitates the event resolution process.

From the technical point of view, one of the main conclusions from the scenarios described is that when we speak about B2B Multi-party Collaboration, a SOA approach is not enough. Both external and internal business processes need to be defined and deployed.

Another important conclusion drawn is that SOA and BPM tools are very complicated to deploy and maintain, especially for SMEs. However some other tools, like email can be used to provide simple messaging functionality needed by SOA systems.

Finally, domain standards like JDF are vital to provide a common language to exchange product design information among B2B partners. Ontologies can be used when those "global standards" do not exist in order to provide semantic interoperability, but semantic web service technology is still too immature to be used in real business scenarios.

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