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Transformation of the Software Components and Web Services Market

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Abstract

The Service Oriented Computing paradigm, with as its main manifestation web-service technology, holds high promises, but exploits its full potential only when third-party web-services are traded in a service market to enable effective development of net-enhanced organizations and business networks. After the introduction of software source code libraries and the rise of Software Component Markets (SCMs) since 1999, Web Service Markets (WSM) represent the third wave in the trade of reusable software components. However, very little is known about the current status, structure and trends within the WSM. We present a longitudinal study of the structure of the SCM in 1999, 2000, and 2006 and a study of the WSM in 2006. The SCM has grown into a large, polluted, and un-transparent market of around 30,000 software components, offered by 28 producers, 28 catalogues, and 8 intermediaries. Our study shows that the WSM is emerging and in the early stage of development in 2006. SCM and WSM still have a long way to become transparent and effective mechanisms for organizations to obtain powerful, re-usable, and interoperable components for business networking.

1 Introduction

Modern enterprises are forced to respond adequately to a variety of business and IT challenges in ever more competitive and global markets. As a consequence, enterprises are organizing themselves in business networks, virtual alliances with intra- and inter-organizational business processes that cover the integrated supply chain to ensure timely deliveries and competitive products and services (Bakos, 1991; Iacomo and Wigand, 2005). Net enhanced organizations (NEO) emerge and coordinate their activities and interactions with stakeholders through the exchange of messages over electronic networks. These business dynamics result in a continuous demand for IT and IT services (Straub and Watson, 2001).

The service oriented computing paradigm (SOC), with its recent manifestation of web-services technology, delivers a profound new way of developing business applications and promises a significant step forward in the ongoing quest of the software engineering community to meet the business demand for new IT services (Kraftzig et al, 2005). In fact, web-services constitute the latest wave of distributed computing technologies, and are in fact the successor to distributed software component technology.

Although web-services (WS) and distributed software-components (SC) are both used for plumbing enterprise applications, there are some profound differences. First, the SC style of communication is based on the Remote Procedure Call (RPC) style and typically involves passing a small number of individual data items that are packaged in multiple requests and synchronously getting a small number of reply data items in return within the boundaries of a single company. In contrast, WS adopt an event-driven, a-synchronous communications style that organizes data within a collection, called a business document, reducing the number of exchanges considerably and catering for distributed, event-driven interactions. Second, SC expose fine-grained object-level interfaces to applications whereas WS expose application-level interfaces. Third, SC rely on tightly coupled interactions that typically involve invocation of multiple fine-grained application programming interfaces (Zimmermann 2004). Such tightly coupled interactions largely depend upon a general acceptance of the SC model on which the application is designed. WS do not need these detailed agreements on the component model, promoting loose-coupling and allowing for truly distributed enterprise computing across enterprises.

Despite these technical differences, the overarching promise underlying SC and WS is virtually similar: that of offering, reusable software solutions that are traded in a commercial marketplace. However, before the tantalizing promises of SC and WS can be delivered, it is of critical importance that they do not only guarantee interoperability, facilitate reuse and promote loose-coupling, but that SC and WS can be assessed through well operating markets.

This paper focuses on the markets of software components and web-services. In particular, this paper focuses on the emergence and development of the markets for distributed software components and Web-Services.

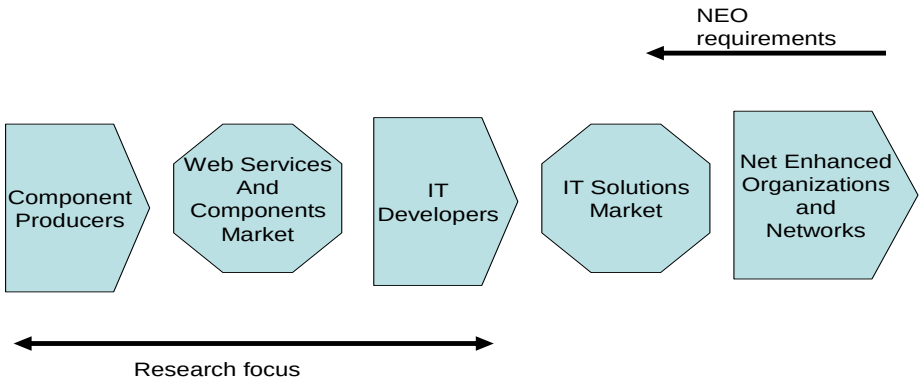

Figure 1. Research focus is on the markets for Software Components and Web Services (NEO = Net-Enhanced Organization).

