RESEARCH PAPERS OF WROCŁAW UNIVERSITY OF ECONOMICS
No. 85 — 2009
Advanced Information Technologies for Management – AITM 2009

Przemysław Polak

Warsaw School of Economics, Warsaw, Poland
e-mail: ppolak@sgh.waw.pl

INFORMATION SYSTEMS INTEGRATION – THE PROPOSAL OF CLASSIFICATION

Abstract: The term "integration" refers to many aspects belonging to the area of interest of computer science and business informatics. Business informatics research usually considers independently integration of information systems within an organization and interorganizational integration. The author argues that this classification is obsolete in terms of current research, business needs, and advances in information technology. For that reason, he proposes a new classification of the information systems integration in terms of the organizational scope of the integration: intraorganizational, extraorganizational and multiorganizational.

1. Integration of information systems

In the field of computer science and information systems the term "integration" refers to many technical and functional aspects. The most common approach refers to the integration of autonomous applications performing complementary functions. There are various classifications of information systems integration [Choe 2008; Polak 2008; Vernadat 1996]. The most popular classifications include two main levels of integration:

– data integration,
– process integration.

The data integration refers to automatic data exchange between computerized information systems. This level of integration may be achieved by shared access to databases by different applications or the mechanism of message exchange. The operational process integration means coordination and/or optimization of activities. It is a common feature of integrated information systems, for example ERP (Enterprise Resource Planning) systems.

Despite the fact that the process integration within organization reached high level of maturity with integrated information systems being an essential solution for many types of organizations, new solution and technologies are constantly developed. Latest achievements include Service Oriented Architecture (SOA). SOA is an

information systems architectural style based on business processes, organized as services [Newcomer, Lomow 2005]. It enables the creation of applications that are built by combining loosely coupled and interoperable services which can be distributed over a network and can be combined and reused to create business applications [Erl 2005].

SOA separates of a business layer and an applications (or services) layer. It leads to two main advantages of this architecture, important from the process integration point of view:

– swift implementation and reorganization of business processes based on existing services,
– easy integration of systems based on different technologies.

These features allows to change completely an approach to building integrated information systems. Instead of building large integrated systems, it enables to integrate independent application without changing their inside.

2. Interorganizational information systems

The models and methods of integrating information systems of different organizations were discussed and developed separately from intraorganizational integration. Consequently, the term "interorganizational information system" was proposed, in order to stress distinctive character of such systems.

The concept of information systems linking independent organizations was first discussed in 1960s [Kaufman 1966]. However the expression interorganizational information system was used for the first time 16 years later [Barret, Konsynski 1982]. At that time large, successful interorganizational systems like SWIFT or SABRE were already in operation. Initially interorganizational information systems were defined as systems built and used by two or more independent organizations. In that approach, stress was placed on functionality and participation of independent parties but not on integration with information systems of respective organizations. Despite that, the development of telecommunication standards and data exchange formats was essential in order to utilize data exchange on a large scale and to expand popularity of interorganizational systems. Consequently, common standards of EDI (Electronic Data Interchange) were accepted. In the 1970s, a large number of national (e.g. ANSI X.12 in the United States and TRADACOMS in the United Kingdom) and industrial standards (e.g. ODETTE in automotive industry, SWIFT in banking) were developed. Gradually, the biggest share was won by EDIFACT standard developed by UN/EDIFACT Working Group and accepted by International Organization for Standardization (ISO 9735 standard).

The spread of EDI standards led to the treatment of that term as almost equivalent to the concept of interorganizational information system [Swatman et al. 1994; Lee, Lim 2005]. But in fact, that approach was limited to data level integration. It reflected traditional interorganizational relations based on paper documents, improving

correctness and speed of transmission, due to automatic exchange of electronic documents between applications [Albrecht et al. 2005].

In the 1990s, changes in the world economy caused an increase of importance of business links between organizations. Attention was focused on integration of information systems with outer environment. The interorganizational information systems were defined, at that time, as systems utilizing computer networks, reaching behind borders of enterprises [Konsynski 1993]. This type of integration is still considered to be one of the most important directions for enterprise development. This trend is represented in a contemporary definition of the interorganizational information systems as systems automating information flows between an organization and its customers, partners, suppliers and relevant authorities. They are also defined as value chains that extend beyond organization boundaries [Soliman, Janz 2004], reflecting the popularity of such management methods like SRM (Supply Relationship Management), SCM (Supply Chain Management) or CRM (Customer Relationship Management)

Based on the types of relations between companies and the tightness of integration, four basic models of the interorganizational information systems integration can be distinguished [Kamiński et al. 2005]:

– corporate system,
– supply chain coordination system,
– standalone information systems integration,
– integration with information node.

