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A Peer-To-Peer system to perform e-procurement transactions with UBL

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Abstract

Typical e-procurement applications rely on centralized architectures such as e-marketplaces or standalone. In both cases, business information is stored and managed by private companies, implying a permanent presence of third parties in every step. A P2P network offers a different approach to a B2B system, because it deploys cooperative networks where participants can interact directly, with no need of external third-parties. Searching for products, a regular task in all e-procurement systems, can also be easily executed and improved in a P2P environment. An e-catalog management system on top of a P2P overlay network is introduced, using UBL as business language. Supplier-peers create and manage UBL e-catalogs which are stored in dedicated server-peers. Customer-peers perform complex searches for products with XQuery, sending queries to the e-catalog servers. Once the right supplier is found, the customer can initiate e-commerce transactions like purchase orders with the supplier. Security concerns are also discussed, using a customized protocol to implement digital encryption and certification.

Key words: P2P, UBL, e-commerce

1 Introduction

E-procurement is commonly accepted as the B2B (Business-To-Business) purchase and sale of supplies and services over the Internet, and it can be considered as the second step in the basic B2B transaction sequence (e-sourcing, e-procurement, e-invoicing and e-payment). E-procurement solutions rely on centralized systems managed by another company, and collaboration between trading partners is done through a third party [1]. Decentralizing B2B interactions would enable direct and full collaboration between partners, with no need of third parties. To reach this objective, peer-to-peer computing applied to B2B can be a powerful business model, because it enables companies to exchange data directly in a decentralized architecture [2]. Our aim is to develop an e-procurement application based on a P2P (peer-to-peer) basis which enables complex searching for products and e-commerce transactions in a well-known language.

1.1 P2P + B2B = PB2B

A P2P network is a distributed computing model that enables decentralized collaboration by integrating devices (known as peers) into subnetworks in which each peer can offer and consume services [3]. Traditionally, P2P paradigm has been associated to file sharing networks, but its use has recently been extended to new applications, for instance voIP and gaming platforms. P2P has been also identified as a business model itself [4], offering a new vision of convergence between B2B and decentralization: no intermediaries, just stakeholders controlling their own business processes. Hence, PB2B is defined as the technology that enables companies to share information and execute business transactions through direct connections instead of centralized hubs [5].

Using a PB2B-based system provides with several advantages [2]: extremely high scalability, massive storage and process capacity, self-administration, service availability and data redundancy. Furthermore, all peers in a P2P network may be equal in rights and duties, although priorities are also allowed, enabling a highly adaptive topology that fulfills every possible business scenario. However, there are open issues not fully resolved yet, like security and network instability [6]. Security uncertainties may be reasonably fixed with distributed public key infrastructures (PKIs) and webs of trust [7].

1.2 UBL

The UBL (Universal Business Language) effort was initially part of the ebXML (E-business XML) framework, but soon it was discarded and it grew as a separate but complementary standard, defining only the business document semantics in XML. It is sponsored by OASIS and based on the older xCBL (XML Common Business Library) standard, which was an evolution of EDI towards XML [8]. Its latest version, v2.0, defines XML schemas for 31 business documents, including catalogs, purchase orders, invoices and quotations among others [9].

Traditionally, there has always been a large amount of e-commerce standards in use, most of them oriented to specific vertical markets. Nevertheless, nowadays we find a progressive narrowing for alternatives: EDI is being replaced by new XML technologies; xCBL and cXML are obsolete and discontinued; RosettaNet is still bound to the semiconductor sector. Thus, UBL is rising as a succesful all-purpose language, not only for e-commerce applications all around the world but for B2G (Business-To-Government) as proven in Europe. Countries like Denmark, Sweden or Spain have implemented or recommended e-invoices based on UBL semantics, while UK has started an UBL full-compliant e-market [10].

1.3 Related work

PB2B is a relatively new concept and, therefore, there are only a few research sources about it. TradingNetwork project outlined an initial design of a P2P e-market with an autonomous decision scheme [11]. Venezia-Gondola project lists possible services to be offered by a PB2B application, but no real implementation has been documented yet [12]. ComercioP2P is the first successful implementation of a PB2B e-procurement system, allowing customer-peers to explore e-catalogs stored in supplier-peers and to make cXML transactions like purchase orders, catalog listing or supplier data [13]. LAURA consists of a framework to implement on-demand virtual organizations (like SMEs), and its implementation uses OAGIS as message payload and ebMS as transport protocol [14]. Semphonia is an e-market based on intelligent agents over a P2P overlay network, which enables auctions and semantic searching [15]. CatalogoP2P is a SOAP based alternative to ComercioP2P, where seller-peers can publish their products in databases stored in dedicated peers; buyer-peers can perform complex product searches to find the best supplier, and initiate cXML transactions with them [16]. All known implementations (LAURA, ComercioP2P and CatalogoP2P) use JXTA as P2P platform.

