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# Web Services in Implementation

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## Abstract

*Web services (WS) promise to expand and enrich the existing distributed computing arena with their ability to connect disparate systems and allow communication between them from anywhere and on any platform. Web services promise to revolutionise the way in which companies interact with each other and also how they come together or discover each other to form business alliances. This paper describes the implementation of a system that has been built and used as an evaluation tool for determining the challenges and advantages involved in the implementation of Web services – particularly in a small to medium enterprise (SME) scenario. Furthermore, a comparison has been drawn between the use of such a system and the use of more traditional technologies to address the same situation of integrating implementation.*

**Keywords**

Web services, SOA, SME

## INTRODUCTION

Web services (WS) offer something that is unique to the Distributed Systems arena as they do not compel and bind developers and implementers to employ a specific vendor's technology. Distributed systems have largely evolved into proprietary based architectures requiring businesses and developers to commit to a particular vendor when creating and deploying the system. As organizations continue to globalise, it becomes essential for their systems and applications to communicate with each other. However, existing applications and enterprises built from differing technologies have varying degrees of difficulty communicating and trading data with each other, especially when they come from different organizations, with different domains, platforms and operating systems. Thus, WS open up new business opportunities by connecting business partners and systems in ways which were previously impossible by providing a framework based on Extensible Markup Language (XML) and other web based protocols, such as Simple Object Access Protocol (SOAP) and Web Service Discovery Language (WSDL). Thus, the WS suite of technologies opens up technological opportunities for integration, as they handle the challenges of communicating applications and data in implementation.

Web service technology enables connection of incompatible standalone systems and integration of complex distributed systems in a way not possible with previous technologies. With protocols such as XML, SOAP and WSDL, software from any vendor can share data with any other application or system. This ability to unite disparate architectures opens up many possibilities for enhancing the trading capabilities for businesses and organisations alike. For the SME wishing to undertake e-Business, the relatively low cost of Web service technology is an attractive option compared to other proprietary means of electronic trading such as Electronic Data Interchange (EDI). This paper discusses the challenges of integration of software applications in a SME environment.

## APPLICATION INTEGRATION WITH WS

So what exactly are Web services?

"A Web service is a software system designed to support interoperable machine-machine interaction over a network. It has an interface described in a machine processable format" (w3c.org, 2004).

The three primary technologies that comprise a SOAP Web service are Extensible Markup Language (XML), Simple Object Access Protocol (SOAP) and Web Services Description Language (WSDL). The data that is transferred using a Web service follows the XML specification and is encased within a SOAP wrapper. The SOAP message is bound to a Hyper Text Transfer Protocol (HTTP) message and sent along the wire using the Transport Control Protocol (TCP) and Internet Protocol (IP). WSDL is an XML document that describes the Web service in terms of the kind of messages the service can understand. It instructs potential clients in how to

interact with it and resides on the server where the service is offered. The point of importance here is that the protocols used are all Internet standard protocols with no proprietary restrictions or limitations imposed upon developers or business users.

As with all Internet resources there must be a means to locate or *discover* a particular service. The Web service directories themselves are where service providers can publish information about their services. These directories can also be Web services that can be used to locate other services and the Universal Description, Discovery and Integration (UDDI) standard has emerged as the accepted means for publishing and discovering information about Web services where the service provider is seeking to expose their services globally. As we shall see, UDDI is not the only solution to Web service discovery and other less complex methods can be implemented especially where the business scenario is that of a well defined *cluster*.

**System Integration within the Corporate Firewall**

Figure 1 shows a platform independent interface to a complex distributed environment provided by Web services. The example is a common scenario where various components and systems inside the company were built and deployed at differing times and hence utilise different technologies and data formats. Each system uses a Web service interface that hides the underlying technology from an outside perspective and also allows different technologies to access the data produced by that system. The concept of e*xtending* the existing infrastructure is evident in this scenario (Mitchell, 2003).

