Master Thesis In IT Management

BUSINESS-TO-BUSINESS IT INTEGRATION
-A study of B2B IT integration patterns for short & long-term goals-

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Abstract

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Introduction As business world has moved into digital era, new trends in business models have been emerged to do business. Digital infrastructure provided by internet enables enterprises to extend their boundaries for new customer and trading partners. Extending the enterprise without a solid IT infrastructure is incomplete, this is the reasons that enterprises are investing more and more in IT to build an IT integrated infrastructure where all its trading partners are linked together. On the other hand, technological world provides solutions and services to build IT integration for such extended enterprises. A wide variety of IT integration solutions and patterns available for enterprise to meet their integration goals, but this often brings unclear situation where companies have to think a lot before implementing IT integration patterns. A slight mistake in this scenario could shake the equilibrium between IT and business, to keep the equilibrium steady companies need to thoroughly examine their short-term and long-term goals and then different integration patterns can be employed to meet these goals.

Research Question What approaches can be helpful for companies to accomplish successful business-to-business IT integration pattern for their short-term and long-term goals?

Purpose The purpose of this thesis is to describe the concept of extended enterprises and, identify and describe the existing B2B IT integration approaches employed by extended enterprises.

Method The research is of qualitative type and secondary data is used to conduct this research. Books and research papers has been used to construct theoretical framework. Electronic databases available at library of Mälardalen University such as Google scholar, Emerald and interlibrary network of Sweden (Libris) are used to search for secondary data.

Analysis   Findings from the detailed literature study are analyzed to answer the research question. Integration patterns are analyzed described by the different authors of integrations patterns in three different ways. Firstly, integration patterns were analyzed in term of their advantages and disadvantages with technology and business, secondly, maturity of these integration patterns are analyzed and finally these integration patterns are analyzed for company's short-term and long-term goals.

Conclusion   Business process oriented and method-oriented approaches are good for long-term goals due to handling of business process management in both approaches and reusability aspects of method oriented approach. For short-term goals portal-oriented approach dominating in the integration community, application interface oriented approach is also good to meet the short-term goals. However, combinations of different approaches are found feasible.

Acronyms

A2A	Application-to-Application Integration
AIOB2BAI	Application Interface Oriented Business-to-Business Application Integration
API	Application Programming Interface
AOB2Bi	Application Oriented Business-to-Business Integration
ASP	Application Service Provider
B2B	Business-to-Business
B2BAI	Business-to-Business Application Integration
B2Bi	Business-to-Business Integration
B2C	Business-to-Consumer
BPOB2Bi	Business Process Oriented Business-to-Business Integration
C2B	Consumer-to-Business
C2C	Consumer-to-Consumer
CRM	Customer Relationship Management
DOB2BAI	Data Oriented Buiness-2-Business Application Integration
DOB2Bi	Data Oriented Business-to-Business Integration
EDI	Electronic data interchange
EE	Extended Enterprise
ERP	Enterprise Resource Planning
ISP	Internet Service Provider
MOB2BAI	Method Oriented Business-to-Business Application Integration
POB2Bi	Portal Oriented Business-to-Business Integration
POB2BAI	Portal Oriented Business-to-Business Application Integration
PIOB2BAI	Process Integration Oriented Business-to-Business Application Integration
RPC	Remote Procedure Call
SCM	Supply Chain Management
SOAP	Simple Object Access Protocol
UDDI	Universal Description Discovery and Integration
W3C	World Wide Web consortium
WSDL	Web Services Description Language
XML	Extensible Markup Language

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1. INTRODUCTION

In this chapter, general introduction of the thesis along with research question and purpose is presented.

The history of Inter-enterprise integration dates back to the early 80s and 90s when electronic data interchange (EDI) was used by companies for exchange of information electronically in a standardized machine process format; with this business partners were able to electronically exchange business documents such as purchase orders and invoices between their computer systems. In the 80s, EDI systems were developed using proprietary technology that did not quite enable multiple firms to use connect, as time evolved towards the era of digital economy with the potential of reaching and connecting with the wide and vast possible number of trading partners, access were limited in the use of EDI between firms based on the fact that EDI was built upon proprietary technology (Applegate et al., 2007).

The dynamic and turbulent business environment with the growing interest of business in delivering an increasing variety of products and services requires much more flexibility in order to build an integrated IT infrastructure. Technological world is delivering solution and contributing to bring sophistication to business world. But with different kinds of IT application integration approaches and patterns available, organizations feel the pressure of selecting the right approach to technically extend the enterprises, an approach which will create real values for each trading partner involved in an extended enterprise, an approach that will enable the enterprises to stay sustained in the changing business environment (Samtani, 2002).

But these requirements extended will have to come from the enterprise being able to have some solid technical foundation, the partnering enterprises have also come to be aware of the different interdependencies and complexities involved in extending the enterprise, they have also come to know that without a solid technical connectivity, it would be hard to bond and do transaction together given the complexities and interdependencies, they have also come to realize that IT is the solution that will hold their chain of network together and give them a strong foundation to stand tall (Linthicum, 2000, p.313).

1.1 The Problem Area

Reflecting on the issues with EDI and pondering on a suitable standard, Bussler (2003, p.5) writes that enterprises use different back-end application systems that need to exchange data, these enterprises can possess a variety of back-end application systems and these back end application systems are designed to operate in isolation which still requires manually entering of data which is error

prone and which is as a result of lack of real time integration between all systems participating in a business event.

B2B application integration is meant to address such issue and enable all participating systems to communicate in a direction with any system automatically and in real time in support of common business events on inter-enterprises level (Linthicum, 2000, p.10).

Consequently, there are factors from the business world which demand this integration or one may say opposite to this that there are technological advances which open up new alternatives to the business world to communicate on inter-enterprise level. Although, it is wise to say that equilibrium between business world and technological side is very important. To keep this equilibrium steady, it is wise to look at the kinds of relationships involved, the kind of trading activities going on within the enterprise and make some thorough examination of the best approach of technically combining all the trading partners within the enterprise, and at the same time being aware that business requirements evolves.

1.2 Issue

Today, in the dynamic business environment with frequent and unpredicted changes, enterprises look for ways of automating business transactions, processes and cutting costs and also leveraging existing technologies. Many enterprises find it hard to meet their goals, especially on inter-enterprise level, which depends so much on IT and greatly demands an approach that is capable of integrating together the different partners in the extended network. Since relations with different integrated partners differ in the context of short and long-term goals so does the strategies and finally approaches to meet these goals. This results in an ambiguous situation for enterprises to choose the right approach to be successful.

What approaches can be helpful for companies to accomplish successful business-to-business IT integration pattern for their short and long-term goals?

1.3 Purpose

The purpose of this thesis is to

Describe the concept of extended enterprise and, Identify and describe the existing B2B IT integration approaches employed by extended enterprises.

1. METHODOLOGY

This chapter deals with the research approach and method used in conducting this study, data collection method is the center of methodology. Limitations of the study and structure of the thesis is also discussed in this chapter.

2.1 Research Approach

According to Fisher (2004) we are conducting qualitative research, thus it does not deal with the statistical data. To conduct qualitative research next step is the selection of data from primary and secondary sources.

2.2 Data Collection

Data collection is crucial part of the research and involves different techniques to gather data (Fisher, 2004). Wide collection of data opens up horizon on the topic area in order to render sufficient knowledge on the research topic. There are two types of data, primary and secondary. Both types have their own advantages and disadvantages but ultimately help in accomplishing the research.

