

Web Services – An Enabling Technology for Trading Partners Community Virtual Integration

Siew poh Lee, Hanboon Lee, Engwah Lee

Singapore Institute of Manufacturing Technology, 71, Nanyang Drive, Singapore 638075,

Tel: +65-67938383, Fax: +65-67916377

{splee, hblee, ewlee}@SIMTech.a-star.edu.sg

ABSTRACT

The Application Service Provider (ASP) model is a widely adopted business model for communities of buyers and sellers to conduct commerce over the Internet in a virtually integrated environment. However, there are limitations imposed by the ASP model. This paper discusses how an alternative combination of peer-to-peer and web services technologies can provide a suitable, low-cost IT infrastructure that could potentially overcome these limitations and enable trading partners in a community to achieve virtual integration. Such an alternative infrastructure would allow trading partners to improve upon their resource utilisation for IT and, instead, focus on their core businesses, discover new business opportunities and form new partnerships dynamically as and when needed, in a loosely-coupled manner.

Keywords: collaborative commerce, distributed trusted network community, peer-to-peer, virtual integration, web services.

1. INTRODUCTION

The current economy faces two key challenges, namely the market challenges and catching up with the rapid advancement of information and communication technologies (ICT). The market challenges are attributed to factors such as the shift from a PUSH¹ to a PULL² economy, shorter time-to-market, erosion of product loyalty, internationalisation and globalisation, and decentralisation of manufacturing activities [2][3][4]. The other great challenge relates to making sense of rapidly evolving ICT, attributed to the fusion of computer and communication technologies, the advent of the Internet and the wide adoption of open and de-facto standards, such as XML, Java™, TCP/IP and HTTP.

Due to these challenges, businesses from various industry sectors have gradually migrated away from their traditional way of conducting business such as the use of the telephone, fax machine, and postal mail, to conducting their transactions over the Internet. For instance, trading partners in the high-tech manufacturing industries are moving away from the rigid, heavyweight, and tightly-coupled EDI interfaces to the XML-based RosettaNet® [10] business-to-business (B2B) standard, to conduct e-business over the Internet.

2. THE RISE OF THE NEW DIGITAL ECONOMY

Technology has revolutionised the way of doing business

over the Internet. Fingar [1] described that technology and business move abreast of one another. Based on the changes in information technology, the timeline of business technology is divided into 6 stages. We are now entering the ubiquitous computing realm which focuses on Internet-based collaborative computing. The B2B interaction will be increasingly be digitised and migrated to cyberspace.

The new digital economy has transformed the business world from the traditional, linear value chain model to a centralised value network model. Figure 1 illustrates how information and product are passed within the traditional linear value chain model. The main drawback of this model is that the visibility of information is tier-dependent. Information is not properly shared between the parties upstream and downstream of the value chain. Even if information is shared, the information systems tend to be rigidly-configured, tightly-integrated, proprietary, non-reusable and unportable, often requiring high infrastructural set-up and maintenance costs. The chain, and hence the information systems to be used, tends to be dominated by the chain master.

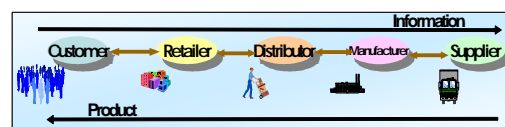


Figure 1 Traditional Linear Value Chain

Figure 2 illustrates a centralised value network where partners form a trusted network community to conduct collaborative commerce via a hub-and-spoke e-marketplace that facilitates the business processes. For example, Covinsit's [2] e-marketplace model transforms the linear chain into a far more efficient network model that facilitates information sharing within the community. However, the infrastructural cost is still substantially

¹ In a PUSH economy, there is more demand than supply. The producer or manufacturer pushes out their products to the consumer.

² In a PULL economy, there is more supply than demand. The consumer dictates the kind of products to be produced.

high, and information systems remain tightly integrated and proprietary. Furthermore, the interconnectivity within the community is static in nature.

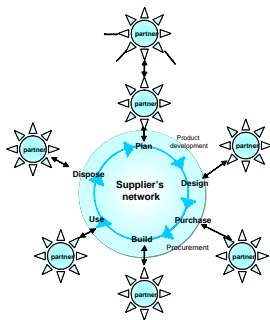


Figure 2 Centralised Value Network Model

In this model, the application service provider has to bear the full cost of the infrastructure that needs to be put in place to provide the service to the community. The cost of enterprise application integration (EAI) to the partners' back-end systems will be high as well, if they choose to have it. The interconnectivity within the community is static because it has to be pre-determined.

