AN OPEN STANDARD FOR THE EXCHANGE OF INFORMATION IN THE AUSTRALIAN TIMBER SECTOR.

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ABSTRACT

The purpose of this paper is to describe business-to-business (B2B) communication and the characteristics of an open standard for electronic communication within the Australian timber and wood products industry. Current issues, future goals and strategies for using business-to-business communication will be considered.

From the perspective of the Timber industry sector, this study is important because supply chain efficiency is a key component in an organisation's strategy to gain a competitive advantage in the marketplace. Strong improvement in supply chain performance is possible with improved business-to-business communication which is used both for building trust and providing real time marketing data.

Traditional methods such as electronic data interchange (EDI) used to facilitate B2B communication have a number of disadvantages, such as high implementation and running costs and a rigid and inflexible messaging standard. Information and communications technologies (ICT) have supported the emergence of web-based EDI which maintains the advantages of the traditional paradigm while negating the disadvantages. This has been further extended by the advent of the Semantic web which rests on the fundamental idea that web resources should be annotated with semantic markup that captures information about their meaning and facilitates meaningful machine-to-machine communication.

This paper provides an ontology using OWL (Web Ontology Language) for the Australian Timber sector that can be used in conjunction with semantic web services to provide effective and cheap B2B communications.

INTRODUCTION

Australian forest and wood products industry sector form an important element of the Australian economy, with a turnover exceeding 14 billion dollars per year. The industry contributes seven and half per cent of the manufacturing output of the gross domestic product (Australian Bureau of Agricultural and Resource Economics 2003). Overall the industry sector supports 674 hardwood mills and 268 softwood mills along with 30 panel board mills employing 78 400 people in the 2000/2001 year (Australian Bureau of Agricultural and Resource Economics 2003). The forestry industry is growing in importance in Australia. The stated aim of the Department of Agriculture, Fisheries and Forest (1997) according to its 2020 vision document is to treble plantation area by the year 2020.

The business process of supply chain management provides an opportunity to improve business efficiency within this industry, increasing profit margins and thus favourably impacting on the Australian economy. The prospect of improving the efficiency of supply chain management is provided by new information and communication technologies. Electronic Data Interchange is an established technology that provides business-to-business communication within the supply chain but demands rigid agreements between organisations concerning the structure and content of communications. From the widespread use of Internet technologies has arisen new methods for automated business-to-business exchange of information using, web-based Electronic Data Interchange. This paradigm adopts a flexible, non-platform specific open standard in which agreement between organisations participating in the supply chain can be more readily brokered.

INFORMATION FLOWS IN SUPPLY CHAIN MANAGEMENT

A typical business receives inputs from a number of suppliers and then may use a number of channels to sell their goods and services through. A supply chain is the flow of information, materials, finances and services stretching from the procuring of raw materials through to the delivery of the finished product to the end user (Turban et al. 2004). Management of the supply chain is done with the intent of improving customer service levels, cycle time reduction, increased inventory turnover leading to agile supply chains (Christopher & Towill 2001). Improvements in these functions increase the effectiveness of business processes leading to improved organisational performance (Power & Sohal 2002; Prem PremKumar, G. 2003).

Supply chain management can be defined as a set of tools and techniques applied to coordinate suppliers, manufacturers, warehouses and retailers so that goods and services are produced and distributed to the required locations within required service levels, while minimising logistics costs (Simchi-Levi, Kaminsky & Simchi-Levi 2003). Fawcett and Magnan (2002, p. 340) describe the ideal of supply chain management as managing from “the suppliers’ supplier to the customers’ customers”, with Nurmilaakso, Kettunen and Seilonen (2002) sum up supply chain management as being about integration.

Members of any supply chain regularly exchange communication to co-ordinate business activities (Sánchez & Pérez 2003) as supply chain management is an organisational boundary crossing activity (Fawcett & Magnan 2002). This need for a flow of information across organisational boundaries has made agreement between trading partners on the meaning of exchanged information and interoperability of their information systems important (Dow 2001; Hasselbring & Welgand 2001). Electronic Data Interchange (EDI) has been a traditional tool for facilitating the information flow. Internet technologies have had an impact on business-to-business communication enabling the collaboration process (Pease 2001) and solving some problems in tools such as EDI.