2.2.1 Secondary data

In this study authors have used secondary source of data, past research papers on the stated research topic will be collected, which will give better understanding on the topic and issues discussed on the topic. Books on the topic of research will be used to go more into detail; research article from different journals and peer-review articles will also be part of second data source. Secondary data will be used to describe and explain purpose of the study and theoretical framework of the thesis.

2.2.2 Data Sources

Electronic databases available at library of Mälardalen University such as Google scholar, Emerald and interlibrary network of Sweden (Libris) will be used to search for secondary data.

2.2.3 Theoretical Framework

Theoretical framework deals with different theories, concepts, perspectives, and different school of thoughts concerning the research topic. This part of the report will act as a guideline for some analytical tools, according Fisher (2007, p.122) theory and conceptual frameworks help in finding ways around research materials, and provides structure and coherence to research works.

2.2.4 Data Analysis & Presentation

Findings through detailed literature review will be collected and will be analyzed on the basis of theories, which we will be using in the theoretical framework. Analysis of data in the light of theoretical framework will help to answer the research question.

2.3 Limitations

This thesis work has some limitations regarding the time available for conducting this study and literature found. Information in finding will be comprised on the data available. We choose some variable in the finding part that has limitations to theoretical study of this study.

2.4 Structure of the Thesis

In order to facilitate the reader to grasp the material of the study, structure of the thesis is given below.

Section 3 consists of the theoretical framework of the thesis. In depth details of different IT integration patterns, challenges, driver and enabling technology that are necessary to discuss and to use for the finding and analysis part make literature review in *section 4*, which leads to finding and analysis *section 5* and *6* respectively. Conclusion ultimately answers the research question in *section 7* followed by the *section 8*, in which future research options will be discussed.

3. THEORETICAL FRAMEWORK

This chapter comprises the concept of extended enterprise; different business groups involved in the digital economy is discussed. Discussion in this chapter also deals with the integration needs for the digital economy to be competitive and model is presented which differentiates extended enterprise integration and market B2B integration.

3.1 Extending The Enterprise

Nicolas Carr in one of his article, points out that the arrival of the Internet has made IT ubiquitous and easily accessible to all and companies now have to focus on their core businesses rather than spending too much on IT (Carr, 2003). A different school of thought in another perspective puts it that ubiquity and affordability of the Web have made it possible for the masses of businesses to automate their B2B interactions (Medjahed et al, 2003), very consistent with Applegate's view that executives ceased the opportunity brought by the internet as an open, non proprietary platform for sharing information and conducting business with multiple partners (Applegate et al, 2007, p.86). Argues further in favor of ubiquitous-ness of IT that has provided the opportunity to extend the boundaries of an enterprise to other enterprises. Anirban also gives this view of extending the enterprise (Anirban et al., 2007) that extending the enterprise looks at the business process, at the level of end to end supply chain within which an enterprise itself will only be executing core business processes within the enterprise, while the remaining business partners will integrate their respective business processes in the framework of inter-enterprise business processes.

Carr is his view of proprietary and monopolistic IT had probably not thought in the context of extending the enterprise, even if he did, his ideal B2B transaction would not go beyond the EDI standard of transaction given that EDI systems were built using proprietary technology, but Applegate's (2007) view EDI as a proprietary asset that can not be leveraged easily and shared organizational boundaries, EDI was only limited to those organizations that adopted the same proprietary technology and would not accommodate multiple organizational transactions.

This concept of extended enterprise (EE) generates new "business models". These different business models are involved in different trade types, for instance, consumer-to-consumer (C2C), business-to-consumer (B2C), consumer-to-business (C2B) and business-to-business (B2B)[*] activities. Among them e-

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[*] Some of the business models deal with B2B, B2C and C2B also but discussion is confined to only those models, which has cross enterprise activities, i.e.-e B2B etc.

Markets, e-Aggregators, Infomediaries, e-Exchanges, Portals and Producers are common models and share business-to-business activities.

The other group of businesses provide digital infrastructure in the form of computer hardware & software, customized solutions, integration services and consultations etc., for above-mentioned businesses. Classification of these two business groups is below.

Digital Infrastructure Providers	Distributors
Software Solution Firms	E-Markets, e-Aggregators, Infomediaries,
Component Manufacturer,	Exchanges
On Demand Solution Providers,	**Portals**
Integration Solution Providers,	Gateway Access Providers
Internet Service Providers (ISPs), Web	**Producers**
Hosting Service Providers,	Manufacturers, Service Providers, Educators,
Application Service Providers (ASPs)	Advisors, Information & News Services

3.1.1 Distributors

In distributors model, the main purpose is to unite buyer and seller; this has two major sides, buyer side and seller side. These models vary in their services, revenue generations and parties involved. Revenue is generated from advertisements, commissions or subscribing fee by passing the buyer to seller, sometimes transaction or service fee is charged also. Price could be fixed or could be negotiable.

3.1.2 Portals

Portals have close links with hosting services and global gateways to access the public Internet. B2B portals provide access to business community networks to search different contents. Portals collaborate closely with IT infrastructure. (Applegate et al., 2007; Samtani, 2002)

3.1.3 Producers

Producers are the ones who produce, manufacture, design and distribute goods and services. Firms in this category join e-Markets to procure the raw material and access other necessary services.

3.1.4 Digital Infrastructure Providers

Digital infrastructure providers provide resources to the distributors and portals to produce their offering, whether in the form of service or goods. Large firms provide hardware and software solutions while other provide integration services to take part in collaborative e-commerce. Infrastructure providers also form partnerships with other firms to provide customized solutions to their customers. Logistic providers also come under this category and provide link

between producers and other parties who provide them value added products during e-procurement and supply chain events (Applegate et al., 2007).

3.2 Extended Enterprises As Source of Success

Today IT infrastructure still plays a significant role in connecting enteprises, the internet has made it easier for multiple trading partners to be able to be integrated and conduct business together online. The open Internet platform and common standard IT infrastructure remains powerful resource for competitiveness in the extended enterprise.

IT application integration activities take place here whereby multiple trading partners integrate there IT platforms together so as to conduct transactions with one another (Applegate et al. 2007, p.81). Extending the enterprise leverages IT infrastructure (Linthicum, p.317) such as business to business application integration by taking advantage of the common link of the internet and the common platform of the web, this make organization become a part of a set of informally connected systems.

The arrival of the Internet has being a huge enhancement in the extended enterprises and has made this concept an invaluable option for trading partners. Internet technologies offer enterprises the opportunity to build interactive relationships with their business partners, by improved efficiencies, and extended reach at a very low cost (Colin, 2002).

It has also been said that by extending the enterprise helps enterprises to leverage the best opportunities available for their supply chain requirements (Anirban et al., 2007). Overall, open standard IT infrastructure forms the foundation for trading partners to connect and do business together.

Inter-enterprise integrated infrastructure offers collaborative commerce to trading customers, business process automation, Supply chain efficiencies and cost reduction. Integration has also brought the competitiveness through increased operational efficiency and reduced cost that are achieved by streamlining, automating business process, and supply chain automation (Tarn et al. 2002), faster time to market reduced cycle time, resulting to cost saving and B2B integration offers better informed decision which have a positive effect on productivity (Samtani, 2002).

3.3 Extending IT Integration

It is important to know the different levels of generic business integration, and in particular integration of business to business against company's short and term

goals. As soon as "static" enterprises becomes extended enterprises, collaboration and cooperation comes on top, which generates different types of B2B integration. One is extended enterprise (EE) integration and second one is market B2B integration (Goethals et al., 2005; Goethals et al., 2004). If we look at the IT based new integrated business models (Applegate, 2007) or digital network of enterprises (Samtani, 2002, p.14) and concept of extended enterprise it is very easy to agree with the following framework provided by (Goethals, et al., 2004), which represents the whole "continuum" of B2B integration.