The corporate system model refers, in most cases, to integrated information systems (e.g. ERP systems) applied into its subsidiaries. These subsidiaries can be a part of one supply chain or can carry independent activities. Although subsidiaries can be independent companies from a legal point of view, they are subjects to one managerial strategy. In this case, usually centralized systems are implemented, however distributed application can also be used, provided that data can be consolidated for managerial purposes.

The model of supply chain coordination system is usually built on the basis of integrated system (ERP) including B2B (business-to-business) module and functional extensions e.g.: SRM, CRM. In the most advanced solutions, it includes SCM functionality. This model is usually built around a leader of a supply chain. Its business partners are independent companies, however they have weaker position and therefore are forced to follow standards imposed by the leader.

The model of standalone information systems integration refers to integration of independent and different systems used by partners having traditional inter-firm relationships. In this case, none of the parties can impose its solution on other partners. Therefore, integration has to be based on commonly accepted standards.

In the model of integration with information node, partners do not communicate directly but through independent party serving as a main node of a information system. Electronic markets follow this model. They not only support data exchange but

also provide the service of searching for suitable partners and perform other value added services. The main node usually imposes data exchange standards and other procedures.

3. From EDI to e-business

The EDI standards, dominating in the 1990s, did not satisfy the needs of medium-sized and small enterprises, mainly due to high cost of implementation and integration with organizational information systems. That situation caused development of new initiatives, for example Lite-EDI or Open Buying on Internet (OBI). The first solution was based on the reduction of EDIFACT standard complexity. An OBI consortium developed a new schema for low cost transactions, however formats of documents were related not to EDIFACT but to ANSI X.12.

Rapid development of the Internet and electronic business called for new solutions. The simplest and the most popular one is electronic form. However, it requires typing in and, in practice, is limited to B2C relations and occasional B2B transactions, so it is no alternative for traditional EDI. A new concept came from XML (eXtensible Markup Language). At the beginning XML was ignored by large corporations, which had made significant investments in traditional EDI systems [Cameron 2002]. Nevertheless in the end of 20th century, large projects aimed at using XML for business data exchange were already on the way. They were based on three main concepts [Marshal 2000]:

– XML functional equivalents of EDIFACT and ANSI X.12 messages,
– adding in XML documents reference tags identifying functionality of data known from already accepted standards,
– new XML-based standard.

The last concept proved to be the most effective. It allowed to create quickly and easily new standards and consequently new application fields for electronic data exchange. However, such approach leads to the emergence of large number of standards, which still bear the notion of traditional EDI, whereas the market calls for enabling closer cooperation of partners in supply chain (net).

Attempts to solve that problem led to the development of more complex methods covering not only data definition but also schemes dealing with processes accompanying data exchange. Those solutions can be classified into three groups:

– universal integration platforms,
– general framework standards,
– industrial standards.

Universal integration platforms allow to define rules and procedures involved in data exchange. The most popular example of universal integration platform is MS BizTalk. The platform allows to define data transformation specifications as well as information flow channels. It supports XML and traditional EDI standards. MS BizTalk also contains interfaces to the most popular standard business applications, e.g.

SAP ERP [Kamiński 2005]. By using universal integration platform, an organization can easily implement any procedure consistent with interorganizational process.

Increasing competition, globalization and specialization has led companies to seek ways to forge closer cooperation based not only on data exchange but also on process integration. General framework standards provide universal architecture covering all aspects of electronic data interchange, including support for business process integration useful in many industries in various processes. The leading solution in this field, ebXML, does not define business processes and messages, but offers a mechanism enabling partners to harmonize processes and data exchange procedures. Nevertheless, ebXML documentation includes a catalogue of hundreds business processes which, however, are only references to processes defined in industrial standards, e.g. RosettaNet, EDIFACT, OAG (Official Airline Guide), AIAG (Automotive Industry Action Group) [*Business Process*... 2001].