3. THE VIRTUAL COMMUNITY

Figure 3 shows an example of the complex, interwoven digital commerce connectivity among different clusters of value network communities (VNCs) that is beginning to emerge. This is a decentralised VNC model. The clusters of VNCs give rise to the dynamic nature of the digital economy. Some of the key characteristics of the digital economy are described as follows:

- each VNC consists of both supply and demand chains that form a value chain driving from customer demand to the delivery of the final product to the customer
- one VNC competes with another VNC
- a trading partner of a community can be a partner of another community
- each trading partner focuses on its core competencies

The success of a VNC requires the sharing of information, business processes and other resources among partners upstream and downstream of the individual value chains. It is therefore vital that partners in the community are virtually integrated with one another. Competing in the digital economy is neither just about technology nor just about business. It is about getting all the value chain partners to work together seamlessly, collaboratively, securely, dynamically as a digital commerce community over cyberspace, and hence, the formation of "Virtual Enterprises". In this context, the "virtual enterprise" comprises all trading partners, customers and suppliers working together as ONE single, extended entity.

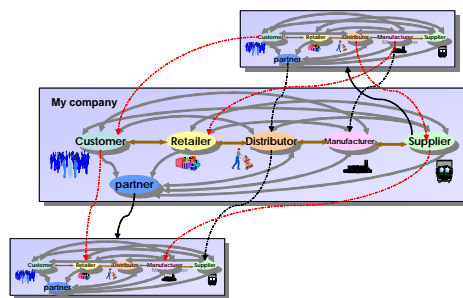


Figure 3 Decentralised VNC

4. CURRENT CHALLENGES

For enterprises, both large and small, to function as a member of a VNC, they are confronted with a number of business and technical challenges. The business challenges include:

- Ability to re-configure itself rapidly
- Lack of common standards in digital commerce exchange
- Ability to handle a diverse, de-centralised and dynamic collaborative environment
- Ability to provide visibility of timely business information

The technical challenges faced relate to making sense of the diversity of technologies and the multitude of applications being used by the members of the community, including

- Diverse IT applications for Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), Supply Chain Management (SCM), Product Design Management (PDM) and other customised applications.
- Diverse programming languages used for the implementation of IT applications.
- Diverse operating system and middleware platforms.
- Diverse networks types and topologies.

The key challenge is, therefore, to connect the islands of technologies and applications for information visibility and the formation of dynamic B2B relationships and connectivity for the network community.

5. VIRTUAL INTEGRATION INFRASTRUCTURE & FRAMEWORK

Reddy [4] defines virtual integration as being based on the enterprise infrastructure that provides the necessary mechanism for integrating a broad range of forward and backward activities within the value chain, including interaction with trading partners, industry networks, customers, and other maintenance and commodity suppliers. The virtual integration IT infrastructure would then consist of a collection of systems that create an Internet-based marketplace for buyers and sellers to transact in a VNC. Such an infrastructure should enable efficient sharing of information and resources as well as

seamless collaboration of trading partners with one another.

It is observed that three major factors need to be considered to achieve virtual integration for a VNC of trading partners, and they are:

- (1) A good IT framework that is able to support e-services, connectivity, interoperability, security, standardisation of business dictionary, inter-enterprise business process, scalability, reliability and flexibility.
- (2) A suitable business model for deploying the IT framework.
- (3) Commitment from top management.

Obviously, satisfying the first factor would put an organisation at an economic advantage as it would have a comprehensive IT framework to conduct on-line business with partners in the VNC. However, not all partners will have the luxury of owning such a framework because of the high cost of investment. There is, therefore, a need for a cost-effective IT infrastructure that can serve as the necessary framework for partners in a VNC to collaborate seamlessly over the Internet, which is proposed in the ensuing sections of this paper.

It is equally important for a company to have full commitment from the top management to ensure streamlining of the company's Internet strategy with its business strategy. Leading strategy experts Robert and Racine [4] proposed a comprehensive framework that connects a company's Internet strategy with the company's business strategy.

6. COMMON E-BUSINESS COMPUTING MODELS

The widely used computing models used to conduct e-business over the Internet are summarised as follows:

- *The centralised web-based architecture* model provides all on-line business applications for a trading partner community at a central location. A central web server is responsible for handling incoming user requests. Upon receiving a request, the web server gathers data from back-end applications, processes the data based on the appropriate business logic and responds to the user with the required information. In this model, the application can be custom-built or procured, and hosted within the trading partner company's premises. This is an attractive solution if the cost of IT investment is not a constraint of the company because it allows for total control and customisation of the application. However, it requires a substantial level of manpower resources to coordinate and execute implementation strategies, as well as maintain and update the systems.
- *Application Service Providers (ASPs)* offer an alternative solution to the centralised web-based model. ASPs essentially put their applications up for "rent" via the Internet to companies that need them. It is a cost-effective model for companies that have limited IT budget and resources. By paying for the use of such

remotely hosted applications, rather than procuring or developing, and maintaining them in-house, the total cost of ownership for a company could be substantially reduced. The ASP provides the majority of the IT infrastructure and manages the hardware and software upgrades. Such a model enables trading partner companies to "try out" newer technologies at lower costs, as there would not be a need for an upfront investment on hardware and software. However, the ASP would need to have a substantial client base to sustain its high set-up cost, operations cost and maintenance cost, and a typically high service availability rate.