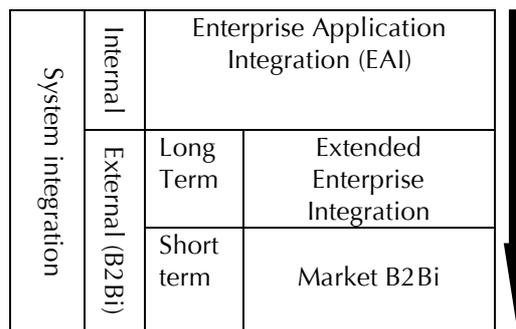| System integration	Internal	Enterprise Application Integration (EAI)	
	External (B2Bi)	Long Term	Extended Enterprise Integration
		Short term	Market B2Bi

Figure1. Levels & Types of Integration in Extended Enterprise
Source: (Goethals et al., 2004)

These two basic types of B2Bi directly communication with short and long term policies or goals, which according to Samtani (2002, p.12-15) is a foundation of B2Bi. These goals are necessary to set before implementing any B2Bi; these goals describe the current and future state of the enterprise.

Above framework is also very helpful in understanding the flow of integration from company's internal integration to external integration. This flow of integration is logical because without completing company's internal integration it is difficult to extend IT integration externally.

Short-term goals concerns with the operational cost, in crease in productivity and automation of other business services, it is much towards about the immediate rewards of B2Bi.

Long-term goal specifies the long lasting partnerships with the trading partners and the sustained value creation for the enterprises (Samtani, 2002). Long-term policies are more towards technological oriented specially the future evolvement of B2Bi with trading partners.

4. LITERATURE STUDY

Literature study is conducted in this chapter; different drivers of IT integration and its challenges are presented. Different types of integration patterns according to three authors are identified and described in this section.

4.1 Drivers of IT Integration

The business environment has moved and has moved towards the era of digital or the event driven economy that demands customers needs to be met within a shortest period of time, a time when a simple error could be too costly for both organizations and their customers, a time when no inventories could kick organizations out of the game. As a matter of fact, it is a time of dynamic business environment where every business activities take place in real time, when organization needs to be proactive. In fact the demands involved outweighs the capability of a single organization to meet up by operating alone and manually. The major business drivers for business-to-business integration are discussed below

4.1.1 Market Expansion

One of the initial drivers in Business-to-Business IT integration is the expansion of current market both virtually and physically. Companies are always in search of finding new markets, business and customers. Connectivity via B2B integration is much faster compare to not being connected with other business partners. (Bessant & Tidd, 2007, p.135)

4.1.2 Supply Chain Efficiency

With improved communication in the value chain via B2B connectivity, organizations have found it much easier to communicate with their suppliers of parts and components and be able to have just in time inventories (Linthicum 2000, p.4), in order to manufacture customer's orders at the right time. There is also the possibility of having access to new markets with a vast range of many suppliers and partners, which gives opportunities to companies for better negotiations and strength for broader product offerings. B2B integration also opens doors for companies to have new ways of adding values.

4.1.3 Business Process Automation

The motivation for this initiative is the transformation of business processes between partners, suppliers and customers alike with the potential of increase growth and success from integrated partnership, Business process automation is one of the aims of implementing business-to-business integration.

According to Gartner group, (cited in Samtani, 2000) the capability of B2B integration leads to some business convenient practices such as shared databases, open tracking systems, enhanced inter enterprise visibility and cooperation, streamlined business process, new cost efficiencies and expanded customers base for every collaborative partner resulting in a competitive advantage that could not possibly be achieved with a traditional way of transaction.

4.1.4 Cost reduction

According to the Samtani (2002) via B2B integration business partners operate efficiently on a real time basis enabling partners to securely connect over the Internet with the facilitation of information and flexibility of business processes. Economically, B2B integration has the potential of increasing revenues via decreased communication, reduction in operational and development costs and automated supply chain and CRM management resulting in higher profit margin.

The Return on investment of B2B integration comes from the increased operational efficiency and reduced cost that are achieved by streamlining, automating business process, and supply chain automation, faster time to market reduced cycle time, resulting to cost saving and B2B integration offers better informed decision which have a positive effect on productivity.

A key reason to reduce the cost of IT investment is that organization involved in digital economy and business to business transaction can leverage their infrastructure as they can integrate their current systems and do not have to create new applications in order to participate in B2B transaction, this way the cost of creating new systems can be avoided (Linthicum 2000, p.11).

4.1.5 Shared Business Networks

According to Bessant and Tidd (2007, p.135), various firms with similar market segments continue to dominate the export market and their success is not found in their strength to work alone but by working together, sharing key resources and collaborating so as to compete externally through close interdependence in a cooperative network. Also, the Business environment today requires a whole of investment in different things such as R&D in order to come up with a new product depending on the demand side of the market, in some cases the funding involved in carrying out such projects is just too huge for one single organization to keep up with (Bessant &Tidd, 2007, p.89), the best way for organizations to involve themselves in certain activities and not get drained financially is by forming some networks with other organizations who has the same goal and maintaining those networks to stay competitive in this kind of dynamic environment. Sharing task, responsibilities, risks are all made possible

by business-to-business integration (Applegate et al. 2007, p.88). Organizations that were usually competitors could now work together via B2B initiative.

4.2 B2B Integration Challenges

4.2.1 Internal Integration

The biggest challenge companies often encounter with is internal integration of their applications and data (Samtani, 2002). Especially large and globally spread enterprises has hundreds applications, including internally developed applications, packaged applications and shared applications within the trading community.

Worst part of this problem is even in the same trading community different enterprises uses different standards and strategies to connect their system internally (Themistocleous et al., 2001). This integration problems need to resolved first before going for B2B integration because fundamentally every transaction has to communicate with back-end system and data (Bussler, 2003, p. 5).

4.2.2 Standards & Heterogeneity

Companies use different components in their IT infrastructure in terms of operating systems, hardware software platforms and types of networks inside and outside the companies (Samtani, 2002, p.38), therefore bringing all these different kinds of heterogeneous layers of IT infrastructure components to homogenous layer demands efforts internally and externally.

4.2.3 Security

The arrival of new technology might bring new security concerns, thus with the implementation of B2B integration security performance also needs to be done (Linthicum 2001, p.330) because companies like NASDAQ and other financial services are concerned about security issues. It is quite sensible concern of companies about their corporate data and other profitable information when data flows across companies (Samtani, 2002, p.38).

4.2.4 Reliability, Scalability & Availability

Reliability, scalability and availability deal with the transaction, which needs to be sent or received. The promise of real-time sending and receiving of transaction with full reliability is a huge challenge for B2B community. Delays in sending or receiving in transactions affect the whole B2B community (Samtani, 2002, p.38-41; Brodie, 2000).

4.2.5 Business processes Alignment

B2Bi is not just connecting systems together; the recent trend shows that companies are serious to manage their business process both internally and with business partners. Different business rules behind same kind of applications to be used for the same purpose wrapping too many complications in business processes (Samtani, 2002, p.39). Inter-enterprise business unit often finds it challenging for developing standardized design of their business processes.

4.2.6 Collaboration and synergy

Collaboration and synergy in B2B is the very basic aspect with which companies deal. The real purpose of extending the boundaries is to interoperate the workflows (Brodie, 2000); businesses processes and share each other's resources. Without this there is no use of applying any B2B pattern or implementing any integration strategy. This collaboration and synergy in the long run is the very objective of the trading community. The trading communities who have long sightedness take this challenge very seriously and it is a huge challenge to maintain and keep up the synergy through B2B integration strategies.