To the best of our knowledge, our previous work CatalogoP2P is the most complete implementation of a PB2B system nowadays. For this reason, our research takes it as the starting point, but improving it with the adoption of the promising UBL instead of the obsolete cXML and adding new and critical features like security.

2 Research

2.1 System overview

A simple e-procurement application has been developed on top of a P2P overlay network. Each participant is mapped into a single peer with a role as defined in section 2.2, although complex organisations can also be mapped into different peers at once. The architecture consists of a group of e-catalog servers which enable decentralized product searches within the P2P network. Searches are a mix of parametric and keyword types. Once a product is found, e-commerce transactions are executed in a decentralized way too.

The system implementation are divided into three layers:

1. P2P layer: it manages all the P2P communication requirements, including peer group membership, peer discovery across the network and basic messaging. JXTA framework has been used to implement it.

2. E-catalog layer: it manages all the information about products, and it enables searches within e-catalogs and over the P2P network. UBL has been chosen as the standard format to describe the catalogs and Xquery to perform complex searches within the catalogs. Xquery is a powerful language designed to query collections of XML data, similar to SQL in databases.

3. E-commerce layer: it processes e-commerce information flow such as purchase orders over a P2P network. UBL has been selected as e-commerce protocol because of its simplicity and wide spreading.

All the messaging flow between layers is fully transparent to the human user, who only sees a “product search” screen with prices and available sellers, for instance.

2.2 Roles

Based on the catalog and commerce layers behaviour, there are four possible roles in our proposed system:

1. E-catalog server: a peer that stores e-catalog files in UBL. It receives XQuery requests from clients to search for products inside the UBL catalogs, sending back the results. Each server owns a different set of e-catalogs.

2. E-catalog client: a peer who owns a catalog stored in a server and performs remote operations on it, such updating, uploading or deleting.

3. E-commerce server: a peer who publishes products in e-catalogs and accepts cXML transactions.

4. E-commerce client: a peer that searches for products in the e-catalogs held by the servers, and performs UBL transactions (typically purchase orders) with the e-commerce server which offers the product.

P2P networks allows and encourages peers to behave as clients and servers simultaneously, hence a single peer is able to assume two or more roles at the same time. In most cases, for instance, an e-catalog client and an e-commerce server are mapped into a single peer at once.

2.3 System behaviour

We will describe the basic message exchange, and therefore the system behaviour, with the scenario depicted in Fig. 1. There are three peers involved: “A” acting as a single e-catalog server, “B” as an e-catalog client and e-commerce server at the same time, “C” as an e-commerce client. “B” wants to register a new catalog in “A”, while “C” is searching and trying to buy a product stored in the catalog.