E-BUSINESS ENABLING TECHNOLOGIES

The interconnection of devices can expand the scope of business and build stronger vendor relationships by allowing information to cross organisational boundaries (Rahman 2004). Rahman (2004) details how Internet technologies have increased the scope of business particularly in supply chain functions. However small to medium enterprises (SME) may not be aware of the opportunities made available by ecommerce and Internet enabling technologies (Mullins, Duan & Hamblin 2001).

Internet technologies provide a reliable and efficient network allowing system-to-system interconnections between suppliers and customers removing technology barriers (Golicic et al. 2002). Organisations that initially used the Internet technologies to provide a visible web presence have now progressed to moving functions of supply chain management to the Internet. Internet technologies provide advantages such as greater control, flexibility, and savings in business overheads (Yen & Ng 2003). Technologies such as EDI and product numbering have provided a means to link information flows with the physical flow of goods and services. In future Burt and Starling (2002) suggest a tightly integrated mesh like e-chain consisting of nodes, communications and seamless information transfer will be an essential part of business.

Towill (1997) states that the making available of undistorted, real time demand information to every echelon in the supply chains leads to a dramatic improvement in the performance of that supply chain. This improvement in overall supply chain performance is a competitive advantage in a market that Bruce, Daly and Towers (2004) argues competes on a supply chain to supply chain basis. Rahman (2004) describes this as competing on how well your supply chain is managed.

Mason-Jones and Towill (1998) describe demand information as the catalyst for the whole supply chain with the best way to contract the information flow is to directly feed each echelon in the supply chain demand information. Childerhouse et al. (2003) suggest that it is crucial that supply chain members have access to information to processes not under their control.

Mason-Jones and Towill (1998) argue that while information technology is an important driver toward compressing the information flow, the focus must be on fidelity and availability of the actual demand data, Ayers (2001) adding that no information is better than bad information. Kalakota, Stallaert and Whinston (1996) and Singh (1996) agree that in order for Information to replace inventory the information must be accurate, timely, available and unambiguous. Organisations where access to timely demand information is available are able to make an informed decision earlier dragging the push-pull boundary closer to the start of the supply chain (Mason-Jones & Towill 1998). Information which is distorted, missing or not timely leads to disruptions within the supply chain, extra costs and the bullwhip effect (Childerhouse et al. 2003; Mason-Jones & Towill 1998).

COLLABORATION

Emerging technologies for supply chain management are collaborative commerce, e-markets and Collaborative Planning Forecasting and Replenishment (CPFR) (Turban et al. 2004). Collaborative commerce is made possible by web commerce, and means that any participants in the supply chain may work together regardless of their place in the supply chain. This characteristic of collaborative commerce tends to produce a supply chain which is not necessarily linear but may be more like a mesh network (Turban et al. 2004). Collaboration may be internal to the organisation as well involving external organisations (Barratt 2004).

Collaboration does not focus purely on the upstream supply chain but considers how to optimise the performance of the entire supply chain, so that decisions throughout the supply chain were driven by the end consumer demand (Ireland & Bruce 2000). Popp (2000) discusses how collaboration is when organisational boundaries are blurred as partnerships are formed with Barratt (2004) adding that collaboration is a move away from an adversarial relationship between trading partners toward a win-win relationship. An adversarial relationship focuses on price while collaborative relationships focus on the performance of the supply chain as a whole (Fawcett & Magnan 2002) . Walker (1994) suggests that it is not until the exchange of in depth proprietary information such as demand data and forecasts that collaboration takes place.

Forming partnerships with suppliers is a means to obtain best performance from the supply chain (Barratt 2004; Ireland & Bruce 2000; Wong 1999). Wong (1999) advocates the forming of a clear vision for the goals of the supply chain, describing co-operative goals as the glue in the relationship between supply partners. Collaboration has as a benefit sizable cost reductions in total supply chain costs but it must be limited to a few trading partners, it is not possible to collaborate with all suppliers as they form partnerships with other trading partners (Barratt 2004; Walker 1994). Barratt (2004) adds limiting the number of collaborative partnerships to a few strategically important relationships is important is due to the resource intensive nature of the relationships. In true collaboration the supply chain acts as a single unit, with decisions being taken for the good of the supply chain (Fisher 1997; Simatupang & Sridharan 2004).