This paper is organized as follows. First we briefly review the analysis of markets and how it can be used to evaluate electronic markets for IT products. Second, we analyze the markets for software components (in 1999 and 2006) in section 3 and for Web Services (in 2006) in section 4. Then we use these findings to clarify the current status of the web-services market, reflecting on lessons learned of the IS component market from which the web-services market may benefit. Lastly, we summarize the main conclusions of our work and outline recommendations for further research.

2 Structure of Markets and Electronic Markets

Wigand et al (1997) define a market as "an economic location on which the supply and demand for goods meet, enabling exchange processes". In this definition, the market for web services or software components may entail a virtual location where demand and supply meet and transactions are prepared, executed, monitored and settled.

Electronic markets (also referred to as hubs and online markets) allow large numbers of buyers and sellers to unite and transparently find and exchange information, negotiate, and trade either virtual or physical artifacts relying a common inter-organizational technology platform, typically realized on top of the Internet (Bakos, 1997). Electronic markets have become increasingly popular alternatives to traditional market forms, as they are considered to have various potential benefits, such as lower transaction costs, lower inventory and overhead costs, increased product and pricing transparency, and increased market liquidity (Malone et al, 1987, Turban et al., 2000). It is important to realize that electronic marketplaces are more than virtual hubs through which suppliers and customers are connected and trade, as they also offer additional services to facilitate auctioning, catalogues, payments, and after-sales services. This makes electronic market inherently different from traditional marketplaces.

Electronic markets can be evaluated from many perspectives. Driedonks et al (2005) distinguish between five types of electronic markets research:

- Analysis of electronic markets in comparison to other electronic coordination mechanisms for demand and supply of products or services,
- Analysis of differences between processes in electronic and non-electronic markets and the effects on market performance (e.g. price formation),
- Analysis of the development of market structures, roles, and functions of intermediaries (the 'institutional view' on markets),
- Analysis of factors that drive or hinder adoption and development of successful market systems,
- Case analysis of successes and failures of electronic markets.

Our research is of the type 'analysis of the development of market structures'. Following the Structure-Conduct-Performance model for market analysis from industrial economics as presented by Shepherd (1985), markets are considered to consist of three different, yet interrelated, facets:

- Market structure (concentration; relationships between market participants; the degree of product differentiation; market specifics such as transparency, accessibility, matching of supply and demand)
- Market behavior (price formation and budding behavior; preferences of market participants; changes in product offerings and demands; customer focus/ differentiation and customer satisfaction; business processes; objectives of market participation; rules and standards for markets; ways to evaluate market performance)
- Market performance (price, volumes, quality, costs, advantages).

In this research we focus in particular on the development of market structure. Structurally speaking, the market connects two basic market player types: IT suppliers and IT consumers. The electronic market itself is typically operated by market makers (intermediaries). In its simplest form, the market maker offers an electronic catalogue from which IT consumers may select and acquire products. However, market makers may also offer more value-adding services (which may in fact be implemented themselves by other market parties) along the entire transaction cycle, including payment services, tracking and tracing services, negotiation services, matchmaking services, auctioning services, forecasting services, and certification services.

At the demand side, IT consumers are typically manifested as IT departments of (integrated) companies, system integrators and IT consultancy companies. While enterprises are increasingly lining themselves up with other companies, forming virtual alliances and integrated value chains, we herein concentrate on demands associated with Networked Enhanced Networks. Generally speaking, these demands (labeled IT solutions in Figure 1) include structural and behavioural assets [Oesterle et al, 2000]. Structural assets include (i) standardized business processes and entities to ease customization of asset specific processes into enterprise specific solutions; (ii) interoperable business components for lower costs to establish virtual collaborations between companies, and (iii) simple product descriptions, because complex descriptions annihilate the coordination cost advantages of markets over hierarchies. Behavioural assets include (i) trustable components for certification and transparency of the physical location of suppliers, (ii) low learning costs due to component functionality that is easy to be understood, and (iii) secure transactions.