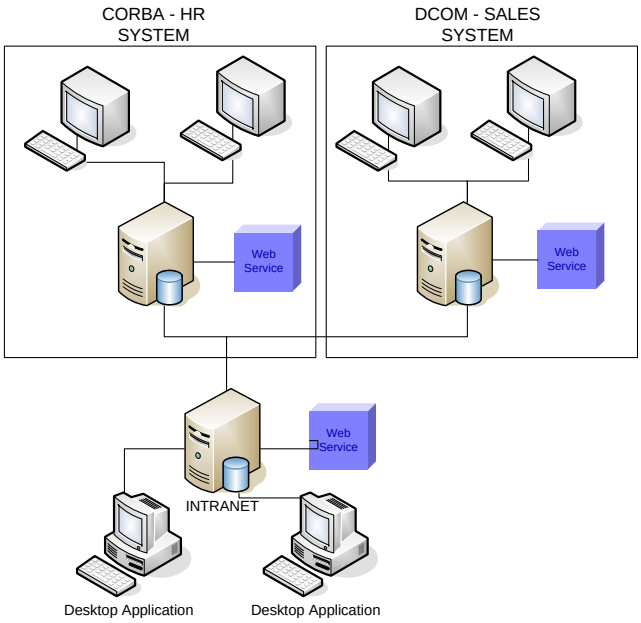


Figure 1: Connection of disparate systems within the Corporate Firewall (Adapted from Mitchell, 2003)

Behind the firewall implementations are often the chosen method of initial deployment for companies who are not completely trusting of a new technology and system integration on a local scale provides a more controlled environment for exploring the capabilities and even weaknesses of a new suite of software. Oellermann, (2002) outlines a strategy or adoption path for easing a company into the deployment of Web services where initial implementation is behind the firewall moving out to trusted partners beyond the Intranet boundary then on to all partners and eventually to a globally available service where clients could be completely unknown entities.

**Beyond the Corporate Firewall**

It is best to think of Web service technology as having the capability to *extend* an existing business system rather than to replace it entirely. To date, many users of Web service technology are finding they are able to expose present data stores and business services to customers without the technological limitations imposed by previous technologies. Essentially this means that maximum value is extracted from the service as it is available to more users. Also, it will be easier for the *potential* business client to connect into the established cluster.

Businesses can provide a platform-independent interface to hide complexity for a system that is utilised by many, unknown clients. It is here that the largest impact is likely to felt as the distributed business environment will effectively be brought out from behind the corporate firewall and integrated into a globally emerging business paradigm where partners can trade more openly and freely. Consequently businesses will need to

rethink the way in which they conduct their business and restructure their business processes accordingly in order to deal with the possibility of *all to all* relationships (Unhelkar, 2004).

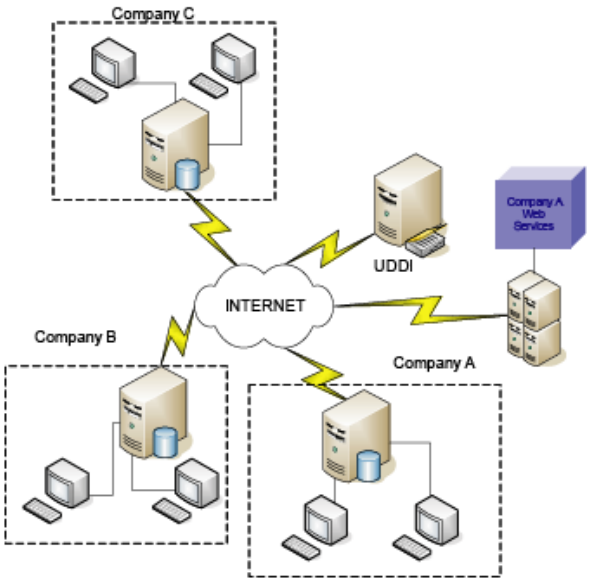


Figure 2: Moving Web services into a global environment

Figure 2 demonstrates a company who publishes their services to a Universal Description, Discovery and Integration directory where business partners or even unknown entities may discover and use the services and also publish their own services. This UDDI *yellow pages* directory represents a link between businesses of paramount importance. It acts not only as an intermediary between various business ecosystems but also as a store house of the service locations offered by a particular ecosystem. The UDDI directory may be implemented internally to an organisation or externally. Figure 2 demonstrates and *external* deployment (Apte & Mehta, 2003).

**The Small-Medium Enterprise (SME) Cluster**

On a smaller scale, and of particular interest to the authors, Web services can offer practical and relatively cheap solutions to the small to medium business market where businesses operating within a known domain can trade and share data and distribute functionality between them.