For collaboration to succeed it is necessary for the relationships to be built on a basis of trust and commitment (Fisher 1997; Spekman, Kamauff & Myhr 1998). Fliedner (2003) details some obstacles to collaboration and CPFR as being lack of trust in sharing information, availability and cost of technology and expertise and fragmented information sharing standards. He adds that synchronising how the metrics of the supply chain are captured and methods of compatible data interchange are important issues. Standardisation of electronic connections across a number of trading partners is an important factor in keeping connection costs low adding to success factors of a project (Christiaanse & Markus 2003). Hasselbring & Welgand (2001) state that for organisations to exchange information they must agree on the form of information messages and define the meaning of the information. Collaboration may be driven by technical partnerships such as EDI (Walker 1994) which provides a vehicle for integration activities (Sánchez & Pérez 2003).

ELECTRONIC DATA INTERCHANGE (EDI)

EDI is one type of business-to-business (B2B) e-business which allows the internal system of one business to transact with the internal system of another business for the exchange of electronic documents (Hasselbring & Welgand 2001). The technology is designed to replace the expenditure, effort, and time incurred by paper-based business transactions (Shim et al. 2000). Senn (1998) describes EDI as a favoured technology for implementing interorganisation systems. EDI has been shown to produce error free current information, while handling a large volume of transactions eliminating some clerical tasks by automation of those tasks (Lu & Wu 2004; Strader, Lin & Shaw 1999; Turban et al. 2004; Witte, Grunhagen & Clarke 2003). The automation of tasks gives EDI the ability of speeding up information transfer (Lu & Wu 2004). EDI is an important element in allowing business-to-business ecommerce to take place with Angeles (2000) declaring that EDI is one of two building blocks the other being electronic payments .

The diffusion rate of traditional EDI has been slow (Angeles 2000; Senn 1998) despite its advantages due to the cost of implementation and the balance of power skewed with one organisation dictating trading terms (Angeles 2000). In Jun and Cai's (2003) study 66 per cent of respondents indicated that they were forced to adopt EDI by their trading partners showing a lack of management buy in to the benefits of EDI. Jun and Cai (2003) state that previous studies have shown that the EDI initiator usually obtain the majority of the benefits, however Prem PremKumar (2000) states that in the long term all parties benefit.

Senn (1998) describes the disadvantages of traditional EDI as the need for a large initial resource investment, the need to restructure business processes to work with EDI, the number of agreements that must be made, and ongoing operating costs. Shim et al. (2000) adding that different EDI standards are used dependent on the country of origin, making international transactions complex. While Jun and Cai's (2003) study showed that a lack of organisational readiness for EDI and trust were factors in EDI implementation failures. Mullins, Duan and Hamblin (2001) state that costs associated with EDI has been a major barrier to EDI adoption by SMEs with some SMEs viewing EDI as a cost of doing business rather than a strategic advantage (Jun & Cai 2003). Senn (1998) adding that the full potential of EDI systems will not be realised until a larger proportion of organisations are able to participate. In a survey undertaken in 2005 of a sample of the Australian timber and wood products industry it was found that 92% of the respondents belonged to an organisation consisting of fewer than 100 employees and so can therefore be classed as SMEs. It can be concluded that cost of traditional EDI has formed a barrier to the adoption of EDI in the industry (Blake & Pease 2005).

Traditional EDI requires trading partners to agree on message standards which dictate the structure and content of the message, with two well known standards being ANSI X.12 which is used mainly in North America and UN/EDIFACT used in the rest of the world (Lu & Wu 2004). Trastour, Bartolini and Preist (2002) describe the necessity for agreement as locking in as trading terms and conditions were locked in as part of the agreement. Traditional EDI involves the use of a Value Added Network (VAN) an intermediary communications network which charges trading partners for the use of the service. A VAN provides a secure environment for transactions, with the ability to translate between standards used by the trading partners (Awad 2002). This process must be repeated with all EDI trading partners. Due to the close collaboration needed to generate agreement on the message standards and translation software, EDI has been restricted to trading partners with a high volume of transactions and scale of operation as implementation costs are high (Hasselbring & Welgand 2001; Senn 1998; Witte, Grunhagen & Clarke 2003). Hasselbring and Welgand (2001) detail that the rigidity of the agreed upon message standards do not allow for the introduction of new products and services without going through a negotiation phase with trading partners or the introduction of new business rules. The interface between trading partners must remain perfectly synchronised with reliance that changes in one side will be reflected in the other by maintenance staff (Hasselbring & Welgand 2001). This implies a level of technical expertise and staff availability which may not be available in a SME.

