Information and Knowledge; Communication

Patterns in Standards and Technologies for Economic Information Systems Interoperability

Vasile Irimia[1]

Abstract: This paper presets results from a review of the current standards used for collaboration between economic information systems, including web services and service oriented architecture, EDI, ebXML framework, RosettaNet framework, cXML, xCBL UBL, BPMN, BPEL, WS-CDL, ASN.1, and others. Standards have a key role in promoting economic information system interoperability, and thus enable collaboration. Analyzing the current standards, technologies and applications used for economic information systems interoperability has revealed a common pattern that runs through all of them. From this pattern we construct a basic model of interoperability around which we relate and judge all standards, technologies and applications for economic information systems interoperability.

Keywords: patterns; economic information system; standards; EDI; ebXML; RosettaNet; Web Services; enterprise interoperability; model of interoperability; collaboration; communication;

JEL Classification: D83; D85; M15; O14; O31; O33

1. Introduction

The current technological environment is characterized by heterogeneous hardware and software. The result is a set of components that cannot communicate and cannot collaborate. Today, there are many incompatible competing standards enabling enterprise collaboration. Questions remain about the utility of these standards and applications.

There are many books and articles discussing the various standards, applications and technologies discussed here, from various perspectives. To this moment I have no knowledge of one research that attempts a review of all major standards, technologies and applications for economic information systems interoperability. However there is some related work done on enterprise interoperability, one particularly important being the interoperability framework. (Man-Sze Li et al, 2006) and (Charalabidis et al, 2008) define the field of enterprise interoperability, the challenges we currently face, a brief state of the art in the field and proposes the

[1] PhD Student, Al. I. Cuza University, Doctoral School of Economics, Romania, Address: 11 Carol I Blvd, 700506, Iasi, Romania, Tel.:+40 (232) 201000, Fax:+40 (232) 201201, Corresponding author: irimia.vasile@gmail.com.

research directions. One such direction, analyzing the current solutions for enterprise interoperability, has inspired this research. (Ullberg et al, 2009) presents a model of the current enterprise interoperability challenges. (Ameedeen et al, 2011) presents a model for interoperability via model driven development. The Athena Interoperability Framework (ATHENA Framework, 2011) is the most advanced work in the field, addressing the problem of interoperability in a holistic way, from different perspectives, including the research elements and the solutions to interoperability issues. Our research, while aware of the broader field, is more focused, dealing with the standards, technologies and applications for economic information systems interoperability.

This paper is structured in the following way: chapter II introduces the concepts used; chapter III sets the foundation of collaboration in communication theory; chapter IV, Standards categories, presents our model for interoperability and we end with conclusions.

2. Concepts

Standard provide the rules necessary for these diverse components, created by different independent vendors, to collaborate. In order for two independent economic information systems to collaborate to achieve a certain goal, they must communicate. Interoperability between two economic information systems is achieved through communication. As such, some concepts from communication theory are used in this paper.

Analyzing the current standards, technologies and applications used for enterprise interoperability has revealed a common pattern that runs through all of them. From this pattern we construct a basic model around which we relate and judge all standards, technologies and applications for economic information systems interoperability.

But before we begin, to reduce uncertainty and increase precision, the following conceptual delimitations must be made.

Standards have a key role in promoting economic information system interoperability, and thus enable collaboration. Standards are agreements between independent individuals or organizations to conform to a set of principles and norms. Standards facilitate collaboration, increase efficiency, reduce costs, reduce complexity, and enable data and information sharing. According to Eric Chiu, a standard is an effort to promote large scale utilization of protocols and formats the enable applications developed by different software vendors to interoperate (Chiu, 2002, p. 14).

According to Oprea D., "an economic information system is an assembly of human resources and capital, invested in a economic unit, with the purpose of collecting and processing the data needed to produce information that will be used at all decision levels of management and control of the organizations activities." (Oprea, 2005, p. 23).