The model depicted in Figure 3 has been implemented by the authors in an effort to understand the challenges and advantages of realising a Web service based cluster. The model is based upon a cluster formed by NSW Cycling Clubs and their governing body the NSW Cycling Federation. Web services are hosted by the Company headquarters (NSW Cycling Federation). Branches (affiliated NSW Cycling Clubs) may connect to the service remotely and use the functions contained therein. The NSW Federation would hold a store of all NSW licensed riders, state wide race calendars and other data that affiliated clubs can connect into and utilise for their own purposes. In this way, data is opened up for known clients to consume. Also shown is a participating business (Bob's Bikes) who offers their catalogue of merchandise (bicycles). This service is a complete online sales service similar to a shopping cart with one difference; merchandise from Bob's Bikes can be sold from anyone who utilises their service. The service will log the seller's identification number and recompense the seller with a commission based on the sale that has taken place.

Also illustrated in Figure 3 is the ability for new potential parties to join the established cluster. The interoperability of Web services reduces the technological hurdle for this to happen and in this way, new relationships can be established with greater ease and clusters can expand. The development time for the services shown in Figure 3 was relatively short and simple.

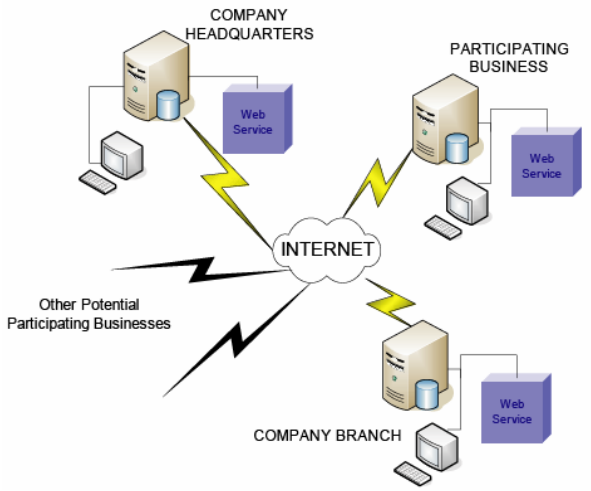


Figure 3: SME Cluster showing extensibility offered by Web service interoperability

## BUSINESS MANAGEMENT STRATEGIES

As well as the obvious technical issues there are managerial issues to be dealt with. These managerial aspects exist outside of software engineering and forward thinking business mangers must carefully assess the new technologies and plan for the changes that will occur on a business level. There are many changes required in management strategies as more and more loosely coupled business processes emerge. Operations that may have been handled internally to an organisation can be distributed more easily to other organizations with more capabilities (Manes, 2003).

Web services do not constitute a new business model as a Web service is only an interface to a business function. Exploiting the freedom that Web service technology offers will require disruptive change in terms of business organisation as when this new technology begins to orchestrate Business to Business (B2B) communications, businesses will interact with each other differently as a direct result of the new technology. Businesses involved in e-Business will need to evolve and mould their processes around the new opportunities that the adoption of Web services will bring (Ibid, 2003).

“Since Web services provide a standardised way by which applications can communicate across networks, regardless of their size or the computing platform on which they are executing at either ends of the interaction, there is a genuine independence achieved by businesses in interacting and collaborating with each other. This is not only a different paradigm in terms of how businesses relate to each other, but ensures a paradigm shift in terms of how transformation from business to electronic business (e-Business) occurs (Unhelkar, 2004).”

### Web Services Choreography

While it is true that Web services have no business model of their own, they *enable* many new business models. These new business models exist by virtue of the fact that Web services are a true Service Orientated Architecture (SOA) where services are loosely coupled and may exist in various geographic locations. These service entities need to be able to communicate and trade data and messages effectively and securely in order for the business model to proceed smoothly from start to finish. This is where Web services choreography comes in.

Web services choreography concerns the observable interactions of a specific set of services with their clients over a particular unit of time. This set of services will most likely be some kind of business transaction such as an *ACID* transaction. Web Services Choreography Description Language (WS-CDL) is a language that describes the technical contract between parties wishing to integrate their services by providing a global view of restraints and ordering conditions under which messages are exchanged. Each party may then use this description to build and test solutions that conform to it thus ensuring interoperability, robustness and a common understanding between organisations involved in the business model (w3c.org, 2004a).