4.3 B2B Integration Patterns

In order to accomplish the integration companies often implement one or more integration patterns depending upon the requirements, their internal integration structure and IT infrastructure technology environment. In this section integration approaches from three different authors will be studied.

4.3.1 Pattern 1 by Gunjan Samtani

Samtani (2002) has identified four fundamental types of available integration patterns in B2Bi.

4.3.1.1 Data Oriented B2Bi

Data oriented B2Bi (DOB2Bi) aims at accessing and sharing the data between enterprises in a trading community. It is the communication between application and one or more data sources, or one data source to another data source.

Normally data resides in databases in the form of data warehouses, data marts and other sources. Trading partner's data format and contents can vary, and even technologies used to construct these databases often differ from each other (Bussler 2003, p.30, 96; Samtani 2002, p.49; Stonebraker et al., 2001), which are built on different database technologies. Different proprietary Application Programming Interfaces (APIs) are used to interact with data, with data oriented integration proprietary APIs can be removed and data can be accessed through single standard interfaces (Samtani, 2002).
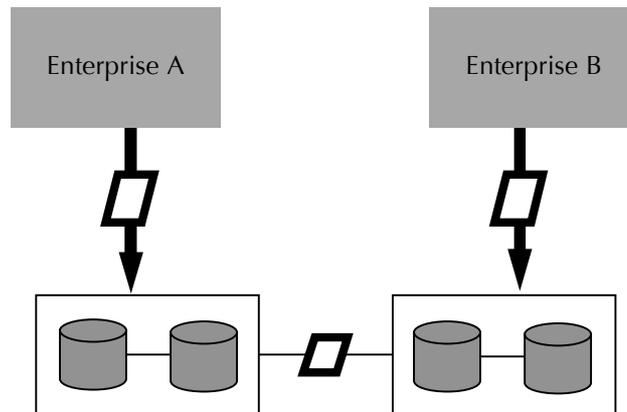
Figure 2. Data Oriented B2Bi
Source: Samtani (2002)

As different database technologies and data formats are involved in this integration pattern, therefore in reality complications arise, for example inconsistent views of data at source and target location, extracting, transforming and loading of data from different data sources, and universal access of data on different platforms and different hardware (Samtani, 2002). There is variety of solutions offered by vendors to cop with these problems and companies can enable their DOB2Bi by

- Data replication solutions
- Extract, transform and load solution
- Multi-database server solutions

4.3.1.2 Portal Oriented B2Bi

Portal oriented B2Bi (POB2Bi) is less complex and widely used integration scheme. Many large and small enterprises use portal-oriented integration to incorporate different business contents, like, ERP systems, CRM and other legacy application.

In POB2Bi information can be accessed through a web browser by using a single web interfaces (Bussler, 2003, p.102). Horizontal portals provide infrastructure upon which vertical portals (B2B Exchanges) are built. Horizontal portals have portal server, which is connected to company's internal and external data and application. Portal server has a service layer that adds services to portals which is to be presented through a common web supported interface by presentation layer (Samtani, 2002, p.70-74)

For e-marketplaces, portal oriented integration provides opportunity to buyer to access the supplier's portal for checking and ordering products. The focus in such an integration method is e-procurement and supply chain services.
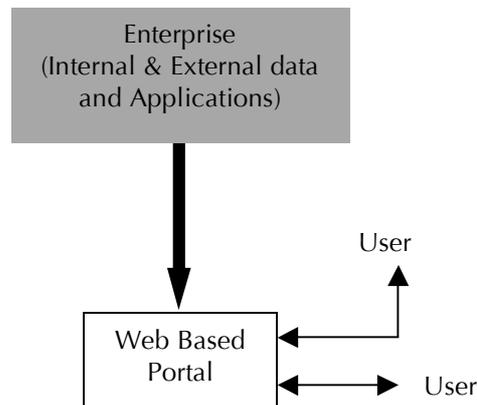

Figure 3. Portal Oriented B2Bi
Source: Samtani (2002)

4.3.1.3 Application Oriented B2Bi

Application oriented B2B integration (AOB2Bi) is the direct integration of one application to another application of one enterprise to another enterprise. It is the communication of APIs or Remote Procedure Calls (RPCs) between application components, thus involves the use of adapter (Bussler, 2002; Samtani, 2002, p. 75).
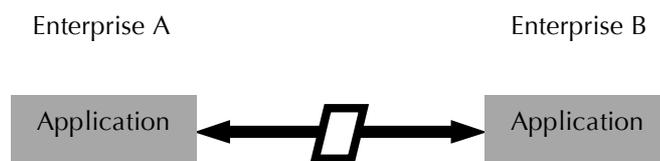

Figure 4. Application Oriented B2Bi
Source: Samtani (2002)

Enterprises have to work closely to achieve application oriented B2Bi and technical aspects involved in this type make it inflexible and less suitable for the trading community because of security issue and difficulties in post implementation changes for new technology (Samtani, 2002).

Bussler (2003, p.91-92) emphasizes on application-to-application (A2A) integration and suggest that A2A integration and ASP integration are complementary entities to talk about B2B integration. He further argues that, since backend application communicate with each other in B2B integration; therefore B2B architecture should support both B2B and A2A (Bussler, 2002).

4.3.1.4 Business Process Oriented B2Bi

Business process oriented B2Bi is an integration scenario in which integration is accomplished by sharing business rules, also known as business logic. This technique is more elegant than data oriented and application oriented integrations (James et al., 2002), and could be achieved via public or private business processes.

In private business process integration, business rules are internally process while in public business process integration; business rules are openly processed between enterprises (Samtani, 2002, p.89-90).

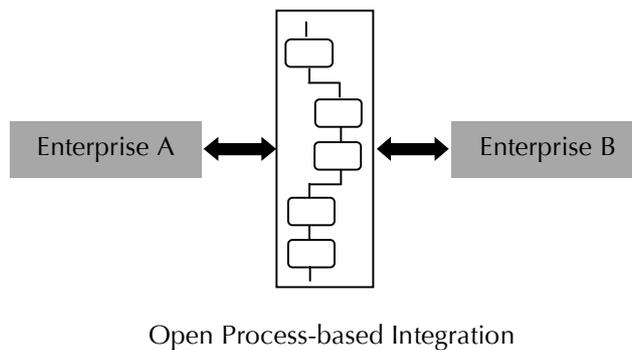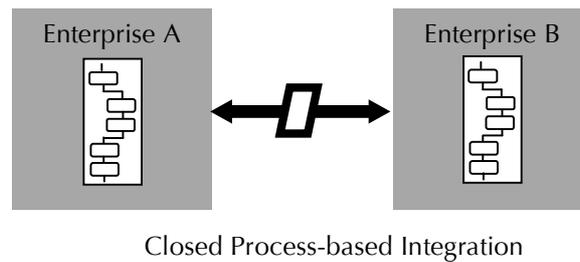Closed Process-based Integration

Open Process-based Integration

Figure 5. Business Process Oriented B2Bi
Source: Samtani (2002)

This type of integration provides trading partners complete independency to handle their technical solution. Companies often use the complete business process management suite to implement this type of integration.

4.3.2 Pattern 2 by David Linthicum

Linthicum (2001) has identified five approaches to business-to-business application integration.

4.3.2.1 Data Oriented

Linthicum's (2001) data oriented integration approach aims at sharing and accessing information among partners involved in the trading community by integrating data and/or databases. For most of the companies it is the starting point of B2B integration, even then sharing and accessing data is not simple enough. Particularly in the case when data has built on various formats and with both loosely and tightly coupled technologies, in such a case when data is linked with application logic it is very difficult to make data oriented application integration work (Linthicum, 2001, p.37). Which is a good reason to employ some other technique along with data oriented B2B application integration.