In this research we focus on the structure of the markets for software components and web-services, how the market structure develops over time, and how market structure influences market performance.

3 The Component Market Place

3.1 Research Approach

Data about the Software Component Market (SCM) was collected from the Internet from May - August 2006 to be compared to the findings on the SCM in 1999 and 2000 (Hillegersberg et al, 2001). To discover the websites where software components are offered, a selection of widely-used search engines were used in the 1999/ 2000 studies. We have consulted these search engines again for the 2006 study. In particular, the following search engines were (re-)applied: Yahoo, AltaVista, Lycos, Metacrawler, Excite and Hotbot. Infoseek.com, used in 1999 and 2000, redirected in 2006 from go.com to Yahoo search. In order to identify marketplaces in the first place, we queried using the following keywords: ”software component”, ”CBD”, ”component-ware”, ”ActiveX”, ”JavaBeans”, ”CORBA”, ”dotNet”, ”component market”, ”component-based software”, ”component software”, ”component Catalog” and ”component vendor”. Before doing the actual market analysis, the list of hits returned by the search engines was filtered wile removing redundant and broken links.

Note that in this way we assessed the market for Software Components similar to software developers and engineers when looking for software offerings. In this way we did not take a sample of the offerings, but made an analysis of the total market structure and the population of vendors, intermediaries and catalogues.

3.2 Structure of the Software Component Marketplace

Figure-1 depicts the basic structure of the Software Component Market (SCM), consisting of five types of market parties: producers (vendors), intermediaries, catalogs, system integrators, and customers. Customers come in a several types, most notably IT departments or consultancy firms. Component producers offer their products directly or through Intermediaries or Catalogs to Customers. A Catalog may be perceived as the most elementary form of Intermediary, bundling a collection of links to sites of various producers. Hence, a Catalogue merely provides a list from which customers may choose appropriate components. Once selected, the catalogue redirects the Customer to the website of a corresponding Supplier, which offers payment and delivery services by himself. An Intermediary provides additional services for the sales transaction while playing a pivotal role between customers and System Integrators (SI). Additional services

vary from (i) defining and performing independent tests and certification, (ii) providing helpdesk support, (iii) guaranteeing that Producers deliver their documentation conform some pre-established quality standard, and (iv) helping in making informed comparisons between various alternate components (matchmaking), and (v) after-sales services (e.g., reverse logistics). These value-adding services provide opportunities for Intermediaries to distinguish themselves from competitors and focus on specific customer groups and niches. A prominent example of an intermediary is ComponentSource (www.componentsource.com), which offers a component discovery facility and services such as a 30-day return policy. Jcom-Sot (www.jcomsoft.com) is an example of a core Intermediary, with no additional services.

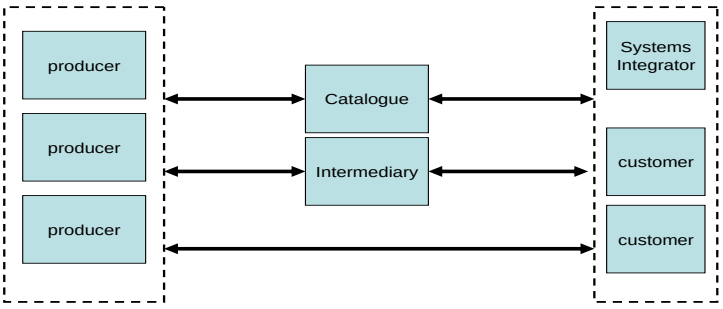

Fig. 1. Structure of Software Component Market

3.3 Components offered by market players

Table-1 shows the number of components that were offered in 1999, 200, and 2006 by three market parties: Producers, Catalogues and Intermediaries. It should be noted here that the level of granularity of these components varied widely: some of them supported discrete business functions whilst some others captured end-to-end business processes. Notably, Delphi components are typically packaged as fine-grained software artifacts. In order to reduce the noise of many fine-grained components, we here present the number of components offered by each partner with and without Delphi components (left hand side and right hand side of Table 1).

Table 1 demonstrates the following with respect to the numbers (#) of actors:

- #Producers has decreased with 34% since 2000,
- #Intermediaries remained approximately equal,
- #Catalogues boomed with 300%.