At the turn of the century, the term interorganizational information system was again rarely used. The phrase "e-" became a popular keyword. Also, terms like electronic business and abbreviations indicating more specific usage: B2B, B2G, etc., were employed not only for indicating the type of business relations but also an IT system used for these purposes [Albrecht et al. 2005].

A lot of attention attracted the concept of virtual company. Network structures are gaining importance in the interorganizational relations. Companies can play a role of an information hub. They do not carry out any production or logistics activities, but their competence lies in finding and knowing partners' expertise and linking together their activities in a value chain [Hagel 2002]. The effectiveness of such business model is based on the close integration of business processes enabling optimization in supply chain management.

Developing advanced form of integration, in order to achieve competitive advantage, requires sometimes a unique model of integration. Therefore, existing data standards, general framework standards, or industrial standards might not provide satisfactory solutions. Fortunately XML provides full flexibility to create new data documents and can be easily integrated with various database management systems and business applications.

4. The proposal of classification

The review of various models of interorganizational integration presented above allows to distinguish two main types of relationships:

– cooperation based on standard, commonly accepted business procedures,
– close, individually design model of cooperation.

The first type reflects traditional business activities. The transactions can be conducted with any organization willing to do so. A company can cooperate with many suppliers, partners and customers, changing them any time it is necessary. Relations are based on commonly accepted procedures. Therefore, all data formats and proce-

dures involved must be standardized and commonly used. Depending on the level of integration, they include EDI standards or public processes and frameworks – general or specific industry oriented.

The second type of relationships involves close cooperation of companies. The solution can utilize supply chain coordination system, any other process oriented cooperation as well as relations bearing the attributes of a virtual organization. In all these cases, relations are well-established, usually long-term, often based on unique rules and procedures providing competitive advantage. Information systems supporting that kind of relationships, especially in case of virtual organizations, acquire the characteristics of intraorganizational systems. Technologies and solutions intended for the integration of systems within organizations can be utilized in interorganizational integration. SOA can be particularly effective for process level integration. Building and implementing dedicated integrated information system for virtual organization is not feasible. Whereas, designing business processes and their swift implementation can be accomplished as a result of integration of services provided by partners' applications. Web services were already considered a useful tool for integrating heterogeneous systems not only within organization but also between partners in the supply chain [Pavlou, Karakostas 2005], whereas, using SOA in the integration model of the supply chain coordination system was proposed by Cherbakov [Cherbakov et al. 2005].

The differences between two models of interorganizational integration described above justify separation of two subtypes: *extraorganizational* and *multiorganizational integration*. Table 1 presents a list of some models, methods and technologies associated with these types of integration, compared also with intraorganizational integration.

Table 1. Models, techniques and standards typical for respective type of integration

	Intraorganizational	Extraorganizational	Multiorganizational
Data integration	– interfaces between applications, – common, shared database	– traditional EDI standards (e.g. EDIFACT), – XML documents, – locally defined, not standardized documents	– traditional EDI standards (e.g. EDIFACT), – XML documents
Process integration	– integrated information systems (e.g. ERP systems), – SOA	– SOA, – SCM, – virtual organizations	– standard public and industry processes, – universal integration platforms, – e-markets

For the proposed taxonomy three prefixes were used:
– *intra* – inside, within,
– *extra* – outside, beyond,
– *multi* – many.

It seems that it would be more precise to use prefix *inter-* (between, among a group) instead of *extra-* but it is used currently in broader meaning. On the other hand, the prefix *extra-* can refer to not public character of cooperation limited only to a group of organizations (compare to a term *extranet*). A semantic problem can be also caused by earlier usage of the term "extraorganizational" system. It was defined as a system in which one or more organizations cooperate with other entities which are not organizations, but rather small enterprises and private individuals [Clark 1992]. However, it did not gain popularity at that time. Later Howard and Vidgen [2003] defined an extraorganizational system as a system which enables multiple firms to share industry-level systems linked by electronic portals and hubs.

5. Summary

The traditional classification of information systems is obsolete in terms of current research, business needs, and advances in information technology. Some methods of interorganizational integration bear resemblance to integration within organization. On the other hand, many variants of interorganizational integration vary from each other. The proposed taxonomy of information systems integration can be helpful in understanding different requirements of extraorganizational and multiorganizational integration. It can lead to develop separate models and framework for cooperation, thus better fitting specific requirements.