With the evolvement in technologies, database oriented technologies are available, which assemble different brands of databases sold by different vendors in a more sophisticated way to deal with the transformation issues of data while accessing the data from one source to another. With these technologies, data replication and transforming is possible to keep the application logic of the source or target database (Linthicum, 2001, p.41-43; Samtani, 2002, p.50-59). But handling of database is still difficult when encountered with those applications whose logic and data is united.

Federation approach to deal with data-oriented integration is presented by Linthicum (2001). Instead of using replication software, physical databases are federated to a single virtual database. This virtual database, which can be regarded as the "single point of entry", can be connected to any number of physical databases of different brands and application logic in this approach dwell in the physical databases (Linthicum, 2001, p.43-44; Gulledge, 2006). The use of middleware technologies in federated database integration is an advantage and provides autonomy to enterprises to maintain their databases, but disadvantage is the difficulty to control the virtual database through a common schema that is not centrally controlled.
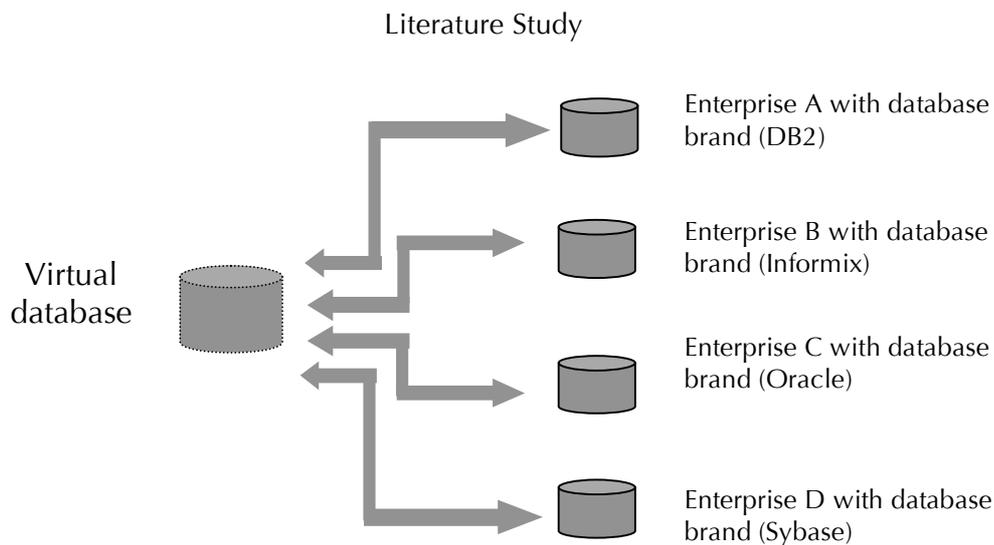
Figure 6. Data Oriented B2B Application Integration
Source: Linthicum (2001)

4.3.2.2 Application Interface Oriented

Application interface oriented B2B application integration is a mechanism of integration through application interfaces. This approach can be applied with data oriented approach to share business logic. Application interface oriented application integration is the well-suited solution for packaged applications.

"Application interfaces are interfaces that developers expose from packaged or custom applications to gain access to various levels or service" (Linthicum, 2001: P52).

Such interfaces allow users to access the services of these applications. These interfaces are exposed through APIs, vendors seem to be dominated here, and many-packaged application APIs are available to expose different interfaces. Linthicum (2001) argues that difficulties in the pattern of integration have greatly reduced due to standardization of interfaces.

4.3.2.3 Method Oriented

Method oriented B2B application integration allows business partners to share the business logic (or method) by any number of applications in a trading community. It also allows application to access each other's methods without putting an effort on re-writing the methods for each respective application; access can be made by sharing the methods on central server or by accessing different applications. Enterprises use method warehouses (Linthicum, 2001: P 80-81), method warehouses supports in bringing the common methods used in application to a central place. Method warehouses are powerful entity in method oriented B2B but expensive.

Inside method oriented B2B application integration different mechanisms and tools are involved, which provide the facility to recognize how to share common methods, in broader sense these tools and techniques shows how to create the shared integrated infrastructure by enabling the common methods that are involved in business processing. There are numerous methods employed by the enterprises to utilize this integration strategy, for instance, distributed objects, application serves, transaction processing monitors, frameworks and approaches to create new applications for combining two or more applications (Linthicum, 2001, p. 28).

Linthicum (2001) argues that the very first things which should be accomplished in this integration is different "scenarios", which include rules, logic, data and objects, and then frameworks (Linthicum, 2001, p.82-88) for B2B are leveraged, finally method oriented integration needs integration technologies to complete this.

4.3.2.4 Portal Oriented

Portal oriented B2B application integration do not integrate the back-end system but allows to view information from internal, external and from trading community to single user interface (Linthicum, 2001, p.29, 91). Trading partner (buyer and suppliers) don't integrate their systems directly but access the required information through web browser.

There are different kinds of portals ranging from single system portal, multiple system portals to trading community portals, depending on the amount of enterprise systems to be integrated. Enterprises use middleware technologies to host their information from the back-end systems to web server, as they are widely used for portal integrations, and portal user access the information in web browser, however portal users need to keep their back-end system up to date (Linthicum, 2001).
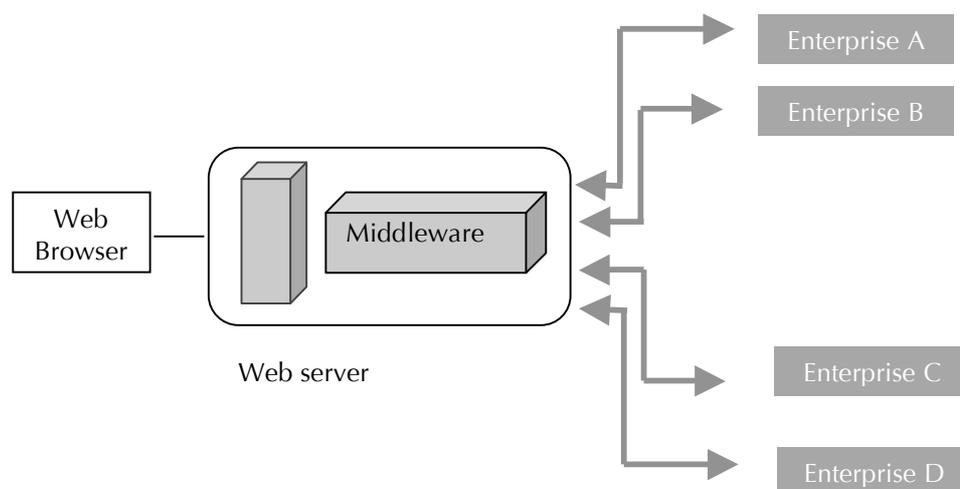

Figure 7. Portal Oriented B2Bi Application Integration
Source: Linthicum (2001)

Important task is designing the portals is to create a user interface and application behavior and to settle on the issues of back-end system (Linthicum, 2001, p.93). Like other B2B application integration patterns defined by Linthicum (2001), portal integration also has advantages and disadvantages in the form of avoiding complexities of integrating back-end systems, automation of information and the lack of real time information, security over the web and less understanding with business events (Linthicum, 2001).

