openXchange Reference Architecture for Automated Business Process Integration

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Abstract

This paper explains the reference architecture developed within the EC funded project openXchange. The main issue is to facilitate an environment which allows the integration of business processes without manual customisation of company ICT systems. Thereby cross company collaboration can be improved and business relationships can be made more flexible. Following the raising ebusiness framework standard ebXML the concept is being proved by the implementation of different instances of the reference at various pilot sites. The proposed architecture supports the whole process of accomplishing automatically executed business processes. As pilot domains the business areas temporary staffing and electronic catalogue buying have been identified at the first place. The architecture is component based in order to assure scalability and to provide easy adoption for further use cases.

Keywords

Business process Integration, ebXML, reference architecture, cross company collaboration, interoperability

1 Introduction

The internet enables organisations to easily exchange data, but more important the internet offers a technology to improve inter-organisational processes. In order to provide organisations with efficient electronic connectedness, a smooth integration into existing business applications is necessary. With the pervasiveness of the internet and XML the ebXML (e-business XML) initiative promises to provide a basis for flexible process and data interoperability among businesses.

The openXchange reference architecture intends to smoothen inter-organisational processes. The work is realised by a European consortium within the research project openXchange funded by the European Commission (IST-2000-28548). With regard to its implementation the openXchange concept is focusing on the ebXML initiative and the application of existing standards as far as available.

In order to show proof of the developed concepts of openXchange as well as of ebXML various pilot implementations of the reference architecture are established.

2 Existing business process integration approaches

E-business activities mainly aim on realising cost reduction and efficiency effects. Information systems of different organisations and companies need to be connected in order to reduce business process lead times, the failure frequency when processing external information, and the number of communication channels. In former times companies used Electronic Data Interchange (EDI) to achieve these goals.
2.1 Standards and integration

Unfortunately EDI applications turned out to be very complex and expensive and not flexible enough to cope with business relationships that change frequently [Stefansson 2002]. However internet-based standards promise to solve this issue.

In the field of inter-organisational business process integration the two areas of standardisation, document and business process standards can be identified. Within a procurement process, for example, purchase orders, order acknowledgements etc. are exchanged between a buying and a supplying party. Examples for document standards are xCBL, cXML, RosettaNet Partner Interface Processes (PIPs), and openTRANS [Frank 2001; Kelkar, Otto 2002]. Besides document standards, there are business process frameworks that define the overlying business process. Some of them emphasise the organisational aspect of a business process (e.g. UDDI) while others are clearly process oriented (BizTalk, eCo, and ebXML).

ebXML is the most comprehensive business process framework since it does not only cover multiple layers of the communication and information interchange stack but also provides mechanisms for the automation of the integration process itself. Therefore, the openXchange architecture is mainly based on ebXML specifications. The elaborated definitions are available at the ebXML web site [ebXML 2003].

2.2 ebXML framework for process oriented integration

ebXML is a framework standard for the electronic exchange of company data and messages needed for business transactions [Kotok, Webber 2001]. It is not limited to a certain industry since it is positioned as a framework, not as a fixed package. An advantage of a framework is that certain parts can be individually chosen according to the specific needs of a company or consortium. The definition of actual message or document standards is left to the individual organisations or industry associations.

Four activities before business transactions can take place are identified and supported by ebXML:

1. Standardisation of messaging and processes
2. Recording of company profiles
3. Arranging an e-business agreement
4. Run-time of e-business processes

However, ebXML also provides input for the implementation of business processes in ICT-systems, but this aspect is not described in closer detail since this idea would impede an automated integration of the processes.

The operational processes for doing e-business and for the exchange of messages within this processes are expected to be modelled in UML and translated into XML by using the so-called core components. These are basic, context-free elements of the messages unlike the operational business processes that can be context-specific. The outcome are business processes modelled against the Business Process Specification Schema (BPSS).

In addition, individual companies have to define their ICT-capabilities by means of a profile (Collaboration Partner Profile, CPP) which contains information about the technical way they are able to do electronic business.