Table 1 demonstrates the following with respect to the numbers of components:

- #components sold by Producers increased with 200%,
- #components sold by intermediaries increased with 50%,
- #components traded through Catalogues exploded with 1777%.

Table 1 demonstrates the following with respect to the average numbers of components:

- #components per Producer increased with 363% and per Catalog 369%.
- #components per Intermediary slightly increased with 49%. We found a significant increase in variation among intermediaries: the largest three Intermediaries offer 5439 components while the largest Catalogues offer 18727 components. Large Intermediaries do not have larger collections than large Catalogues.

We now focus on the variety of the product types offered per market player. Figure 2 depicts the market share per technical component standard in 2006. This figure drafts

market shares with and without (fine-grained) Delphi components. In particular, the bar chart at the right hand side of Figure 2 illustrates that Delphi components have the highest market share, followed by ActiveX, .Net Java, JavaBeans and CORBA. Note that, comparing the right and left hand side of Figure 2 (2006 including Delphi and 2006 excluding Delphi) shows only a significant difference in the number of components offered by Catalogs. The "Delphi factor" amplified the total component growth from 267% to 445% and the number of components traded through Catalogs from 1006% to 1777%.

Table 1. Numbers of components offered by three market players (2006, 1999, and 2000))

			Including Delphi (2006)			Excluding Delphi (2006)		
Year	Market player	#Sites	#components	#comp/ site (sd)	Min Max	#components	#comp/ site (sd)	Min Max
1999	Producers	27	375	14 (6.7)	10 25			
	Catalogues	6	1,037	173 (127)	30 329			
	Intermediaries	5	2,697	539 (663)	10 1,326			
	totals	**38**	**4,109**					
2000	Producers	43	865	20 (14)	5 84			
	Catalogues	7	1,591	227 (212)	40 626			
	Intermediaries	8	4,832	604 (606)	30 1,516			
	totals	**58**	**7,288**					
2006	Producers	28	2,611	93 (229)	1 1,004	2,207	78 (215)	1 1,004
	Catalogues	28	29,865	1,067 (2,225)	0 10,933	17,605	628 (1044)	0 4,937
	Intermediaries	8	7,234	904 (1,044)	13 3,244	6,951	868 (973)	13 3,011
	totals	**64**	**39,710**			**26,763**		

To further analyze the product offerings on the Software Components market, a component-based taxonomy was developed, distinguishing between three categories:

- Infrastructure components: constitute the backbone to allow for interoperation between software components ranging from the network- to the application (OSI-) level. Examples are encryption components, database connectors, compression components, etc.
- Generic business components: offer horizontal, cross-industry functionality. Examples are document viewers, email clients, an address entry component.
- Specific business components: offer vertical functionality.

To gain detailed insight in these three component categories, we investigated three key characteristics that allow for successful trade at an e-marketplace: Component Type (3.4), Component Model or Technical Standard (3.5), and Component Documentation (3.6).

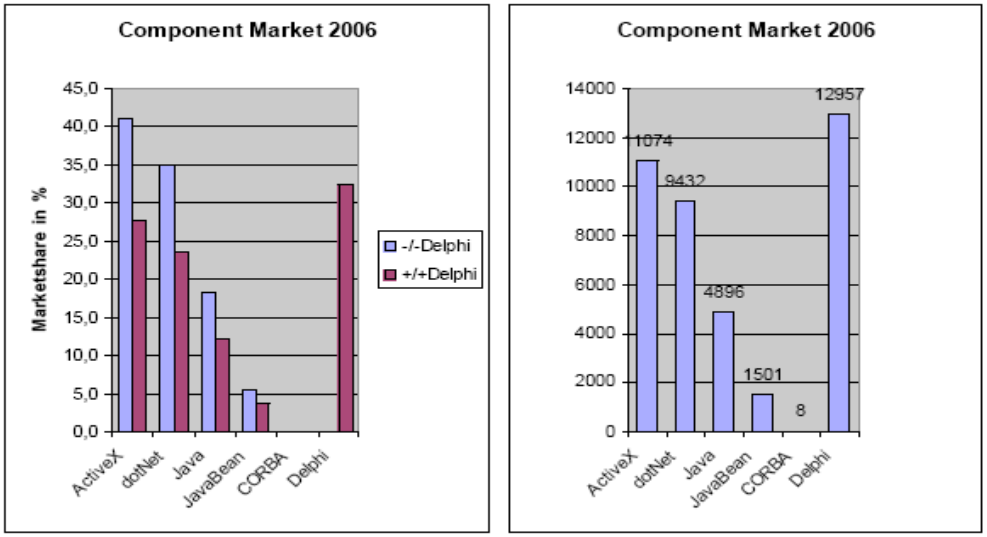

Fig. 2. Market shares (%, left) and numbers (right) for Component Technical Standards