References

Albrecht C.C., Dean D.L., Hansen J.V. (2005), Marketplace and technology standards for B2B e-commerce: Progress, challenges, and the state of the art, *Information & Management*, Vol. 42, pp. 865-875.

Barret S., Konsynski B.R. (1982), Inter-organization information sharing system, *MIS Quarterly*, Special Issue, pp. 93-105.

Business Process and Business Information Analysis Overview v.1.0 (2001), Business Process Team, UN/CEFACT and OASIS.

Cameron J. (2002), *UN*-EDIFACT or XML: A critical ecommerce decision, [in:] *Wybrane problemy zastosowania Electronic Data Interchange i Electronic Commerce*, Ed. M. Niedźwiedziński, Acta Universitatis Lodziensis, Folia Oeconomica 157, Wydawnictwo Uniwersytetu Łódzkiego, Łódź, pp. 111-123.

Cherbakov L., Galambos G., Harishankar R., Kalyana S., Rackham G. (2005), Impact of service orientation at business level, *IBM Systems Journal*, Vol. 44, pp. 653-668.

Choe J. (2008), Inter-organizational relationships and the flow of information through value chains, *Information & Management*, Vol. 45, pp. 444-450.

Clark R. (1992), *Extra-Organisational Systems: A Challenge to the Software Engineering Paradigm*, paper presented at the IFIP World Congress, Madrid, http://www.rogerclarke.com/SOS/ Paper ExtraOrgSys.html.

Erl T. (2005), *Service-oriented architecture: concepts, technology, and design*, Prentice Hall Professional Technical Reference, Upper Saddle River.

Hagel J. III (2002), Leveraged growth: Expanding sales without sacrificing profits, *Harvard Business Review*, Vol. 80, October, pp. 68-77.

Howard M., Vidgen R. (2003), Overcoming stakeholder barriers in the automotive industry: Building to order with extra-organizational systems, *Journal of Information Technology*, Vol. 18, No. 1, pp. 27-44.

Kamiński A. (2005), Designing the integration platform of information systems in MS BizTalk 2002 environment, [in:] *Information Management*, Eds. B. Kubiak, A. Korowicki, Uniwersytet Gdański, Gdańsk, pp. 294-300.

Kamiński A., Polak P., Wieczorkowski J. (2005), New tendencies in integration of information systems, [in:] *Information Management*, Eds. B. Kubiak, A. Korowicki, Uniwersytet Gdański, Gdańsk, pp. 206-210.

Kaufman F. (1966), Data systems that cross company boundaries, *Harvard Business Review*, January-February, pp. 141-155.

Konsynski B.R. (1993), Strategic control in the extended enterprise, *IBM Systems Journal*, Vol. 32, pp. 111-142.

Lee S., Lim G.G. (2005), The impact of partnership attributes on EDI implementation success, *Information & Management*, Vol. 42. pp. 503-516.

Marshal B. (2000), *Applied XML solutions*, Sams Publishing, Indianapolis.

Newcomer E., Lomow G. (2005), *Understanding SOA with Web services*, Addison-Wesley, Upper Saddle River.

Pavlou T., Karakostas B. (2005), Web services: Enabling technology supporting interoperability in e-supply chain, [in:] *Information Management*, Eds. B. Kubiak, A. Korowicki, Uniwersytet Gdański, Gdańsk, pp. 370-385.

Polak P. (2008), Prospects of using service oriented architecture in interorganizational integration, [in:] *Advanced Information Technologies for Management – AITM 2008*, Eds. J. Korczak, H. Dudycz, M. Dyczkowski, Research Papers of the Wrocław University of Economics No. 35, Publishing House of the Wrocław University of Economics, Wrocław, pp. 150-157.

Soliman S., Janz D. (2004), An exploratory study to identify the critical factors affecting the decision to establish Internet-based inter-organizational information systems, *Information & Management*, Vol. 41, pp. 697-706.

Swatman P.M.C., Swatman P.A., Fowler D.C. (1994), A model of EDI integration and strategic business reengineering, *The Journal of Strategic Information Systems*, Vol. 3, pp. 41-60.

Vernadat F.B. (1996), *Enterprise Modeling and Integration: Principles and Applications*, Chapman & Hall, London.