4.3.2.5 Process Oriented

Process Integration approach has the ability to define a common business process model that defines the sequence, hierarchy, events, execution logic, and information movement between systems residing in a single and multiple organizations.
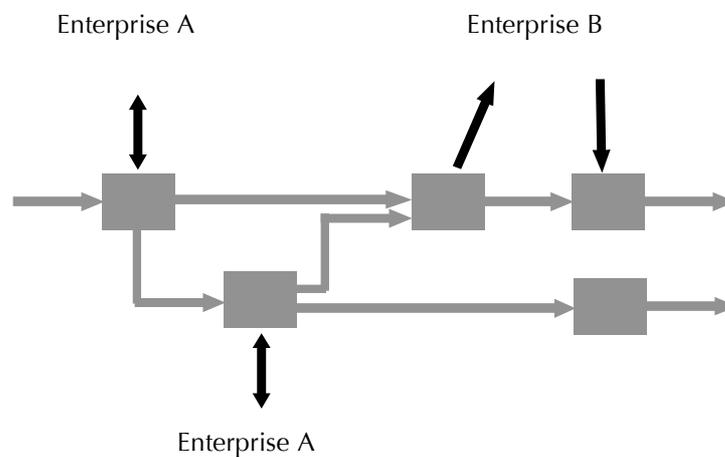
Enterprise A   Enterprise B

Enterprise A

Figure 8. Process Oriented B2Bi Application Integration
Source: Linthicum (2001)

David Linthicum (2002, p.105-108) takes this approach as a strategy and a technology that strengthens enterprises the ability to interact with their trading partners by integrating entire business processes both within and between enterprises. This approach deals with several organizations using metadata, platforms, and processes. This approach has a flexible technology providing a translation layer between the source and target systems and the process integration engine. This approach works with several types of techniques including message oriented and transaction-oriented middleware.

This approach is said to have the capability of managing the movement of data and the invocation of processes in the correct and proper order to support the management and execution of common processes that exist in the extended enterprises. This approach provides another layer of easily defined and centrally managed processes and data within trading partner's applications.

Process integration approach is also said to be able to aggregate business process modeling, business process automation and workflow. Process integration approach implements and manages transactions in real time business processes that span multiple applications, providing a layer for creating common processes that span many in integrated systems.

4.3.3 Pattern 3 by Andre Yee

According to Andre Yee (2001) there are seven patterns are available for business integration, out of which four deals with the internal integration of the enterprise and rest of the three he attributes to B2B integration. These are direct application B2Bi, data exchange B2Bi and B2B process integration.

4.3.3.1 Direct Application B2Bi.

Direct application according to Andre (2001) can be regarded as the integration of different application of two enterprises; this more looks like the externalization the enterprise's internal application integration, because back-end application of source company communicate with back-end system of target company and reach out each other's boundaries. Different companies use different software packages from different vendors and apply technologies like integration broker and adapters over the public network. Similar discussion can also be found in Bussler's (2002) way of explaining it. According to Andre (2001) this does not fully interact with B2Bi environment, but an effective way of supply chain between two partners.

Network

Enterprise A
ERP

Enterprise B
ERP
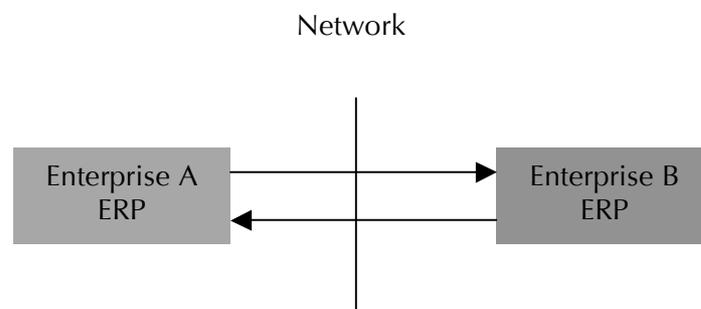
Figure 9. Direct Application B2Bi
Source: Yee (2001)

4.3.3.2 Data Exchange B2Bi

Data exchange B2Bi allows B2B electronic transactions to be done by using common data exchange format. Companies using this technique translate data form different sources to xml document and then transmit data through the use of data exchange gateways on both ends. Andre (2001) holds gateway service responsible to handle data (with security envelops) and route the data through standard transport.

Data exchange B2Bi removes the difficulties raised by application-to-application B2Bi and provide the opportunity for the entities involved to exchange data freely, it is most widely used technique today (Andre, 2001).
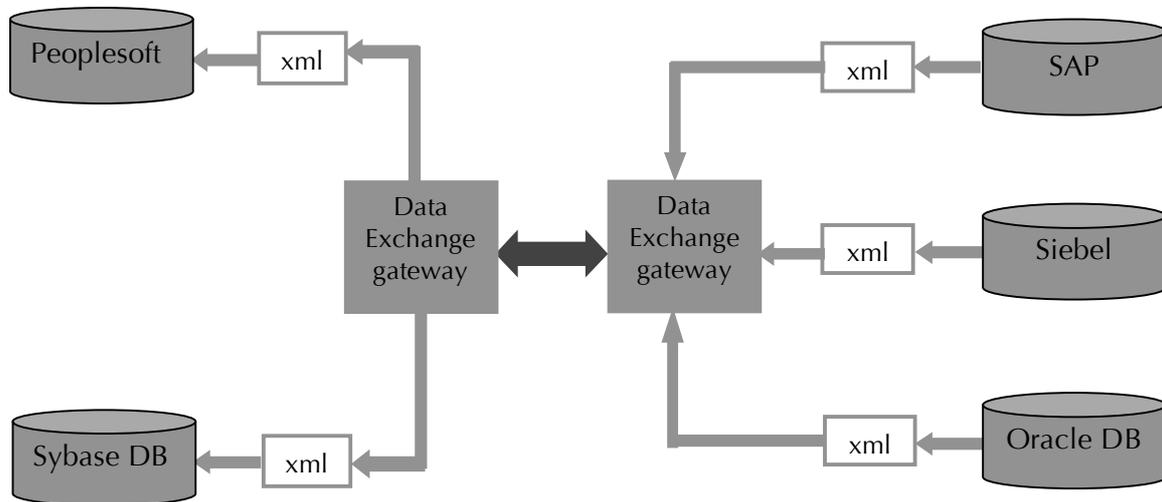

Figure 10. Data Exchange B2Bi
Source: Yee (2001)

4.3.3.3 B2B Process Integration

Process integration comes where data exchange B2Bi has limitations. Process integration is the same as data exchange method as Andre (2001) puts it that just as partners exchange data dynamically through data exchange gateways in xml documents, in process integration, companies share processes in the same way.

Process integration in B2B is important in the context that it standardizes the sequence of business transactions, which creates external business processes; those external processes are responsible for the development of standards of B2B protocols in the business environment.

Andre (2001) also breaks down process integration in B2B as closed and open process integrations. In closed process integration, enterprises externalize the key business processes through data exchange gateways; while in open process integration business processes are shared between multiple partners involved the process.

4.4 B2B ENABLINGING TECHNOLOGY

It is difficult to go through all the enabling technologies in B2B integration however common technologies, which are necessary to explain, are below.

4.4.1 Middleware

There are many definitions of middleware, according to Linthicum (2001, p. 128) *"middleware is a mechanism that allows one entity to communicate with another entity or entities"*.

According to Samtani (2002, p.214), *"middleware is a distributed software that reside in the middle of the client/server system providing a uniform 'conduit' for client applications to communicate with the server"*

So, simply middleware is software provides facility in communication. Most of the B2Bi discussed deploy a point–to-point middleware, which only allows one application to link with another. This point-to-point middleware is limited by not being able to properly combine or integrate two applications.

Moreover, many–to-many middleware employed by the process oriented B2Bi has the capability of linking many applications to many other applications, this capability makes it the best option for B2B integration as it provides flexibility and applicability to the B2B application integration problem domain (Linthicum, p.128-131).