3.4 Variety in product standards: Software Component Types

Six types of software components are distinguished, ranging from fine-grained client-side to large-grained server-side components, viz.:

- Controls, visual components for design of graphical user interface;
- Containers, visual components, that can also maintain context;
- Command package: back-end, server-side components that interact with visual, client-side components;
- A library, a collection of independent, back-end functions or classes;
- Framework: set of generic components supporting a business process and expandable by plug-ins;
- Business component: server-side software component that implements business logic. They may manifest themselves as industry- or enterprise specific or common (cross-industry) business components.

Table 2 shows the percentages of producers that offer a particular component type in 1999, 2000, and 2006. The main findings can be summarized as follows. A majority of the Producers (80%) offer controls, while 77% of them sell containers, which is about the same percentage as in 2000 (72%). The supply of control components by Producers rises from 60% (in 2000) to 80% (in 2006). In 2006, 57% of the Producers sell command packages: in 2000 this was 44%.

Table 2. Component types per market player in 2006, 2000, and 1999

			Six technical standards					
Year	Market player	#sites (100%)	Controls	Containers	Command package	Library	Frame work	Business component
2006	Producer	35	80	77	57	51	6	3
	Catalog	27	100	96	96	85	19	4
	Intermediary	8	100	100	88	75	63	13
2000	Producer	43	61	72	44	28	12	5
	Catalog	7	100	100	86	71	57	29
	Intermediary	8	100	100	100	100	88	50
1999	Producer	27	59	82	48	22	15	4
	Catalog	6	100	100	83	50	17	17

	Intermediary	5	80	100	100	80	40	20

3.5 Variety in product standards: Technical Standards

Technical standards for software components basically comprise two dimensions: component model and programming language. Since the 1999/2000 study, several novel component models have emerged that allow network- and platform-transparency, notably, J2EE, CORBA Components and .NET. Next, several programming languages became widely used, some of which in support of the component models, notably Java (including JavaBeans, applets and servlets) and Delphi. The technical standards in the 1999-2000 studies were ActiveX, JavaBeans, and CORBA. In 2006 new standards were added, particularly, Delphi and .Net. Novel component technologies such as AJAX were not included in our analysis because their market share is (still) very low.

Table 3 assesses the number of market parties that support one, two, or, three or more standards in 1999, 2000, and 2006. Also, it lists the average number of components that are offered per party. In 1999, 30 out of 38 Producers, Intermediaries and Catalogues offered merely one standard, whereas the other eight market players offered two product standards. In 2000, again most market players (42 out of 55) offered only one standard. The majority of Intermediaries (75%) offered two or more standards. In 2006, the number of Producers, Intermediaries and Catalogues that offer two standards or more has increased to 41 out of 58, including a substantial number offering three or more. Catalogs have become more differentiated in products and standards offerings and offer 11% of components implemented in one particular technology. A similar market pattern was detected for Producers where homogenous offerings of one single component technology have dropped from 83% in 2000 to 42% in 2006.

Table 3. Market players and the variety of product standards offered (2006)

		1999	1999	2000	2000	2006	2006
Market Player	# technical standards offered	#sites	Products/ site	#sites	Products/ site	#sites	Products/ site
Producers	One standard	20	15	34	19	11	13
	Two standards	7	12	7	19	11	490
	Three or more	0		0		4	6
Intermediaries	One standard	4	671	2	896	3	589
	Two standards	1	10	5	459	2	665
	Three or more	0		1	746	3	1381
Catalogs	One standard	6	173	6	215	3	30
	Two standards	0		0		6	2382
	Three or more	0		0		15	795

3.6 Variety in product standards: Component Documentation

The component documentation that was packaged with the component was also studied. Component documentation entails an essential part of a component, as it not only captures information on the basis of which a component may be actually acquired, but also, detailed knowledge about how a component may be plugged to another one. The latter is especially important for medium and large grained components. In addition to these categories of documentation, the following artifacts were considered as being part of component documentation, including, test reports, component source code, external references and white papers.