Although enterprises, as part the national and international economic systems, are interdependent, their economic information system is independent in the sense that it can exercise its functions autonomously, without depending on someone from outside.

Enterprise Interoperability is a relatively new term for a new domain of activity that aims to improve the way in which enterprises, with the help of Information and Communication Technology, interoperate with other enterprises, organizations or other business units within the same enterprise, to achieve its goals. The Interoperability is defined by the IEEE as the common execution of a task by two or more different systems. (Irimia, 2011)

The economic information systems interoperability deals with the way in which two independent economic systems communicate, cooperate and collaborate to achieve a certain goal. Economic information system interoperability can be seen as the easy connection and communication between two different enterprise information systems, within a network of suppliers and business partners, with the help of the new information technologies. (Irimia, 2011)

A language is a system of communication. A symbol is a distinctive sign, object, image that represents indirectly an object, a being, a notion, idea, characteristic, feeling, etc (DEX, 1998). A word is the basic element of a vocabulary and represents the associations between a meaning or a complex of meanings and sound complex (DEX, 1998). A word is a particular type of symbol. The grammar includes the rules required to combine words into messages. The message is used to communicate. The message contains the words and the relations between them. A code is a system of signs and conventional signals used to transmit a message, to communicate. To codify means to use a code to represent a communication.

A data format represents the total characteristics of a data structure used to communicate a message. A data format includes the grammar and the vocabulary; as such it is a language, even if very primitive and particular.

3. Communication and Collaboration

In basic communication theory model, communication is achieved by transmitting messages from an emitter to a receiver using a communication channel. Due to their particular processing and communication characteristics, computers are used

nowadays to accomplish more efficient, activities that were previously done by people manually. Today we teach computers to do what we were doing using our own natural abilities. Unfortunately, even with today's most advanced technology it is almost impossible to transpose the cognitive abilities of a man into computer software. However, computers are used to communicate between them in an automatic and autonomous fashion, independent of the help of any user. For this, there have been developed communication protocols, similar to our natural language but much more primitive and particular. These were created to solve very specific problems. Their development was bottom-up, resulting in a multitude of languages, and later on we've started witnessing the emergence of unified languages like UML, MOF, etc. There are a series of characteristics common to all these languages: a sum of finite symbols which make up a vocabulary and o sum of rules used to combine these symbols into messages that can be interpreted by the machines. To sum this up: we are trying to program computers to do a multitude of cognition and communication activities just as we do them naturally.

But electronic computers cannot process and store internally the letters and numbers that we use in our daily communication, only binary data. As such, there have been developed a series of symbols that mediate the difference between the binary format and the alphanumeric format. These are known as character sets: ASCII, Unicode, ISO-8859-1 etc. These form a codification system. These are usually part of a language but because of the multitude of different encodings available that can be used almost interchangeably, we can view them individualized.

Using the basic characters and numbers defined above, we form data structures similar to the words and phrases in our natural language. We may form simple or complex structures (e.g. business messages) that are composed of more than a simple structure. These structures have a certain syntax, a certain order of structuring the elements. Each structure carries with it a semantic charge. These are the basics of a language: grammar and vocabulary. There have been many languages used to communicate messages between different economic information systems using computers: EDI formats (X12, EDIFACT, KEDIFACT, GS1 EANCOM etc.), GS1 XML, xCBL, UBL, NES UBL, UN/CEFACT CCL, RosettaNet RNTD etc. In the same category we can mention the standards for classifying products, like GS1, the standard for country codes: ISO 3166-1, the standard for currency codes: ISO 4127, the standard for date and time format: ISO 8601, etc. In order for two partners to communicate, they must agree on the language used.

To reach the receiver, the message must be sent using a communication channel. For this purpose there are many standards and technologies, some public, other private. The most known and widely used standard for communication between applications is TCP/IP, the Internet standard. In most cases, though, to accomplish

certain requirements needed for transmitting business messages, for example, this standard is further completed by superior level standards like http, smtp, web services, ebMS, EDIINT AS2, etc, and the message is enveloped in a data envelope like MIME, S/MIME, SOAP, etc. In order to collaborate, the two partners must agree on this level, too.