WEB-BASED EDI

Senn (1998) argues that due to traditional EDI's reliance on formal individual agreements, translation software and VANs it is not an enabling technology for long term interorganisation systems. The barriers to traditional EDI's use mean that SMEs and large organisations that do not place a large volume of orders are not able to justify the amount of resources necessary to use EDI.

The World Wide Web was developed as a data repository, allowing users in separate locations to collaborate on common undertakings (Berners-Lee et al. 1994). Web-based EDI uses the capabilities of the World Wide Web and Internet technology as a low-cost, publicly accessible network with ubiquitous connectivity, which does not demand any particular network architecture (Goldfarb & Prescod 2004; Senn 1998). Web-based EDI offers the opportunity to participate in EDI at a cost three to ten times cheaper than traditional EDI (Wilde 1997). Angeles (2000) describes the use of the Internet as an EDI channel, as leading to the democratisation of ecommerce.

XML has emerged as a flexible efficient language that may be used to exchange information (Shim et al. 2000). XML is used as a platform independent, language neutral (Witte, Grunhagen & Clarke 2003) web-based language, which maintains the content and structure, but separates business rules from content (Goldfarb & Prescod 2004). XML identifiers and syntax are used to structure electronic documents, and those documents are sent through the Internet. The use of XML means that messages do not have to be as highly structured, with the length and sequence of attributes able to be varied. This flexibility makes agreement on electronic business standards between trading partners easier to negotiate (Hasselbring & Welgand 2001). One of the benefits of XML is that every one in the supply chain can work with the original data with no need to reinterpret the data at each echelon of the chain to match individual data-types (Dow 2001).

Downing (2002) found that organisations using web-based EDI reported a higher degree of improvement in their overall performance when using information technology, and rated long term commitment with their suppliers as higher than those organisations with no EDI or traditional EDI. Nurmilaakso, Kettunen and Seilonen (2002) study compared traditional EDI with a XML based integration system designed to support EDI. They found that the implementation costs of traditional EDI were much higher, with establishing a new message type cost three to four times higher.

Web-based EDI offers an alternative to traditional EDI implementation and also provides the means to compliment current EDI arrangements (Senn 1998; Shim et al. 2000). XML and web-based EDI can broaden the scope of supply chain integration by including those organisations that are not willing or able to justify the resources necessary for traditional EDI (Nurmilaakso, Kettunen & Seilonen 2002). The introduction of web-based EDI offers the opportunity for a mature EDI architecture where current EDI can be integrated with web-based online transactions (Moozakis 2001). Those organisations that currently use traditional EDI have the opportunity to save costs using web-based EDI to bypass the use of a VAN (Angeles 2000) Internet technologies providing the necessary interoperability.

INTEROPERABILITY

In business-to-consumer (B2C) ecommerce the requirement is for the business to interface with a small range of web browsers so interoperability is not a major concern. However in B2B ecommerce a business is required to interface with a diverse complex range of technologies making interoperability a priority (Shim et al. 2000). Interoperability is the ability of two or more systems to exchange information and to use the information that has been exchanged (Awad 2002). Prem PremKumar (2003) states that in order to overcome interoperability problems it is necessary to use a third party intermediaries such as VANs adding to the operating cots or establish an open information system architecture that can exchange messages irrespective of hardware and software.

The existence of open standards is a vital factor in promoting interoperability (Department of Communications Information Technology and the Arts 2004). An answer to the integration problem is the use of Internet technology, protocols such as Hyper Text Transfer Protocol (HTTP), and common data exchange languages such as eXtensible Markup Language (XML) (Dow 2001; Goldfarb & Prescod 2004).

Murtaza and Shah (2004) make the point that an organisation which chooses to use XML for its internal systems has already dealt with the need for interoperability. They go on to state that XML based web-services can provide an uncomplicated path for low-cost efficient interorganisation systems. General approval of web services and its associated protocols have meant that this is a well defined path for interoperability (Murtaza & Shah 2004).

COMMON UNDERSTANDING OF SEMANTICS

The development of a common global standard will facilitate and hurry the transition from traditional paper-based or inflexible methods to ecommerce methods (Mulligan 1998). Hasselbring and Welgand (2001) describing the need for the standardisation of message formats and meanings of the messages as a barrier to the wide-scale adoption of e-business. The use of XML and technologies such as web services help to solve the technical demands of interoperability but there is a need for descriptions of products and services to share common semantics (Trastour, Bartolini & Preist 2002).