4.4.2 XML

XML is defined by Webbens online dictionary as an extensible Markup Language for specifying data. XML is not a single, predefined markup language: it is a meta language - a language for describing other languages. According to Bray et al, (1998), XML, is a platform-independent open standard defined by the World Wide Web consortium (W3C). XML is a Meta mark-up language for expressing structured documents, and it defines the syntax in which other specific mark-up languages can be written. Bray et al, (1998) highlights that just having information in a XML document does not make the applications understand each other; it mainly provides a way to access information.

XML allows the structure of information to reflect more on more readable forms that could be understood by human readers while retaining a capability for machine processing which provides an efficient structure for evaluating content for information that in a more manageable manner.

4.4.3 XML & Web Services Technologies

Web Services technologies are defined using XML that can be employed by other applications using Internet protocols (Motta et al., 2003). Web services are potentially important in a number of areas, including enterprise portals and online exchanges. Enterprise portals could exploit web services not only for publishing and implementing services for internal and external applications, but also for personalization of services based on user identity, history, and runtime circumstances. Private and public exchanges might use web services to exploit

these same opportunities, but could also use them to dynamically bind buyers and sellers, according to exchange-specific heuristics.

The foundation for implementing the web services model is mostly in place, but few real world implementations exist today. Like the other application patterns we've examined, the autonomous distributed pattern, based on the web services framework, will seek its own level beside other integration patterns, as business models evolve to take advantage of this new approach. The basic Web Service technologies include Simple Object Access Protocol (SOAP), Web Services Description Language (WSDL), and Universal Description Discovery and Integration (UDDI).

According to (Gudgin et al, 2001), SOAP defines a framework for describing what is in a message and how to process it, a set of encoding rules for expressing instances of application-defined data types, and a convention for representing remote procedure calls and responses. It is the messaging layer for Web Services.

(Christensen et al, 2001) says that WSDL defines services as collections of network endpoints or ports. In WSDL, the abstract definition of endpoints and messages are separated from their concrete network deployment or data format bindings. The basic Web Service client's code can be generated automatically from the WSDL making it easier for programmers to use the service.

5. FINDINGS

In this section findings of different integration patterns are presented. Characteristics of each category of pattern according to three literature sources is shown in the table form below.

5.1 Integration pattern Characteristics

Table 1.

Reference	Integration pattern	Characteristics
Samtani, (2002)	**Data Oriented B2Bi**	• Eliminate the use of proprietary interfaces to access data. • Can be real-time or non real-time integration. • Integrate legacy, ERP, CRM, SCM. • Provides unified view. • Independent from partner's database, operating system and network channels. • Different database technologies and data formats. • Semantic discrepancies occur. • Can be achieved via data replication, ELT and multi server database.
	Portal Oriented B2Bi	• Not Complex & Expensive • Quick and efficient way to maintain business relationships. • Provides single web interface to trading partners. • Integrate ERP, CRM and legacy systems. • Lack of business process management. • Mostly fails to achieve true B2Bi. • Involves horizontal and vertical portal to work together.
	Application Oriented B2Bi	• Direct A2A integration. • Supports cross platform and cross-enterprises applications. • Requires adaptors to connect applications. • Synchronous integration (real-time). • Facilitated by APIs. • Limitations of APIs are involved. • Integrate ERP, CRM and legacy systems. • Requires close technical collaboration of trading partners. • Lack in business process improvement. • Security issues involved

	Business Process Oriented B2Bi	• Sophisticated than data oriented and application oriented B2Bi. • Gradual implementation required. • Involves public and private business processes. • Flexible and more beneficial for the trading partners. • Real time integration
Linthicum, (2001)	**Data Oriented**	• Entry point of integration. • Database technologies and complexities of data integrity. • Semantic differences involved. • Coupling and de-coupling of data with application and interface. • Simple and quick (to market) integration. • Can be made real-time by using advanced B2B integration technologies. • Can be achieved via data replication and federation schemes. • Generally doest not require changes in source or target application.
	Application Interface Oriented	• Appropriate for packaged solutions. • Standardization of APIs makes it feasible. • Efforts required on both process and data. • Dynamic and real time APIs. • Message brokers are preferred solution. • Generally doest not require changes in source or target application.
	Method Oriented	• Standardize able in trading community by sharing common business logic. • Provides reusability in the enterprise applications. • Integrate business process and data. • Generally requires changes in source or target application to take full advantage of integration. • Good for small trading communities
	Portal oriented	• Single user web interface. • Avoids back-end system integration. • Back-end systems needs to be updated. • Best approach to move information to user interface. • Faster to implement. • Not real time integration. • Security issues involved. • Not a true B2B integration. • Automation of business transactions.

	Process oriented	• Support for real time integration. • Encapsulate data, application method and portal integration. • Highly beneficial to trading community. • Integrate workflows, systems, processes and data. • Support for redesigning of the systems.
Andre, (2001)	**Direct Application B2Bi**	• Entry point for B2Bi. • Applications are linked directly. • Only relevant applications are exposed. • Mostly for SCM and service to customers. • Each participant account for security and integration environment. • Demanding to implement. • Not scaleable in B2B environment.
	Data Exchange B2Bi	• Overcomes the difficulties of direct application integration. • Commonly used and simple. • Business processes are static. • Common data format is used.
	B2B Process Integration	• Scalable in B2B environment. • Handles more complex relationships in B2B. • Manage protocols of business transactions. • Costly to implement.

5.2 Integration Pattern Comparison

In order to dig deeper into findings, comparison table (see table 2) is presented of these integration patterns. Seven variables are used to compare the different features of the integration patterns; variables are chosen on the basis of literature studied and the information found in the integration patterns. Chosen variable reflect the challenges and drivers of integration patterns as well. However, short description of the variables is given below.

Real Time: variable shows that whether the pattern handle information on real-time or not.

Scalability: Scalability shows whether a pattern has the capability to evolve in future with the emerging changes.

Security: It reflects the amount of security involved in the pattern.

Flexibility: Flexibility is the level of autonomy companies needs to have in that particular integration pattern, both in terms of application and collaboration.

Business Process: It measures ability of integration to manage the business processes.
Cost Effective: It shows whether the integration pattern is cost effective or not.

Business Automation: It is the ability of integration pattern to automate the supply chain, customer relation and other services.

Table 2

		Real Time	Scalability	Security	Flexibility	Business Process	Cost Effective	Business Automation
Samtani (2002)	Data Oriented B2Bi	Yes/No			Yes	No	Yes	Yes
	Portal Oriented B2Bi	Yes	Low			No	Yes	Yes
	Application Oriented B2Bi	Yes	Low	Required	No	No	No	Yes
	Business process Oriented B2Bi	Yes	High		Yes	Yes		Yes
Linthicum (2001)	Data Oriented B2BAI	Yes					Yes	
	Application Interface B2BAI		High					Yes
	Method Oriented B2BAI		High		Yes/No	Yes	High	
	Portal Oriented B2BAI	No	No	Required			Yes	
	Process Integration Oriented B2BAI		High	Required	Yes	Yes		
Yee (2001)	Direct Application B2Bi		Less	Required	Less	No		Yes
	Data Exchange B2Bi		Medium		Yes/No	No		
	B2B Process Integration		High		Yes			

6. Analysis

In this chapter, findings are analyzed. Analysis is being conduct by using the model described in the theoretical framework and other relevant parts of the literature review.

Based on the findings, different authors group different integration patterns according to their perceptions of the patterns. Opinion of three authors of these integration patterns differs the way they focus on different integration patterns and the way they highlight different focal points of these patterns. It is analyzed that some particular aspect of some particular integration pattern according to one author might not be described with the same intensity by other authors.