The fact that we can transmit a message from an emitter to a receiver using a common language is not enough to collaborate. Even if the receiver gets the message and can understand it, it doesn't mean he has to do something about it. Collaboration presupposes that the two have a contract, a protocol, an agreement of collaboration. In general, the collaboration between partners to achieve a certain goal is done in a succession of steps that must be known and respected by both the participants. This succession of steps defines a choreographic process, in which both participants respect the same protocol. These processes are defined by standards like ebXML and RosettaNet but they can also be the subject of particular agreements between both sides. The processes can be defines using standards like BPMN, BPEL, WS-CDL. If there is an agreement up to this point, we can say that both partners can collaborate.

The lesson of building high walls we have learned it from our enemies. Security has become an essential part of communication nowadays. We confirm identity using digital signature. We ensure non-repudiation of origin and receipt. Confidentiality and integrity is achieved by encryption and digital signatures. There are many security standards: S/MIME, SSL, X.509, XML Encryption, etc, and most of them use the asymmetric key algorithm X.509– this is a point of convergence in security.

Using the construct laid out so far we can begin to classify the standards.

4. Standard Categories

Today, there are a multitude of standards and specifications used to support the collaboration between economic information systems. To achieve interoperability of economic information systems we must agree on a language, a transmission method, a collaboration protocol and the security used (at least identity, integrity, confidentiality and non-repudiation). We have standards that solve a very particular problem, standards that solve two or more problems of interoperability and a group of "complete" standards that address all the mentioned issues of interoperability.

The hierarchy of interoperability illustrated in the figure above can be detailed on each level, with examples of standards as follows:

1. **Interoperability level**: ebXML, RosettaNet

1.1. **Language**:

1.1.1. Codification: ASCII, Unicode, ISO-8859-1, etc

1.1.2. Vocabulary: ISO 639-1, ISO 3166-1, ISO 4216, etc

1.1.3. Vocabulary + syntax: EDI (X12, EDIFACT, KEDIFACT, GS1 EANCOM, SAANA EDI, Odette, TRADACOMS, Ryutsu Business Message Standard), XML, etc

1.2. **Transmission**:

1.2.1. Application level: web services, ebMS, RosettaNet RNIF, EDIINT AS2, BusDox, http, smtp, etc

Network level: TCP

1.2.2. Internet level: IP

1.2.3. Link level: ARP, etc

1.3. **Protocol**: BPMN, BPML, BPEL, BPSS (ebXML), PIPs (RosettaNet), WS-CDL (web services), etc.

1.4. **Security**:

1.4.1. Enveloping: S/MIME, SOAP, SwA, PKCS#7, etc

1.4.2. Identity: RFC 2459 , RFC 3039, ITU-T Recommendation X.509 (1997) | ISO/IEC 9594-8 (X.509, RSA, DSA), XML Signature, etc

1.4.3. Confidentiality: XML Encryption, S/MIME, etc

1.4.4. Integrity: RFC 2459 , RFC 3039, ETSI TS 101 862 v. 1.2.1, XML Signature, etc.

1.4.5. Non-repudiation: RFC 2459 , RFC 3039, ITU-T Recommendation X.509 (1997) | ISO/IEC 9594-8, XML Signature, etc

We could have easily said the same thing as follows:

1. Languages for interoperability

1.1. Languages for data/messages

1.2. Languages for messaging

1.3. Languages for protocols

1.4. Languages for security

In this form we can decouple from the technical, hardware part of the interoperability, which, for the most part would be correct in our context (enterprise information systems interoperability). There have been substantial efforts made in the current standards to separate the language from a particular type of hardware representation, which has been a major step forward in interoperability and collaboration.

