Chapter 32
Towards Supporting Interoperability in e-Invoicing Based on Semantic Web Technologies

José Manuel Gómez-Pérez
Intelligent Software Components (iSOCO) S.A., Spain

Víctor Méndez
Intelligent Software Components (iSOCO) S.A., Spain

ABSTRACT
Since the use of electronic invoicing in business transactions was approved by the EU back in 2002, its application in Europe has grown considerably. However, despite the existence of standards like EDIFACT or UBL, widespread take up of electronic invoicing has been hindered by the enormous heterogeneity of proprietary solutions. In this chapter, the authors present an approach towards addressing the interoperability problem in electronic invoice exchange, based on ontologies and Semantic Web technologies. The authors propose methods and provide usable tools that leverage the knowledge of users of electronic invoicing systems by empowering them to define correspondences between sample electronic invoice data and a formal model of electronic invoicing represented as networked ontologies. The chapter follows a learn-by-example approach where, based on such correspondences, networked ontologies serve as a semantic hub for large-scale transformation of e-invoice data between heterogeneous e-invoicing formats and models. The approach has been evaluated through the development of a reference implementation and its deployment in the pharmaceutical sector.

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INTRODUCTION

Since the new EU legislation on electronic invoicing\(^1\) was approved in 2002 and implemented by member countries in 2004, it is possible to send and receive e-invoices electronically in business transactions, provided that a digital signature is included. The potential savings are enormous, assuming that appropriate technological solutions exist. For example, within the context of the Single Euro Payment Area\(^2\) (SEPA) alone, the overall savings of applying e-invoicing at the European level are estimated at around 64.5 billion Euro per year for businesses.

According to studies like (Grandon and Pearson, 2004) and (Fillis et al. 2004), investments in electronic invoicing have been done mainly by large organizations expecting to save costs by reducing the amount of paper used and postage costs, the amount of human effort required in the e-invoicing process, and the error rates and payment times. In parts of Europe such expectations have led to a proliferation of proprietary software products by vendors like SAP and ORACLE providing e-invoicing solutions. However, almost all current solutions are standalone applications, each with their own model of an electronic invoice and their interpretation of the standards, and are therefore hard to interoperate. Consequently, many industries suffer from migrating legacy systems to the formats required by the current e-invoicing solutions. This is obviously an entry barrier, especially for small and medium enterprises; large companies suffer less because they can ‘force’ their providers to comply with a particular format, or else they are out of business.

Taking into account that a middle-sized organization processes around 100,000 e-invoices per year, the potential benefits for them are also high. However, the risks are equally considerable given the size of the investment required on one hand side and the consequent vendor lock-in on the other hand. It is obvious that technologies with the potential to reduce the cost of migrating from one format to another and to interoperate between them are extremely attractive. This is especially true for middle-sized companies, who otherwise are bound to lag behind big players in the adoption of e-invoicing technologies, as evidenced by studies like (Al Quiirim, 2003) and previously by others like (Iacovou et al. 1995) for the more general case of e-business.

Throughout industry, there is a large duplication of effort towards e-invoice exchange that could be significantly reduced if companies in the same sectors were willing to share models and infrastructure; a pre-condition which is made more complex by the competitive environments where they operate. The main limitations to this kind of approaches include the following.

1. **High investment is required** (acquisition and maintenance) for industrial stakeholders to set up their own business IT infrastructure;
2. **Difficulty in setting up business partnerships due to high IT integration costs**; this requires integration and communication across heterogeneous infrastructures, with additional investments to be made as each new partner joins such partnership. In practice, this implies the development of ad-hoc transformation software between each pair of e-invoice formats and models potentially participating in economic transactions, which is time-consuming, expensive, and cumbersome.
3. **Scarce reuse of e-invoice models**: Lack of opportunities to benefit from the fact that business partners of companies in a same sector are often shared and their e-invoice models could be common.

The overall scenario provides an opportunity for building applications that support (especially, but not only) middle-sized companies to develop a joint effort for improving their participation in new technologies. In our case, the application of Semantic Web technologies particularly allows...
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