### Business Transfer Protocol (BTP)

BTP is a protocol released by the Organization for the Advancement of Structured Information Standards (OASIS) that can be utilised to co-ordinate the transactions between applications controlled by multiple autonomous parties. “It is an Extensible Mark-up Language (XML)-based protocol for representing and seamlessly managing complex, multi-step business-to-business (B2B) transactions over the Internet” (OASIS,

2001). The ability of Web services being able to handle long running transactions has been a topic of concern for many analysts and BTP addresses this situation by providing a framework for organisations to utilise when doing e-Business together. Examples of what can be achieved with BTP are:

- Long running transactions may be cancelled by a party due to a time restriction requirement of a business process.
- Transactions may operate with discontinuous services – especially important when the unreliability of the Internet provides the 'wire' connection.
- Autonomous parties can come together in well-defined, temporary relationships that reflect their reciprocal business interests. The parties' systems are synchronized by agreement.
- BTP messages can be sent over any communications protocol and can be combined with any applications message (Green & Tacaksc, 2001).

The above protocols build on top of the *base* level Web service protocols of SOAP, WSDL and XML to provide an augmented Web services stack. This allows greater reliability, security and manageability of an e-Business cluster. So, while the mechanisms are in place for reliable e-Business using a Web service infrastructure, it will take time for the Web services stack to establish itself within the distributed computing world, thereby providing the confidence needed for business managers to make the decision to employ a true Service Orientated Architecture.

## THE IMPLEMENTATION

As briefly described previously, the model system is a Web services based system for use in a small to medium business collaboration, See Figure 4. For the purpose of this research the business collaboration chosen is a chain of cycling clubs with one governing body, the NSW Cycling Federation (NSWFED). This scenario was selected for two principal reasons, those being the availability of generous amounts of data in the subject domain and the fact that the author is personally familiar with the business model encompassed by this system. These two factors will aid the research in that it will not be necessary to invest large amounts of time defining business rules and data. A robust design process was not deemed necessary, as the purpose of this project was to focus on a model for Web services. The researcher acknowledges the fact that a formal design process would be required if this project was to be employed in industry.

It should be mentioned that the system is not designed to be a robust enterprise level structure but more a model to illustrate what can be achieved with Web services and also to aid the authors in their understanding of the challenges and advantages involved in creating such a system. Also, not *all* necessary data is captured during the sale of merchandise from Bob's Bikes. The author is aware of the fact that there are many more fields and functions required for such a transaction.

### Web Services for Local and Remote Data Access

The system itself incorporates functions which can be considered local and others that are invoked across the network (Internet). Web services have been used to implement all system functionality whether it is *local* or *remote*. A Web service directory acts as the middle tier in what is essentially a classic three tier architecture where the middle tier separates data and presentation layers. The advantage of using Web services for local data access is that this data can easily be exposed and provided at will across the network for any system or platform to consume. The advantages of providing a Web service for remote data access and transactional capability is that it is extremely easy for a new business partner to connect into the infrastructure no matter what software language or platform they are using due to the universal nature of XML. These advantages will be dealt with in more detail in a further section of this paper.

### Modelled Processes

Data Sharing

Penrith Panthers Cycling Club (PPCC) represents one of many such affiliated clubs that each has the NSW Cycling Federation as their governing body. NSW Cycling Federation (NSWFED) holds data that is relevant to each club in the form of NSW licensed riders, the NSW race calendar and state wide news. This data has been provided through the use of Web services for the clubs to consume and use as they see fit. PPCC site invokes the relevant Web service and retrieves the data. The functions can be seen in Figure 4: GetRiders(), GetCalendar(), GetNews(). There is a separate page for displaying this information on the PPCC site, as can be seen in Figure 4.

Bob's Bikes is a participating business who sponsor major NSW race events and are allowed an advertisement on the home page of the PPCC site. Bob's Bikes provides their catalogue of merchandise and also some relevant news via Web services. The PPCC site connects to these services and retrieves this data. The news information is displayed within the small advertisement and is therefore automatically updated when the page loads on the PPCC site. Browsers of the PPCC site can place an order for a bicycle by entering the identification code of the bike and submitting the form data to Bob's Bikes. Three events are triggered when the user hits submit.