Interoperability of information systems does not solve the problem of differences that organisations have in their representation of things in their system, such as products, relationships and units of sale. An example of this, is one organisation defines a pack of timber as a number of linear metres, while another organisation considers a pack to be a set number of pieces of timber leading to semantic heterogeneity (Colomb 2005). Dow (2001) talks about common vocabularies or ontology's bringing the same benefits as the small number of tags whose meanings are known brings to HTML. The ontology provides the means for multiple users or multiple organisations to straightforwardly share data and to unambiguously understand that data. In traditional EDI this facility was provided by the use of coding systems such as UN/EDIFACT. The move to Internet based EDI does not negate the need for the shared understanding of the meaning of data elements and their relationships (Reimers 2001). An open standard for the timber and wood product industry consisting of an ontology provides the means for cross institutional data exchange without having to be concerned with the trading partner's internal representation of products. The organisation will have to commit to the ontology foregoing some autonomy but they do not have to commit to mapping to other organisations representations (Colomb 2005).

BUSINESS-TO-BUSINESS FRAMEWORKS FOR E-BUSINESS

One approach to achieve interoperability in the B2B e-business domain where there is a requirement for the automation of transactions is to develop B2B frameworks typically using XML. The frameworks provide a standard means of electronic communication between organisations using the same standard (Shim et al. 2000). Examples of the frameworks are RosettaNet, Electronic Business using eXtensible Markup Language (ebXML) and Australia's BizDex (Standards Australia International Ltd 2003).

ebXML's development was started in 1999 by the Organisation for the Advancement of Structured Information Standards (OASIS) who planned a five layer data specification. The layers are for business processes, core data components, collaboration protocol agreements, messaging and registries and repositories (Organization for the Advancement of Structured Information Standards 2005). Peng, et al. (2004) describe ebXML as a set of specifications for a global e-business marketplace where organisations can conduct business through the exchange of XML-based messages (see Figure 1).

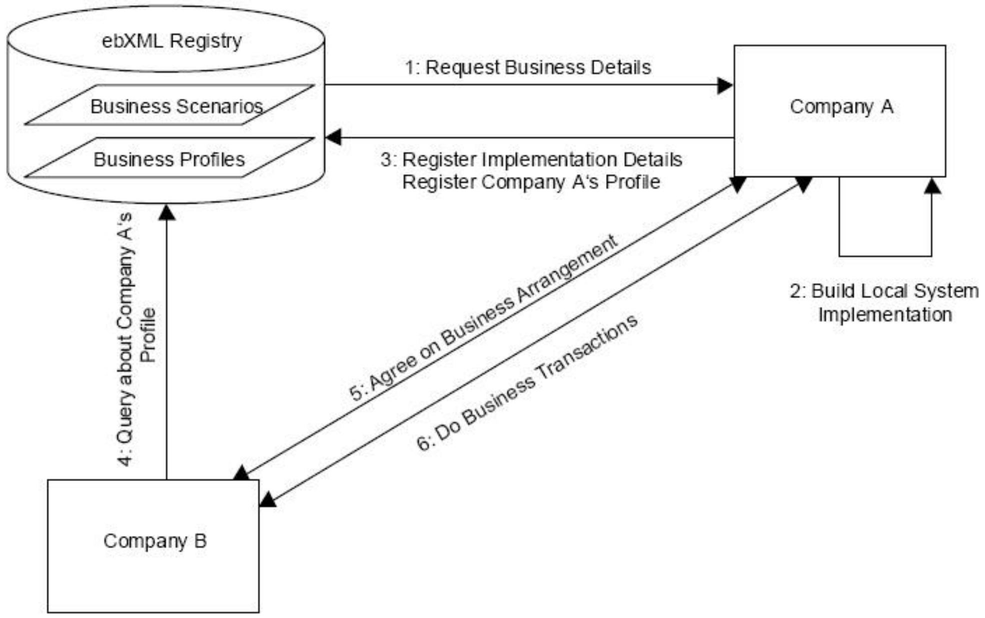

Figure 1: ebXML scenario (Hofreiter, Huemer & Klas 2002)

ebXML provides a framework and tools for the e-business to be conducted but there still must be agreement between the organisations on business semantics. This facility is provided by the core component layer which provides for an organisation to view potential trading partner's core components and develop software components to access the core components of supported business processes. Hofreiter, Huemer and Klas (2002) suggest that it is necessary to research support for interoperability between e-business vocabularies or develop domain specific ontology's.