Two CPPs of potential collaborative partners are matched and stored in a collective agreement (Collaboration Partner Agreement, CPA). The agreement defines the way in which two (or more) companies actually will perform e-business transactions as a two-party (or multi-party) collaboration. For the run-time environment ebXML offers facilities like an envelope to exchange messages based on the Simple Object Access Protocol (SOAP).
3 The openXchange approach

The openXchange reference architecture aims on the development of software applications that support the automation of the integration and execution of inter-organisational business processes by applying ebXML defined principles. In pilot user sites the applications will be implemented and evaluated.

![openXchange Reference Architecture](image)

Figure 1 openXchange Reference Architecture

The openXchange approach is twofold. On the one hand the openXchange provides an architecture to conduct e-business processes automatically, and on the other hand, openXchange specifies business process components for certain industries. In order to accomplish the development task, the openXchange reference architecture is split, in accordance with ebXML, into the four phases

- Modelling Time,
- Profiling Time,
- Agreement Time,
- Transaction Time.

The architecture provides a meta process giving a guideline on how a company can make itself ready for automated execution of business processes. On the level of the single phases the relevant tools and components are specified which are to be instantiated when implementing the components [openXchange 2002a].

In order to show proof of the concept of the reference architecture and thereby also of ebXML, various pilot sites are being identified and realized by the project. Each pilot focuses on different issues of the overall principle since not all components of the architecture need to be implemented to achieve a functional prototype. The pilots are realised for different business domains and branches. For the domains reference processes are specified using the UN/CEFACT modelling methodology (UMM) for a standardised description of business processes [UN/CEFACT 2003].

The addressed business domains are temporary staffing and electronic catalogue buying. These were chosen as a consequence of the acquired user requirements [openXchange 2002b]. As business branches were selected the domains of electrical supply distribution, building and construction, and the temporary staffing sector, too. The specific aspects of the pilots are discussed later in this paper.

In the context of openXchange a network of expertise has been set up for interested people and organisations who can register on the project web site [openXchange 2003]. Within the network detailed technical project information is available. The members of the network are also involved in a feedback process in order to assure the relevance and correctness of the project developments.

In addition to the technical developments openXchange is closely related with the relevant standardisation organisations (UN/CEFACT, CEN) by participating in committees and by providing feedback about the applicability of the specifications.
3.1 The openXchange Modelling Time

The Modelling Time specifies the business processes for a certain industry or domain (cf. Figure 2). OpenXchange specifies sector specific sets of business process components. One sector, for example, is electronic catalogue buying.

![Diagram of Modelling Time](Figure 2 openXchange Modelling Time)

The sets of business processes are identified and specified within the user requirements analysis of the openXchange project. The input for the Modelling Time is graphical, formal, or verbal information about business processes of certain industries or domains.

For the Modelling Time a business process modelling tool is applied. The tool is required to be able to handle UML activity diagrams and export these into XML-based business process specification complying with the XML-Schema (BPSS) for business processes provided by ebXML.

3.2 The openXchange Profiling Time

The main objective of the Profiling Time is the creation of a technical and business related profile of a business partner (cf. Figure 3). The result of the Profiling Time is a machine-readable partner profile that contains the following types of information:

1. Technical information about the interfaces and transport protocols the partner uses defined in an ebXML CPP.
2. Business process information stored in an ‘enhanced’ ebXML BPSS.

The aim is the creation of XML documents that are in accordance with the partner profile. The system is equipped with a graphical user interface to model the specific process using predefined process components.
Since there are already tools available which support parts of ebXML openXchange focuses here on the meta level of the architecture. The goal is to create CPPs and BPSS for the involved companies complying with the definitions and specifications and to provide the following phases with the relevant documents.

3.3 The openXchange Agreement Time

The objective of the Agreement Time is to match the profiles of two business partners and to create an agreement document that describes the common business process and the circumstances under that the process can be executed (cf. Figure 4).
The results of the Agreement Time are an ebXML CPA and a common ‘enhanced’ ebXML BPSS. In case the two profiles do not allow a successful matching, a log file is produced that contains information about matching details, e.g. statements such as ‘transport protocol incompatible’. The Agreement Time architecture consists of three main openXchange components, which are:

1. MergeValidator & Matchmaker
2. Evaluator & Negotiator
3. CPA Generator

These are supported by three components which are intended to assure document quality and conformity to ebXML specifications and schemata.