- The bicycle identification code is submitted to Bob's Bikes
- The order details are logged into the Bob's Bikes database
- The order details are logged into the local PPCC database

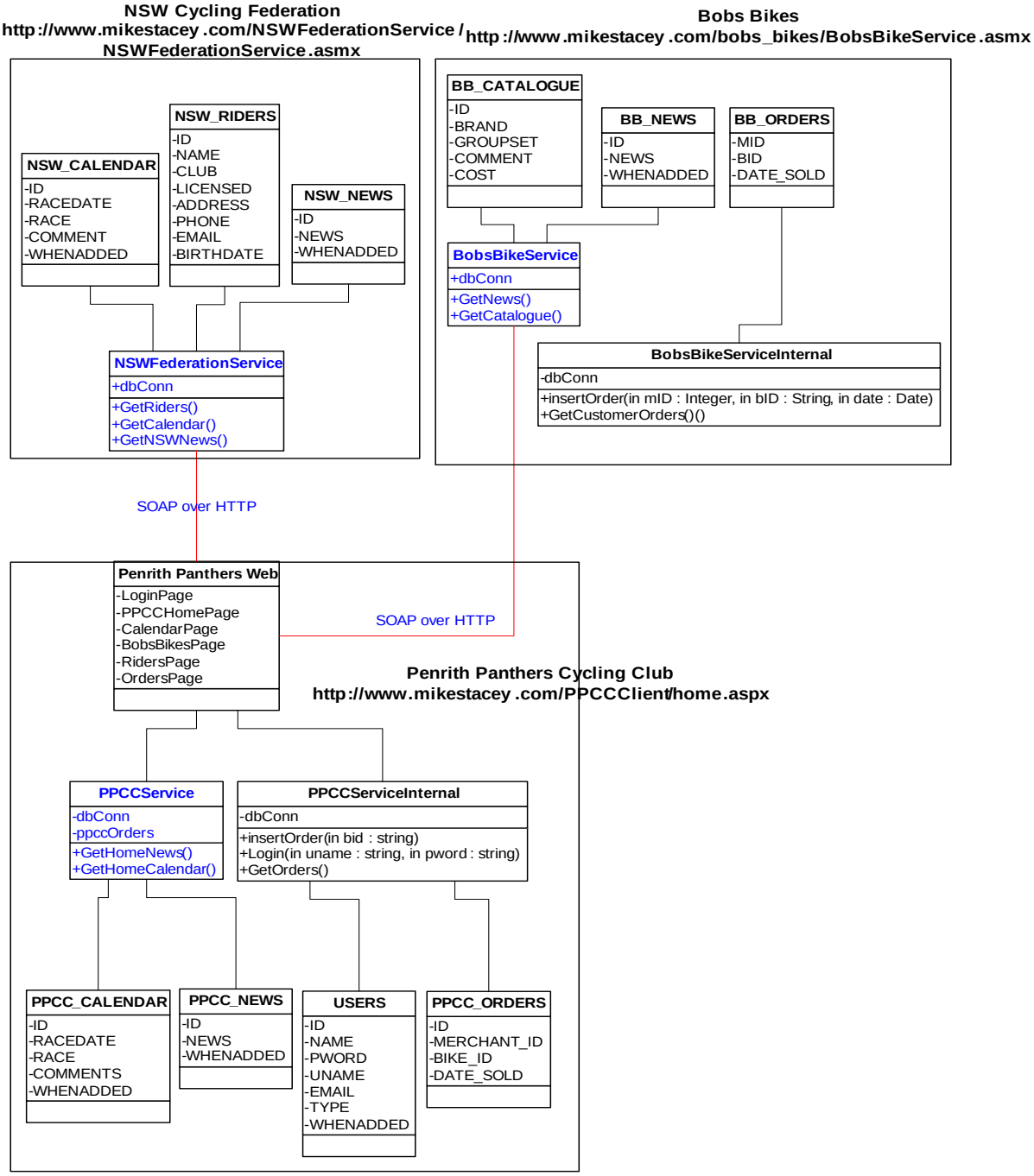


Figure 4: Conceptual diagram of the Web service model system. In this model only the Penrith Panthers site has a user interface. Bob's Bikes and NSW Federation simply contain Web service directories where services can be discovered and invoked. PPCC and Bob's Bikes have Internal Web service directories that contain local and private functionality not accessible to remote clients.

Order details captured at the PPCC end are the merchant identification code which identifies Bob's Bikes as the source of the merchandise and other data related to the sale such as the bicycle identification code and the data of sale. Hence, PPCC knows what was sold, the value of the sale, when it was sold and who the merchant was.

Order details stored at Bob's Bikes are the same with the exception that the seller identification number is stored so that Bob's Bikes knows who the bicycle was sold by. There may be many resellers of Bob's Bikes products, each with a unique identification code.