BizDex is a national interoperability standard designed to promote business-to-business e-business in Australia. The concept behind Bizdek is to reduce the implementation costs of providing for cross business interoperability and application to application integration. The lowering of costs is to facilitate making the benefits available to small to medium enterprises and low transaction flows (Standards Australia International Ltd 2003). BizDex leverages the capabilities of the ebXML frame work to provide this capability.

THE EAN•UCC SYSTEM

The EAN•UCC system is familiar to us as the bar codes on goods. The system is made up of three components, standard numbering structures, data carriers (for example bar codes) in a machine readable format and eMessaging standards. It is a set of coding rules for the assignment of a unique Global Trade Identification Number (GTIN) and its representative machine readable bar code (EAN Australia 2004).

The Hardware Industry Work Group is a steering group of a hardware industry B2B e-business project to achieve supply chain efficiencies and cost savings through the development and implementation of a standardised approach to B2B transactions. There are four sector groups, one of which is the Timber Industry E-commerce Group (TIEG) (Hardware Industry Work Group 2004). A set of standards has been developed by the TIEG for the identification of timber and wood products using the EAN•UCC system (Tom 2002).

In these recommendations a GTIN is assigned at the product and packaging level, so that the same product sold by piece, bundle or pack would have a unique GTIN dependent upon how the product is packaged. It is recommended that the onus is on the customer to use the GTIN that must fully defines the item.

A possible problem with the GTIN being both product and packaging specific and substitution being so common in the timber industry is that an organisation may use its own product coding internally meaning that mapping must take place between the external GTIN coding and the internal coding. This means that a customers system must be tightly integrated with a supplier's system imposing implementation and maintenance costs.

Another potential problem with this approach is that different mills commonly produce different size packs of the same timber and these packs are generally regarded as the same product, so that different pack sizes are substituted freely for each other. This creates a problem in that the customer must know from which mill a pack of timber is coming from to use the correct GTIN. A later amendment "The implementation of fixed and variable measure GTINs for set length packs" (Tom 2003) makes an interim provision for this problem by stating that a generic GTIN for the product may be used for ordering as long as the correct GTIN is bar coded on the packs. The expectation is that in time the mills would move toward standardising the pack size negating the need for a generic GTIN (Tom 2003).

An alternative to having a third party EDI provider is for all trading partners to agree to a single identifier or a code for each product. For example this could be a 'Global Timber Code' for the timber industry. Each trading partner, when sending an

EDIFACT message, could then use this global code in all transactions. They can continue to using their own (existing) product code internally while using the ‘global code’ when ordering. This way, each trading partner would have a mapping table that would map their own product codes to the ‘global code’.

The creation of a global code would eliminate many problems by providing a consistent ordering process across the industry. This way, any new customer or a supplier would also have no problem in becoming a trading partner at any time. Defining a format for a global code that the industry is prepared to accept is difficult. There are concerns that a global timber code would “commoditise” timber products, and make the marketing strategy of branding and packaging the same or similar products in many different ways, redundant.

ONTOLOGY

A key barrier to the interoperability of business systems is the lack of an ontology which is an explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them (Gruber 1993).

Tim Berners-Lee describes the web as only achieving its full potential when data can be shared and processed by automated tools (Carvin 2004). To achieve this, the World Wide Web must contain machine readable metadata describing the data, relationships and the knowledge domain. Defining metadata of a domain to give a shared understanding of data elements results in a domain ontology.

An ontology can be represented as a hierarchical data structure showing the data entities and their relationships and rules, and this data structure can be represented in a language which is often based on XML (Colomb 2005).

XML’s syntax is a subset of Standard Generalised Mark-up Language (SGML) and is a flexible data representation language (Benatallah, Rabhi & Mehandjiev 2003) which allows for a set of self-descriptive tags containing information about the data enclosed within these tags (Benatallah, Rabhi & Mehandjiev 2003; Dow 2001; Goldfarb & Prescod 2004; Hasselbring & Welgand 2001). XML is a simple text based language, which separates the structure and presentation of a document from its content. XML’s advantages are that it is platform, language and technology independent, while maintaining its extensibility and simplicity (Goldfarb & Prescod 2004; Ritter 2000). The simplicity of XML is that at its core is a generic standard which allows other standards such as vertical industry standards or XML dialects to be integrated (Ritter 2000).