Table 4 is based on Hillegersberg et al (2000) and our research in 2006 shows that in 1999 and 2000 a great majority of all the market participants restricted themselves to providing a simple description of their components. In 2006, Catalogs show a significant improvement at all levels of the documentation classification, whereas the technical documentation of Producers has decreased slightly. Although still very popular under Producers the availability of demos and trial versions has decreased slightly, while this increased for Catalogs and Intermediaries. Test reports are still available for a very modest percentage of software components. Probably driven by the Open Source Community, the availability of source code has improved. Remarkable is the high number of Intermediaries that publish source code.

Table 4: Percentages of market parties that offer various component documentation types

		1999						2000				
% of sites that offer this doc.type	nr sites	d1	d2	d3	d4	d5	nr sites	d1	d2	d3	d4	d5
Producer	27	96	52	89	7	22	43	98	56	81	16	21
Catalog	6	17	0	0	17	0	7	71	14	0	14	0
Intermediary	5	100	40	40	60	0	8	100	50	50	38	25

	2006					
% of sites that offer this doc. type	nr sites	d1	d2	d3	d4	d5
Producer	35	91	43	66	17	23
Catalog	27	96	26	82	22	48
Intermediary	8	100	38	100	50	63

d1: simple description, d2: technical details, d3: demos, d4: test reports, d5: component source code

3.7 Conclusions on the Software Component Market

We conclude that in 2006 it is still cumbersome to obtain software components, because the usage of search engines is still the most effective way to find them and that this is clearly a time consuming and error prone alternative. Since several years, research efforts such as the Semantic Web aim at improving component discovery, but the results of this research have clearly not yet been adopted in practice.

Since 1999-2000, 3 Intermediaries, 4 Catalogs and 11 Producers have vanished. The market has been turbulent: various mergers (e.g., ComponentSource took over competitor Flashline), others have ceased to exist, especially after the burst of the Internet-bubble. The amount of software components has exploded from 4000 components offered by 38 market participants in 1999 to 40,000 components and 64 participants in 2006. Actually, this market has still much growth perspective given the fact that new component technologies are emerging (AJAX) and existing component technologies are gradually maturing (dotNet and J2EE).

Analysis of the 2006 market shows for al market players a relatively high standard deviation, indicating that each market domain is dominated by a few large parties. The category of Intermediaries has the smallest variation and contains a few equally sized Intermediaries. In 2006, each Producer offers a significant higher percentage of components while the relative supply of Intermediaries remained equal in comparison to the 1999/2000 studies. We conjecture that many Producers offer their products indirectly to their customers through other market parties (Catalogs and Intermediaries).

In particular, we observe that since 2000 there has been a significant increase in component trade through Catalogs. Apparently, Producers prefer to do business with Catalogs instead of Intermediaries. We carefully conclude that the added value of Intermediaries is at this time still (too) limited. In some isolated cases however,

Intermediaries are exploited quite fruitfully, as shown by sites like ComponentSource. Analysis of the components, component types, component technologies and documentation show a substantial increase in both diversity and quality since the 1999/2000 studies.

The strong increase in the number of business components might indicate that the market is slowly maturing to the level that it can support business processes. Another important development is the emergence of a market, in particular a 'bazaar', of Open Source and FreeWare components. Although not further investigated, this development will probably have an impact on the future e-market for software components.

4 The Marketplace for Web Services

4.1 Research Approach

The research approach that was espoused for evaluating the WSM was very different to the analysis of the SCM: only nine major players exist in 2006. Therefore, a detailed assessment of parties at the WSM was conducted to allow for a preliminary comparison with the Components market. Similar to the analysis of the software components market, the web services market was assessed by using (the same) search engines. The following keywords were used to locate the relevant websites were: "component service", "web service market", "web-service market", "web services vendors", "web-service vendors", "Web marketplace" and "service marketplace". We used the market model of SCMs to asses WSMs as the SCM model resembles that of Service Oriented Architectures (SOA). In particular, *Catalogues* manifest themselves as *Registries* in SOA, while *Intermediaries* manifest themselves as *Service Aggregators* or *Service Brokers* in the eXtended Service Oriented Architecture [Papazoglou]. Clearly, there was no need to explicitly distinguish between various types of web-service implementation technologies as these completely transparent to the customer.