The use of the Internet for e-Commerce has, to date, largely been based on the centralised, multi-tier computing model, such as the two described above. Typically, the functionality of such systems is broken up into three separate tiers, namely, the presentation, business logic and the data source tiers. Such a model may not fit well in the new era of digital commerce due to the complex business interfaces among trading partners. It also does not facilitate information to be shared easily among the VNC due to the complexity involved in B2B integration and the diverse technologies and information systems used by individual partner companies.

7. IMPACT OF PEER-TO-PEER ARCHITECTURE (P2P)

What is *peer-to-peer*? Briefly, it is an architecture model for that can be used to better utilise resources that are connected to a network, such as the Internet. It facilitates the sharing of data, computational resources and services by computers and devices residing on the network.

The main characteristics of P2P are outlined as follows:

- Peers understand both *requests* and *responses*.
- A peer can either act as a *client* or a *server*. It is a client when making a request and a server when responding to one.
- Peers are interconnected with one another via a network, such as the Internet.
- There is no single point of failure.
- Information and resources remain at the edge of the network.

The P2P architecture abstracts traditional, hierarchical networks into a set of nodes that are interlinked based on a set of well-defined rules that provide increased flexibility and mitigates traditional bottlenecks and points of failure. Presently, P2P networks are largely server-mediated. Each network contains both peers and a handful of central servers. These servers are responsible for maintaining a registry of the peers on the network so that they can locate one another. Multiple instances of these servers are usually present for the purpose of ensuring performance and providing redundancy in the event of failure of one or more servers.

In the dynamic digital economy, collaborative product commerce in a VNC is approaching that of a tier-less model. Transactions are being carried out between partner endpoints at the edge of the network community. Each partner endpoint can perform a dual role, one of being a commerce services *provider* as well as commerce services *consumer*. This relates well with the P2P computing model where clients can be servers and servers can also be clients.

From this close correlation between the characteristics of the VNC and those of the P2P computing architecture, it is apparent that the latter would potentially be a good fit for the former. Moreover, P2P overcomes the limitations of the centralised-server computing model by allowing trading partners to provide information services directly to one another. An example of the P2P computing model is Gnutella [7], an open, decentralised network that uses P2P technology for file sharing over the network. Figure 4 illustrates how Gnutella works.

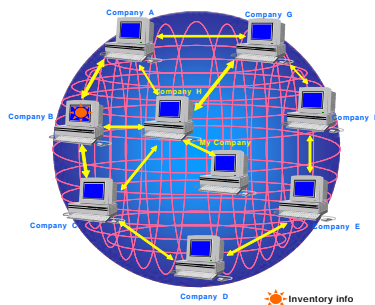


Figure 4 Gnutella Network

When My Company searches for inventory information located in Company B, the search is transmitted to everyone connected in the Gnutella network horizon. Although My Company is not directly connected to Company B, as long as the latter has allowed all partners in the community to view its inventory information, the former will be able to access it through one of the peers that is connected to the latter. Common characteristics of such a network are:

- Any peer can *publish* any information one wishes to share in the network.
- Any peer can *discover* new information in the network.
- Any peer can *consume* the required searched result.
- Any peer can be an information *provider* as well as an information *consumer*.
- New peers can easily *connect* to the network.

P2P technology is an ideal candidate to model the real-world dynamic connectivity required of the virtual integration among partners in a VNC. Each peer in the VNC represents a company that provides its core business functions as e-Services for its partners within the community to consume.

Mirroring the characteristics of the P2P network architecture, the key benefits of a P2P-enabled collaboration community are:

- Each partner in the community can be a service provider as well as a consumer.
- The ability to publish new information to the community as and when it is available.
- The ability to discover and consume new information introduced in the community.
- The ability to rapidly integrate the trading partners in the community.

However, there is a drawback imposed by the existing P2P architecture in that although new information being published to the network can be automatically discovered and consumed, the same cannot be said of services. When a new service has been published to the community, each peer would have to be notified and reconfigured for it to be able to consume the new service. There is no standardised way of describing services and how a peer can be configured to consume new services. One way to resolve this is to leverage Web Services technology to enhance the P2P architecture.