Resource Description Framework (RDF) was developed by the World Wide Web Consortium (W3C) as an XML based framework for describing and sharing metadata, this is designed to be applicable for sharing web metadata, creating machine processable data on the Internet (Klyne & Carroll 2004). To ensure extendibility RDF assumes an open world in which anyone can make make statements about any resource. RDF is designed to represent information in a minimally constraining, flexible way. RDF represents resources in a basic structure called a triple; these

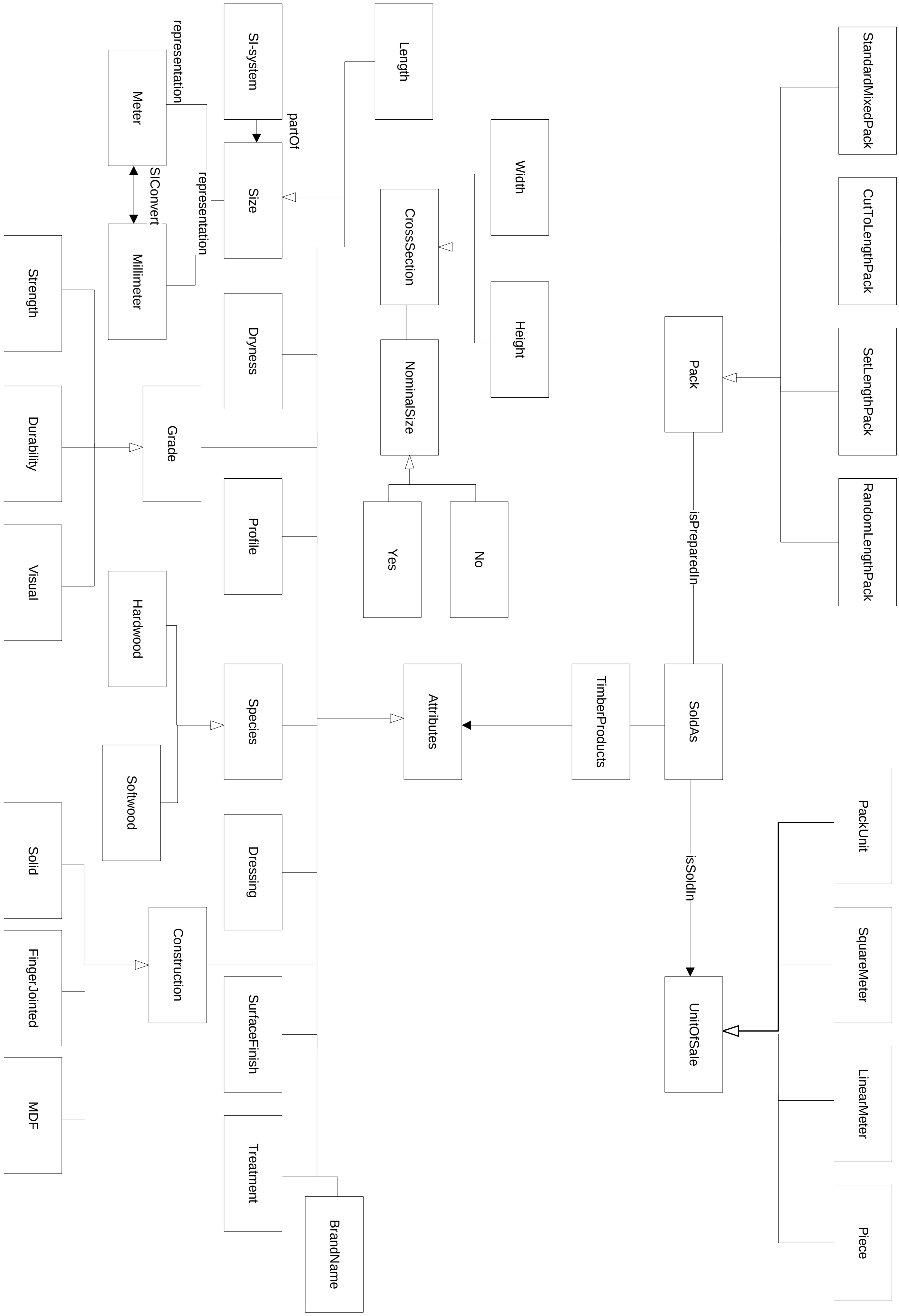

Figure 2: A model of an ontology for the Australian timber and wood products industry.

consist of a subject, predicate and object. The RDF triple is used to state that the relationship indicated by the predicate exists between a subject and object. RDF uses Uniform Resource Identifier's (URI) to identify resources It can be used in isolated applications, where individually designed formats might be more direct and easily understood, but RDFs generality offers greater value from sharing (Colomb 2005; Klyne & Carroll 2004).