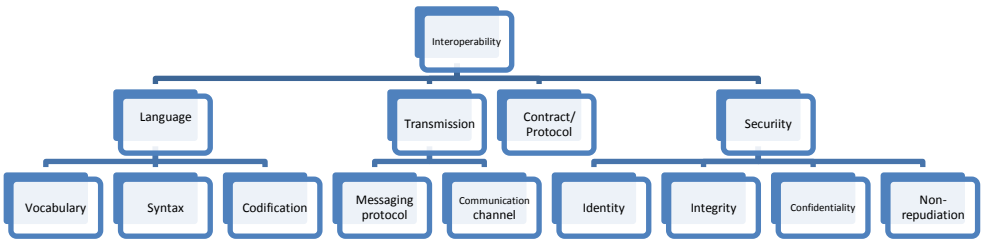

Figure 1. The hierarchy of interoperability

5. Conclusion

In order for two independent economic information systems to collaborate to achieve a certain goal, they must communicate. Interoperability between two economic information systems is achieved through communication. Standards have a key role in promoting economic information system interoperability, and thus enable collaboration. Analyzing the current standards, technologies and applications used for enterprise interoperability has revealed a common pattern that runs through all of them. From this pattern we construct a basic model around which we relate and judge all standards, technologies and applications for economic information systems interoperability. Today, there are a multitude of standards and specifications used to support the collaboration between economic information systems. To achieve interoperability of economic information systems we must agree on a language, a transmission method, a collaboration protocol and the security used (at least identity, integrity, confidentiality and non-repudiation). This model can be used to distinguish between the various components required to make interoperability happen, reuse the common elements as much as possible, and even develop interoperability methodologies and courses for future projects.

6. Acknowledgment

This work was supported by the European Social Fund in Romania, under the responsibility of the Managing Authority for the Sectoral Operational Programme for Human Resources Development 2007-2013 [grant POSDRU/88/1.5/S/47646]

7. References

(2011). *ATHENA Framework*. Retrieved from http://modelbased.net/aif/, date 03.03.2011.

DEX (1998). *Dictionarul explicativ al limbii romane/Dictionary of Romanian language*. Bucharest: Romanian Academy, Institute of Linguistics "Iorgu Iordan".

(2011) EbXML. *Enabling a Global Electronic Market*. Retrieved from http://www.ebxml.org/, date 03.03.2011.

Eric Chiu (2002). *EbXML Simplified A Guide to the New Standard for Global E-Commerce*, John Wiley & Sons Inc.

Johan Ullberg, David Chen & Pontus Johnson (2009). Barriers to Enterprise Interoperability. *Lecture Notes in Business Information Processing*, 1, Volume 38, Enterprise Interoperability, Part 1, 2009, pp. 13-24.

Ameedeen, M.A. B. Bordbar & Rachid, Anane (2011). Model interoperability via Model Driven Development. *Journal of Computer and System Sciences*, Volume 77, Issue 2, March, 2011, pp. 332-347

Man-Sze Li, Ricardo Cabral, Guy Doumeingts & Keith Popplewell (2006). *Enterprise Interoperability Research Roadmap Final Version*, p. 4, available online from URL ftp://ftp.cordis.europa.eu/pub/ist/docs/directorate_d/ebusiness/ei-roadmap-final_en.pdf.

Oprea D., Mesnita G., Dumitriu F. (2005). *Analiza Sistemelor informationale/Analysis of Information* Systems. Iasi: Editura Universitatii Al.I. Cuza.

(2011). RosettaNet. Retrieved from http://www.rosettanet.org, date: 28.02.2011.

Vasile Irimia (2011). Economic Information Systems Interoperability. *Annales Universitatis Apulensis series Oeconomica*, no 13, pp. 42-47.

Yannis Charalabidis, George Gionis, Karl Moritz Hermann, Cristina Martinez (2008). *Enterprise Interoperability Research Roadmap, v. 5,* available at URL ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/enet/ei-research-roadmap-v5-final_en.pdf.