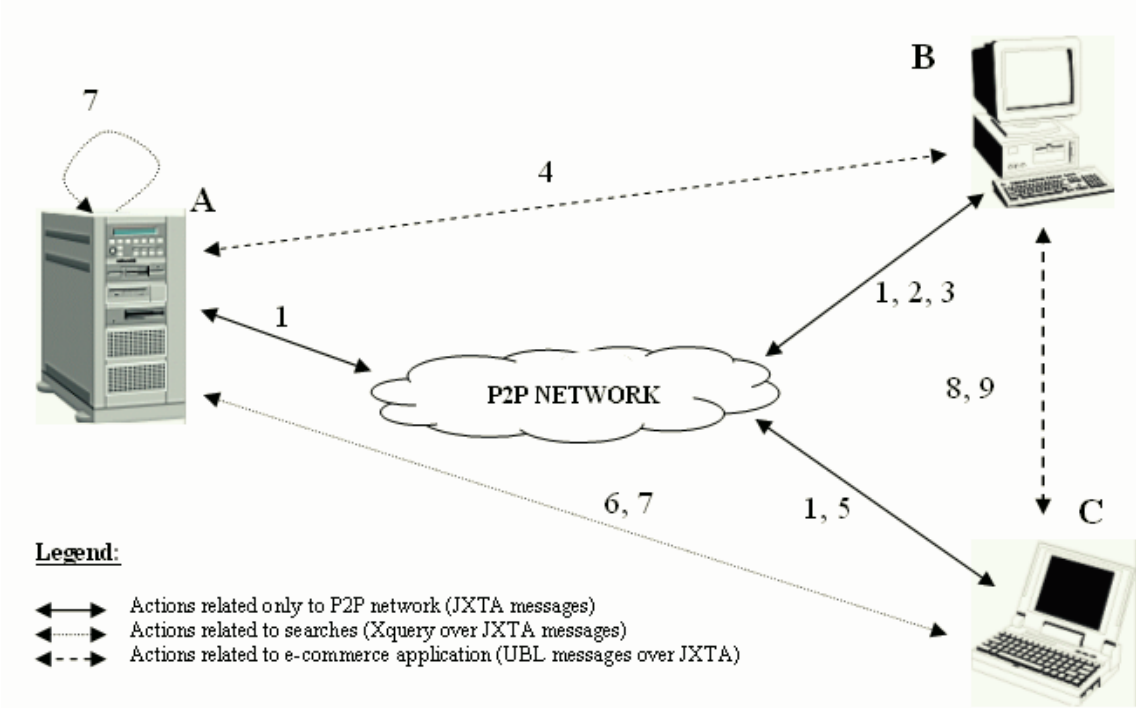

Figure 1: Basic messaging interaction within P2P network in the e-catalog system

According to the figure, the message choreography follows this sequence:

1. Each peer ("A", "B", and "C") joins the P2P network. "A" identifies itself as an available catalog server.

2. "B" as e-catalog client wants to register a catalog with a product named "Acme", so it asks the P2P network which catalog servers are connected and available.

3. The P2P network replies with a JXTA message containing the desired list. "A" is included in the returned list.

4. "B" as client sends to "A" the UBL Catalog through a JXTA message. "A" stores it locally.

5. "C" wants to purchase a lot of 100 "Acme" units. Firstly it searches for e-catalog servers, as seen on 2 and 3. "A" is included in the returned list.

6. "C" makes a XQuery with filtering parameters and sends it to the catalog servers through a JXTA message.

7. Each catalog server performs the product search within their stored e-catalogs according to the query. "A" replies to "C" with the results of the Xquery, which includes "B" as the seller of "Acme".

8. "C" knows now that "B" has available the product "Acme", so it sends an UBL purchase Order to "B" wrapped in a JXTA message.

9. "B" as e-commerce server receives and processes the Purchase Order. If OK, it sends a Order Response reply to "C".

2.4 Security aspects

Due to the nature of the information exchanged in e-commerce transactions, procurement systems are always exposed to different kinds of attacks or critical failures that may cause severe economic losses to buyers, sellers and financial institutions. A secure e-commerce system should guarantee at least these four issues:

1. Data confidentiality: private data should be out of reach to anyone but the trading partner.

2. Authentication: to avoid identity supplanting, partners should be sure who the other is.

3. Non-repudiation: the integrity and origin of data should be ensured.

4. Protection against denial of service: if the system fails and cannot perform transactions, the seller may lose customers and reputation.

To fully achieve these requirements, we have implemented the following customized protocol using JXTA Security Libraries:

1. Peer "A" sends a message to "B"; this message is encoded with the public key of "B" and it is signed by "A". A symmetric key is stored in it.

2. Peer "B" decodes the message with its private key and extracts the symmetric key. It acknowledges with a message encrypted with the symmetric key and signed by "B".

3. Hereafter, every message should be encoded with the symmetric key and signed by the sender.

Message encryption ensures data confidentiality, but using this hybrid solution between symmetric and asymmetric keys involves another two advantages: less resources are required (because symmetric keys are always faster than asymmetric ones) and security is improved. The use of digital signatures addresses the authentication and non-repudiation issues. Finally, denials of service attacks are quite difficult to avoid, but they are minimized setting a maximum number of connections per peer and a maximum UBL message length.

3 Conclusions

The system described forsakes the centralized approach of traditional e-procurement systems, exploring decentralized collaboration between trading partners. The PB2B model perfectly suits e-procurement requirements, specially product searches, which may be performed through a vast and changing network. Instead of a single centralized e-catalog server, our system allows multiple and independent servers to join and exit the network dinamically. There is a reasonable degree of centralization, because of the searching optimization: queries are sent only to e-catalog servers to avoid flooding the network with unnecessary messages. Our implementation lies on widespread technologies which increase compatibility and reduce adoption costs, such as UBL, XQuery and JXTA. Our layered architecture prevents our system from being obsolete: if UBL is no longer accepted, it is easy to substitute the e-commerce layer for a new one compatible with a new e-commerce standard. Although planned to work in a B2B scenario, our application could be easily translated into a B2C (Business-To-Consumer) environment.

Future work includes exploiting more PB2B capabilities, such as decentralization and collaboration. Our aim is to establish a fully decentralized e-catalog database, with thousand of peers acting as servers, sharing and synchronizing the same information in order to manage updated catalogs. To improve security, a digital certificate system will be added to ensure trust among partners. A web-of-trust mechanism would also fit perfectly the PB2B conceptual model, because trust between peers may spread across the whole network with no external (and thus centralized) certification authority needed.

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