Note that the InsertOrders() and GetCustomerOrder() functions are stored within the internal service directory at Bob's Bikes as these methods are not for public consumption.

**Challenges and Comparison with Alternative Technologies**

Data Sharing

The business model employed in the system is a common one where a group of clubs, organisations or businesses share data and resources. Within this situation there will usually be other associated parties who maintain some interest in the established cluster. They may sponsor the cluster or parts of it, in some way or sustain another business interest with the group. Hence, the model is one that can also be implemented using traditional Web technologies although not with the same flexibility, benefit or efficiency.

The processes that are involved purely in data sharing between PPCC and NSWFED such as GetRiders(), GetCalendar() and GetNSWNews() can and have been accomplished using alternate means. This situation is a conventional content management scenario where data from external sources must be integrated into an organisation's data store and used within the company for distribution to employees or assimilated into a Web site. Without Web services a content manager would manually browse the Web and copy and paste (screen scrape) the data required and insert it into the data store. With the Web service implementation, this data is received automatically from NSWFED in XML format and automatically inserted into the PPCC database, all without human intervention. (Strohlein & Stearns, 2003) reveal a similar outcome whilst analysing the integration of data before and after implementation of a content management system that utilises Web services. They cite figures indicating a significant ROI where work hours were reduced from a total of four hours by a team of two to less than one hour per day by a single worker.

After the data is obtained from the NSWFED there are a number of options open to the invoker of the service. The data is in XML format and so can be presented any way the user desires whether that be directly into a web page, a printed newsletter or text file. In this case the data is stored into the PPCC database and also displayed in a web page, again this process is executed without human intervention and requires zero hours of work to complete the task.. Using more traditional means this process would require a number of hours of manual intervention to transform the data into the required presentation format or to extract the data and then insert it into the database.

There are a number of processes internal to the PPCC organisation that are handled by Web services. These procedures can be seen in Figure 4. There is no strict requirement that Web services be used to conduct these functions but we would argue strongly that once Web services are used for local data access, the data has the potential to be consumed by other interested parties which may enhance business activity for the company. According to (Lim & Wen, 2003), the notion of opening up an organisation's service applications and /or data for sale to another organisation could bring about increased revenue from the IT department as opposed to the situation where IT is seen as the "cost centre" of an enterprise.

Web Services for e-Business and Cluster Expansion

Sales of Bob's Bike's merchandise by PPCC are also achieved without human intervention, the sale being logged both locally by PPCC and remotely by Bob's Bikes so that both parties are aware of sales status. In other words, PPCC knows how much commission Bob's Bikes owes them and Bob's Bikes knows who has made the sale. Details not implemented are the purchaser's personal details; this is a simple addition to make once the system is set up. Again, this system could be accomplished without Web services but with greater degree of complexity. A small Bob's Bikes advertisement displayed on the PPCC home page is automatically fed with the latest news from the merchant with information such as latest bicycles on sale or particular bargains available.

Possibly the largest benefit to the cluster as a whole is that Web services make it very easy for other potential businesses to connect into the system and either trade data or do business. This facility cannot be offered by traditional Web technology or by traditional legacy information systems that utilise dedicated point to point connections. As (Hagel, Brown, & Seely, 2001) correctly assert , a more open ended and malleable collaboration is offered through the use of Web services both to members of the company and also its business partners. Services are *loosely coupled* which offers a degree of freedom to an organisation with respect to

altering their agreements or alliances and can lead to all to all relationships where the very nature of business communications changes from the typical hard wired proprietary connection to one where companies are involved with an ever increasing number of business partners (Unhelkar, 2004).

In the system implemented it is clear to see that NSWFED are offering data that can be consumed by any of the one hundred or so affiliated clubs around the state of NSW. Bob's Bikes represents a business outside of this organisation of clubs that offers a service relevant to all of the affiliated clubs and has a lot to gain from this association. The use of Web services expands their presence and presents their merchandise to a larger audience. Standard Web technology can also be used by simply placing a link to Bob's Bikes on each of the club's sites but sales must then be made at and by the Bob's Bikes server. In many ways the Web service reseller model is similar to Bob's Bikes employing a number of salespeople to distribute and push merchandise without the associated cost. (Lim & Wen, 2003) use the familiar scenario of the travel agent where an online airline reservation system is linked to one of its partners car rental systems. Travellers can rent a car and at the same time book a flight. This business model is distinctly different to preceding ones and opens up a new paradigm in terms of the number of possible new business partners and relationships available to an organisation.