8. WEB SERVICES

Web Services are software components that are programmatically accessible as services over the Internet. The platform- and language-independent interfaces of Web Services allow for easy integration of diverse applications residing on heterogeneous systems. Web Services focus on moving data around using XML [6] to keep inter-application communication loosely-coupled. The publication, discovery and invocation of Web Services over the Internet make use of the following open standards:

- **Web Service Description Language (WSDL)** [8] – a standard that describes a Web Service type and its interfaces.
- **Universal Description, Discovery and Integration (UDDI)** [9] – a standard mechanism for the registration and discovery of Web Services.
- **SOAP (formerly an acronym for Simple Object Access Protocol)** [7] – a standard messaging protocol for Web Services.
- **Extensible Markup Language (XML)** [6] – defines the structured data to be interchanged among applications.

Web Services and P2P complement each other to provide an infrastructure to support the virtual integration of partners within a VNC to enhance their collaborative commerce activities. Figure 5 depicts the conceptual roles and operations of peers in a Web Services-based environment. It illustrates the way Web Services and P2P work side-by-side to complement each other.

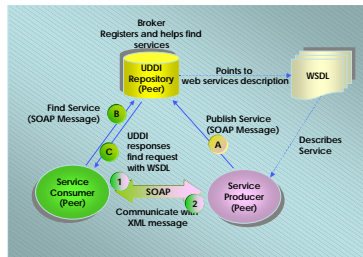


Figure 5 Marrying Web Services & P2P

There are three basic roles. They are the service *provider*, the service *consumer*, and the service *broker*. The service provider makes available the service contract and registers (A) the service with a service registry. A service consumer queries the registry, which serves as the broker, and finds (B) a compatible service. The service registry gives the service consumer directions on where to the service is located and its relevant contract (C). The service consumer uses the contract obtained to bind ((1) and (2)) the client to the service.

The service provider can be a service consumer, and vice versa (for example, in the case of service aggregators). The service registry's responsibility is to maintain a central repository or directory of information on services that have been published for consumption.

9. BENEFITS OF COMBINING WEB SERVICES AND P2P

The use of Web Services and P2P technologies for virtual integration will give rise to the following potential benefits:

- As it is a distributed architecture, the cost is shared among the partners of the VNC, each bearing a fraction of the infrastructure cost. This is in contrast to the centralised web-based architecture where a single party bears the cost and controls the applications that serves the community.
- VNC members can concentrate on providing core business functions as web services for partners to discover and consume, as and when needed.
- VNC members can dynamically discover, establish and conclude short-term trading partnerships without substantial integration overheads.
- VNC members have the flexibility to add new services or update existing services as and when needed, at the edge of the network without affecting other peers.
- The VNC can share resources, for example, by not duplicating existing services that are already being offered by a member.
- VNC members own their business data and maintain their own applications. There is no concern of data privacy as opposed to that of a centralised approach.
- By allowing the community as a whole to better utilise and manage its resources, it is able to achieve better efficiencies to compete with rival communities.
- Information can be pushed as well as pulled, on-demand when required.

- Scalability is enhanced for the VNC as a whole, and single points of failure and other performance-related issues are reduced.

10. CONCLUSION

The combination of Web Services and P2P provides an ideal platform for the virtual integration of partners in a VNC. Using such a platform, individual trading partners have the freedom to make and break short-term partnerships without having to incur large overheads required in integrating with each partner they collaborate with. Data and services provided within the community are always up-to-date as they are put out by the members themselves instead of a central service provider. Data privacy concerns are also eliminated with each member of the community hosting its own data and services instead of making use of a centralised service provider. Performance issues are mitigated by the distributed nature of the services, resulting in a more efficient VNC as a whole.

11. FUTURE RESEARCH

Despite all the benefits described earlier, there remain a number of gaps to be filled before the full benefits of virtual integration can be realised. They include:

- The definition of an inter-enterprise public business processes standard. This to ensure a common set of business dialogues for business process integration between partners in a community.
- The definition of standard business and technical dictionaries to be used for terminologies to be exchanged in documents and messages in business transactions over the network. This is to ensure that a common business language is used between trading partners for on-line B2B transactions.
- The definition of an architectural layer for business process management (or BPM) that enables the orchestration of business processes across the various stages of the life cycle of a project.

REFERENCES

- [1] Fingar, Peter & Aronica, Ranald, *The Death of "e" and the Birth of the Real New Economy*, Meghan-Kiffer Press, 2001.
- [2] Raisch, Warren D., *The e-Marketplace Strategies for Success in B2B eCommerce*, McGraw Hill, 2001.
- [3] Reddy, Ram & Reddy, Sabine, *Supply Chain to Virtual Integration*, McGraw Hill, 2001.
- [4] Robert, Michel & Racine, Bernard, *e-Strategy Pure & Simple*, McGraw Hill, 2001.
- [5] <http://www.gnutella.com/>
- [6] <http://www.w3c.org/XML/>
- [7] <http://www.w3c.org/2000/xp/Group/>
- [8] <http://www.w3c.org/2002/ws/desc>
- [9] <http://www.uddi.org/>
- [10] <http://www.rosettanet.org/>