Creating matches between two CPPs and the related BPSS requires a good understanding of the ebXML specifications. The components need to be able to read the necessary information within the XML files and to extract the required corresponding content. For example, a company will play a determined role in a business process. Provided that, it can take over the "buyer" role which is requesting a "seller". This information is contained in the available documents. In that case the component needs to be able to interpret the "Role"-tag and to conclude the required corresponding tag. While dealing with ebXML the extraction and the interpretation of matching rules is one of the most complex aspects. The available documentation provide basic guidelines about how to derive the relevant information.

After an agreement successfully has been created the information systems of both partners refer to that agreement during transaction time. In case the matching process was not successful the log file helps to identify the gaps between the two affected companies and by this means allows strongly reduced customisation and implementation times.

3.4 The openXchange Transaction Time

During Transaction Time the actual business is carried out. A triggering event causes the instantiation of a certain business process. Business documents are then exchanged according to the business process specified in the CPA.

![Diagram of openXchange Transaction Time](Source: openXchange 2002a)

Figure 5 openXchange Transaction Time
The Transaction Time architecture consists of six main components (cf. Figure 5):

1. 'Business Document Service' to validate single documents against specified restrictions
2. 'Business Process Service' to log and control the process execution
3. 'Messaging Service' to send and receive openXchange compliant messages
4. 'Cartridge Service' to provide the connection to existing information systems (e.g. ERP systems)
5. 'Specification Access Services' to provide access to the relevant XML documents
6. 'Administration Service' to allow administration of the environment

The different services are intended to be generic in the first place. Since the specific requirements of business domains differ quite strongly it is indicated to also have semi-generic and specific components which allow coming over these deviances and to already implement pilot applications. For example the cartridge service will have to be specific to the addressed pilot company since the back end systems are at present not equipped for handling generic interfaces.

The optional components and services are necessary for a comfortable handling of the whole environment but are not critical to the basic functionality. They will be implemented at a later stage of the developments.

At the point of execution of a process instance the starting event is triggered from outside by a normal business process. An event can be activated by a company back end system as well as by the user himself. The event itself is not part of the openXchange architecture.

4 Pilot implementation

The developments made here are implemented as instances of the reference architecture at the pilot sites. Table 1 shows the main aspects realised at the specific sites.

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<thead>
<tr>
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<th>Modelling Time</th>
<th>Profiling Time</th>
<th>Agreement Time</th>
<th>Transaction Time</th>
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<tbody>
<tr>
<td>Electrical Supply Distribution</td>
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<td>Temporary Staffing</td>
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<td>Complex Catalogue Buying</td>
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Legend: ?: fully applied, ? partly applied, ? not applied

Table 1 Pilot applications

In the electrical supply domain two pilots are addressed focussing on different aspects of the domain. At one site the handling of processes by small enterprises which do not have complex back end systems available is addressed. The other focuses on the integration with a SAP R/3 implementation which is already involved in complex electronic business applications. The applied document standard for the electronic exchange is openTRANS.

The other pilots are mainly emphasising the business process modelling aspect of the architecture. The goal is to establish reference models which are supposed to be applicable for the whole business domain. In these domains business process modelling following UMM was accomplished with the goal to create reference processes which can be used in others implementations in the same domain. The models are available through the openXchange network of expertise.
5 Conclusion

The openXchange project addresses the integration of business processes and underlying systems. Current e-business activities often fail to provide reasonable implementation times and costs. The openXchange architecture allows the automation of the integration process. This can be achieved by providing not only a solution for the transaction time but also for the preceding phases (modelling, profiling and agreement time). The openXchange architecture is based on the utilisation of business standards such as ebXML or openTRANS.

Since ebXML is still under development the acceptance has not yet achieved a satisfactory status. By the ongoing efforts in showing proof of the concept and implementing pilot environments the awareness and acceptance is supposed to be improved. Additionally the development of the standard has to be carried forward.

Continuous work on analysis, modelling and standardisation is necessary in order to meet the requirements of business processes in various other business areas for a later automated execution. This will also help to create broader acceptance.

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