Findings will analyzed in three different ways, firstly, integration patterns will analyzed in term of their advantages and disadvantages with technology and business, secondly, maturity of these integration patterns will be analyzed and finally these integration patterns will be analyzed for company's short-term and long-term goals.

6.1 Integration Pattern Analysis

All three authors of integration patterns perceive some difficulties with integration patterns, which involve data (*data oriented*) as a target source of integration, due to different and inconsistent databases involved making it hard to create common schema among integrated systems. Samtani (2002) observes that data oriented B2Bi is the communication between application and one or more data sources, or one data source to another data source, meaning that this approach has limitations on the number of applications that can be connected. This brings us to the point-to-point middleware technology (Linthicum, 2001) based on the description of this integration patterns, it uses point–to-point middleware technology for integrating different applications and is limited by not being able to properly combine or integrate two applications. So this probably will not be a good option for integrating the multiple trading partners in an extended enterprise. Most of the organizations start B2B integration from data oriented type as companies are handling data or databases from long time and it is the logical

Portal oriented integration is not a true B2B integration but is being used commonly due to its speed to market. Many small and medium size companies who cant afford sophisticated technologies use this integration. One conflict concerning portal oriented integration according to Linthicum (2001) and Samtani (2002) is that the real "timeness" of this type. So we agree with both authors that this pattern does not quite satisfy the requirements of B2B integration. Security is another major issue of concern of this integration pattern,

in such a heterogeneous environment, all data of the trading partners needs to be more secured; however, security is an issue of this integration type.

It is also analyzed concerning application oriented integration that the technical aspects involved makes it inflexible and less suitable for multiple trading communities as this pattern deals with a direct integration from one application to another application of one enterprise to another enterprise. Linthicum (2001) on the other hand observes that the type of business information that are accessible through application oriented B2Bi is limited by the features and functions of the interface. This approach requires building interfaces into existing application, meaning that there will be a lot of developing and testing going on with this approach which really not cost effective.

Bussler (2002) however emphasizes on the application-to-application of this approach, bringing us back again to point–to-point middleware integration technology, with this notion, this approach probably does not have the capability of integrating multiple trading partners. Yee (2001) use direct application integration terminology for this type of integration and finds this as a logical extension of company's internal integration.

Samtani (2001) and Yee (2001) don't talk about the *Method Oriented Integration* pattern, but the outlook of it as described by Linthicum looks good as it provides reusability in the enterprise applications and leveraging technologies. Sharing of methods on central server and accessing different applications are made possible by this pattern, this pattern gives the impression that it employs the open standard IT infrastructures for integrating of partner's applications. Linthicum (2001) however also says that this approach is suitable for smaller trading communities. This approach could be regarded as very costly if changing in the applications is happening very frequent, which makes it not difficult in the long run but could be beneficial with effective utilization of technology involved in method oriented integration and by sharing the post implantation cost among the partners of trading community.

Both Authors including (James et al., 2002) view *Process Oriented* approach as roughly meeting most of business and technical drivers for B2Bi integration. Much more, this approach employs many-to-many middleware technologies and XML technology standards, the Open standard and generic nature of this integration pattern make it possible for extended enterprises to integrate with multiple trading partners. This approach recognizes the changing business environment and gives room to accommodate growth and re-engineering if business requirements evolve. Real time transaction and business process automation continue to be among the main drivers for B2Bi integration and these features are employed by process-oriented pattern, just as its name implies.

6.2 Maturity of Integration Patterns

We also analyze that going through the entire existing integration pattern it can be seen that these patterns are laying on each other and create a certain order. Since these patterns have been explored over long period of time and certainly represent the maturity in the integration.

Integration drivers and associated challenges have played a main role to bring maturity in these patterns. This has been viewed that sometimes single integration pattern is not fulfilling the demands company and can produce batter result when combined with some other approach, which ultimately lead to the next pattern of integration.

Maturity of these patterns is not just by combing them with other patterns but is lightly coupled with the standardization of technology and different standards, which support the communication and enable these integration patterns.

6.3 Short & Long Term B2Bi

It is wise to analyze these patterns on the basis of model described by Goethals et al., (2004). As described in the theoretical framework part of this easy, extended and market B2Bi corresponds to short and long-term integrations (and integration goals). These patterns certainly are employed on the basis of collaboration, cooperation and partnering of companies (Goethals et al., 2004).

We analyze that deployment of these integration patterns are concerned with company's short and long-term goals and barriers they need to fix. Types of integration patterns and the associated long and short-term goals demand these patterns to be implemented at appropriate time because there is always time and needs to migrate from one integration pattern to another integration pattern.

On the basis of available findings and above analysis, we dig deeper to analyze them by classifying these integration patterns as follows.

Long term B2Bi Patterns: Business process and method oriented integration due to its tightly coupled relationships with the partnering companies are good for accomplishing long-term goals. Furthermore, the reusability of applications found in the method integration seems good to achieve the long-term goals.

Short Term B2Bi Patterns: Portal oriented integration is good to achieve the short term goals associated with market B2Bi because of it is not based on tightly coupled relationships. Short terms goals with portal oriented integration provides opportunity to take full advantage of integration in the net community.

Primary B2Bi Pattern: It is impossible to overlook the basic patterns like data and application oriented integration because they provide the foundation of these patterns.

7. CONCLUSION

In this chapter, conclusion has been presented that has been generated by doing analysis on findings.

In this report, we described the different integration patterns, associated challenges and the drivers of these integrations that could be found within an extended enterprise as well as the different trading partners, and models that could be found within, as long as inter-enterprise integration is concerned, it is necessary to make clear of who to be integrated in order to know the right integration approach.

We conclude that these integration approaches has their own merit and weight and scenario in which these approaches can be implemented. Each integration approach meets certain challenges and demands of the companies. One single approach cannot be select as the best approach, not even that approach fulfills the entire integration mechanism.

We cannot readily elect one approach to meet both short and long-term goals. But it can be seen that Process Oriented approach have some advantages be more suitable for integrating extended enterprises due to the fact it has some advantages over the rest of the approaches. The justification for this is based on the fact that a chosen approach has to able to integrate multiple trading partners of the extended enterprise, also, one of the main drivers for B2B integration is real time transaction, these reasons make the process oriented approach more appealing over the other integration patterns. We also conclude that method oriented-integration is also good solution for the long-term objectives due to its reusability of common application logic.

As short-term goals are associated with market B2Bi, thus portal oriented integration is reasonable approach due to its speed to market and low cost. Combination of data oriented integration with applications interface integration could also be helpful in this regard.

We further conclude that companies should set the long-term goal associated with integration patterns, in other words shared and integrated IT infrastructure is necessary to create after establishing long term goals, short-term integration patterns can be exploited to grasp the opportunities quickly in the market.

At the end, we found out that implementing B2B integration technology is not a straightforward decision. Different type of business model that defines extended enterprises requires different integration approaches. Integration challenges, business requirements and expected benefits must be taken into consideration before employing any integration technology for short and long-term business

goals, just applying more sophisticated integration approach without determine the exact integration needs and goals is not a good policy in the long run.

8. FUTURE WORK

In this chapter, different possible future research options are discussed.

Due to limitations we were encountered during the study of thesis, very first step regarding the future work of this thesis could be to explore more groups of B2B IT integration and analyze them.

During this study we have come across the fact that existing patterns overlap with each other when different technologies are used to implement these patterns. This would be extremely helpful to categorize IT integration patterns on the basis of their behavior.

Another aspect of the future work would be to judge the findings and analysis by collecting data from both vendors who supply these B2Bi solutions and companies who use these solutions. By doing this plausibility of arguments can further be tested and more solid results are expected.

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