The model shown in Figure 4 is only the beginning. There are countless opportunities for this small cluster to expand. For example a delivery service for Bob's Bikes could connect into the cluster and offer their rates and services via a Web service. NSWFED could offer employee information via a portal to its employees. Typical data would be accrued leave, total tax and net pay for the current year and even information targeted directly at individual workers. The underlying mechanism is content syndication, which (Goldfarb, 2004) describes as being the use of meta data to direct information to the rightful destination based on a client's particular needs or profile. XML combined with Internet transport protocols forms an ideal foundation on which to support such systems.

The notion of *e-Transformation* as described by Unhelkar (2004) suggests a completely different scenario for enterprises who are either already involved in e-Business and also for those organisations who are contemplating moving into e-Business for the first time. The practical model implemented for this study demonstrated an ease of development which would undoubtedly cost less than an alternative technology such as EDI thereby opening up the e-Business world to companies such as SMEs whose finances may not allow the deployment of EDI

**Challenges**

The issues that a particular installation will face are largely dependent upon the nature of the ecosystem that Web services are installed into and the particular technology employed for the job. We have compiled a list of the present challenges faced by Web service technology with no particular implementation in mind. As our implementation was developed under the Windows platform some of our solutions are Windows specific. This is noted where relevant.

| **Web Service Technology** | |
|---|---|
| **Challenge** | **Solution** |
| Incomplete specifications for some extended aspects of technology | Common in immature technologies. Time and further development aid in gradual solution and completion. |
| Enterprise Transactions | ▪ Business Transfer Protocol (BTP)<br>▪ Asynchronous Web services conforming to REST style<br>▪ WS-Atomic Transactions<br>▪ WS-Coordination<br>▪ Web Services Choreography Description Language (WS-CDL) |
| Standards Based Technologies exhibit potential incoherencies. Development time is often lengthy - a company may propose a solution to a specific problem and most parties accept it. | Greater level of cohesion within the organisations that unite to produce standards |
| Message Reliability | WS-Reliability protocol |
| Security | ▪ Authenticate users<br>o Wrap credential in SOAP message<br>o HTTP 'Clear Text' authentication: useful in combination with other methods |

| | |
|---|---|
| | ○ HTTP 'Digest' authentication: hashed credentials<br>○ Client Certificates – SSL<br>○ Windows Authentication (Windows specific): - IIS Server can map a user to a Windows user<br>▪ Guarding data<br>○ Access control lists<br>○ SQL based security: example SQL Server allows limiting who accesses various tables and stored procedures<br>○ NTFS: limits the files a user accesses (Windows specific)<br>○ Active Directory: limit network resources to particular users<br>▪ Track User Activity<br>○ IP address<br>○ User ID<br>○ Time<br>○ Search for patterns<br>▪ Equipment Deployment<br>○ Firewall or router between company Intranet/databases and Web service server<br>▪ XML specific firewall: XML passes through standard firewalls<br>▪ WS-Security framework for SOAP messages<br>▪ Implement Identity Management System<br>▪ XML Signatures<br>▪ XML Encryption |
| XML Processing | ▪ XML proxy: standalone dedicated XML processing application<br>▪ Proprietary solutions: risk of compromising interoperability of XML<br>○ Add more attributes to elements: saves parser from traversing extra tags<br>○ Short tag names: faster for parser but reduces human readability<br>○ Install XML processing hardware board into server<br>▪ Future processors will most likely include XML processing instructions<br>▪ Future processors will be faster |
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Table 1: Typical challenges facing Web services technology. Material for this table obtained from (Seely, Smith, & Shaffer, 2002), (Foody, 2003), Green, A. et al. (2001), (Brambilla, Ceri, Comai, Fraternali, & Manolescu, 2002), (Schmelzer, 2004) and (O'Toole, 2003).

## CONCLUSION AND FUTURE DIRECTIONS

In this paper we have discussed the WS technologies, and how they can be used to implement a software solution within a SME. For that purpose, a cluster of clubs in the Western Sydney region was selected. The implementation of WS-based solution provided some interesting insights into the challenges posed by WS technologies. These issues and their proposed solutions were discussed and summarised in Table 1. We plan to extend this study to encompass the challenges of integrating multiple applications from various service providers within a cluster. We also plan to incorporate Mobile technologies together with WS, in order to extend the current implementation.

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