The Web Ontology Language (OWL) is a specialisation of RDF also developed by the W3C. OWL is used when the information is intended to be machine-processed and can be used to represent an ontology (McGuinness & van Harmelen 2004). Owl has been designed to support reasoning with tools such as "Protégé" to support this and is part of the activity surrounding the semantic web activity. Like RDF, OWL makes an open world assumption, so a class defined in one ontology can be extended in further ontologies (McGuinness & van Harmelen 2004).

The ontology described below provides a foundation for an Australian timber and wood product ontology, because of the open world assumption by both RDF and OWL this ontology can be extended to generalise the ontology to more organisations. The foundation of this ontology is a product listing detailing categories that the organisations 40 000 products fitted into. The products are organised into broad categories dependent upon timber attributes, this forms a hierarchy of classes which can be used for machine processing and the semantic web or as a basis of a XML document.

The figure 2 shows a model of the proposed ontology for the timber industry, showing the classes that will be used for reasoning. This model can be extended and made to fit more enterprises as the ontology is adopted, lowering the level of ontological commitment for the enterprise.

The classes, properties and instances in this model can be explicitly defined by using OWL. As OWL is based on XML it is verbose so that it is not possible to show the whole ontology, examples of a class and the namespace declaration are given of the OWL representation of the model. The OWL shown below was generated by an ontology editor Protègè, used in conjunction with the reasoner racer.

A standard initial part of an ontology is the namespace declaration as shown in the figure 3.

```
<?xml version="1.0"?>
<rdf:RDF
   xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
   xmlns:owl="http://www.w3.org/2002/07/owl#"
   xmlns="http://www.owl-ontologies.com/australianTimber.owl#"
  xml:base="http://www.owl-ontologies.com/australianTimber.owl">
```

Figure 3: OWL namespace declaration

The namespace declaration allows for the means to interpret identifiers unambiguously. The line below states that any unprefixed qualified names refer to the current ontology.

xmlns="http://www.owl-ontologies.com/australianTimber.owl#"

The following is a example of the Profile class, showing that it is disjoint from other classes, a subclass of Attribute and showing how an instance is defined with the rdf:ID syntax.

```
<owl:Class rdf:about="#Profile">
        < owl:disjointWith>
                < owl:Class rdf:about="#Size"/>
        </ owl:disjointWith>
        < owl:disjointWith rdf:resource="#Construction"/>
        < rdfs:subClassOf rdf:resource="#Attributes"/>
        < owl:disjointWith rdf:resource="#Grade"/>
        < owl:disjointWith rdf:resource="#Seasoning"/>
        < owl:disjointWith rdf:resource="#Species"/>
        < owl:disjointWith rdf:resource="#SurfaceFinish"/>
        < owl:disjointWith rdf:resource="#Dressing"/>
</owl:Class>
  <Profile rdf:ID="Batten"/>
  <Profile rdf:ID="Fascia"/>
  <Profile rdf:ID="DoubleRebatedSawnNoiseBarrier"/>
  <Profile rdf:ID="Cladding"/>
  <Dressing rdf:ID="DressedOneSide"/>
  <Profile rdf:ID="SingleRebatedSawnNoiseBarrier"/>
  <Profile rdf:ID="Decking"/>
```

Figure 4: OWL class definition

The provision of an open standard domain specific ontology for the Australian timber and wood product industry gives the industry a number of options. The ontology provides a path for the industry to be part of the semantic web movement, both now and due to the ontology's extensible ability, in the future. The ontology may also be used in the web-based EDI paradigm, providing a common set of data elements that an organisation may map to, rather than having to map to individual organisations representations. These abilities give an ontology the means to bring the benefits of EDI to SMEs, while lowering the traditional barriers of technical complexity and high implementation and maintenance costs. Web based EDI provides a path for organisations to exchange real time data across organisational boundaries bringing the productivity gains and tighter supply chain that this enables.

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