4.2 Assessment of Parties operating in the WSM

Up till recently, the UDDI registries were an important source for web-services. However, in January 2006 the public UDDI registry (UDDI Business Registry) was discontinued. UDDI is nowadays subsumed in the software solutions of software vendors, including Microsoft, IBM and SAP. We therefore restricted ourselves to the following list of nine major players in the WSM, which resulted from the above-mentioned Internet search queries:

- www.xmethods.com. Xmethods provide a flat listing 490 of services, but unfortunately, offers no search facilities. The offered services can be accessed through the following interfaces; UDDI v2, WS-Inspection, RSS, SOAP and DISO. The majority of the services retrieved from the website could be categorized as Common Services (477) while a small number of Infrastructure services (11) and Business Data Container services (2) were found. Xmethods provides several additional facilities, notably a test facility and a WSDL parser.
- http://www.bindingpoint.com. BindingPoint offers 4202 services categorized in 8 main categories. However the website contains a large number of inactive services (1561) leaving 2641 active ones Of the offered services 97% (2562) can be categorized as Common Services and 3% (79) as business data container service. The inactive services were not investigated.
- http://www.web-serviceswatch.com. As web-services watch is just an ordinary search portal and offers no direct links to e-markets for web services this site was not investigated.

- www.grandcentral.com. During the period of this study June / august 2006 the website of GrandCentral was under construction and could not be investigated. Instead data was used found in existing (case) studies, articles and white papers.
- www.service.sap.com. Wit the ES Workplace SAP offers a place to find and learn about SAPs enterprise services. The ES Workplace SAP customers and partners to browse and test enterprise web services. Services that SAP provides and ships for customers to use in their own systems. As the ESWorkplace is only accessible for SAP customers and partners the web services possibly residing on the ES Workplace could not be investigated.
- www.strikeiron.com. A marketplace for commercial web services that are categorized into 17 categories. In these categories 207 services can be found that can be categorized as Common Services (180) and Business Data Container Services (17).
- http://www.web-servicelist.com. Web Service List is a website for developers. Next to web service related information, resources and tutorials, it also contains a list of web services. In particular, it contains 7 categories in which210 web services are stored that can all be classified as Common Services.
- Web-serviceX.net offers 81 services categorized in 8 categories that can all be classified as Common Services
- Woogle offers 2136 services in 52 categories; these services can be classified as Common Services.
- Remotemethods.com. RemoteMethods offers 322 services in 38 categories that can be mainly classified as Common Services an a few as Business DataContainer Services (5 10).

Except for the ES Workplace, the above nine parties could all be classified as Catalogues. The ES Workplace incorporates SAP web services. Surprisingly, no Intermediaries were found during our study.

4.3 Conclusions for the Web Services market

From the ten sites a total of 4116 web services from approximately 900 different service providers were found. 99% of the available services are Common Services (resembling type 1-5 components), varying from simple weather forecasts to the 'joke of the day'. In addition, these services are characterized by a low level of granularity, and embody virtually no business functionality. Analyzing the available services in more detail leads to the insight that there exists an extremely high redundancy of the implemented functionality. In addition, the same web-services are offered at multiple catalogues through the suppliers.

Analyzing the market from a provider's perspective, it seems as if the web-service world has collapsed or at least turned into internal markets after the public UDDI Business Registry was stopped. Since then it has become difficult to find web services as UDDI Registry implementations of IBM, SAP, Oracle and Microsoft are not public. The WSM is very turbulent indeed, witnessing the departure or fusion of players such as SalCentral and GrandCentral. The inventory of web service Registries show that it is intricate and inconvenient to discover and locate web service marketplaces. Again, initiatives of the domain of Semantic Web Services do not (yet) make their promise a reality.

In conclusion, the performance of the WSM is currently very low in comparison to that of software components: currently the volume of web-services offered through some market party is relatively low, just like the number of web-services that are traded. From a structural vantage point the WSM also scores relatively bad: product variety is extremely low, the market is hard to find and enter, while facilities to match supply and demand are virtually non-existent. Although in line with the SOA, the WSM should cater for various flexible payment models, publicly available services are priced just like regular

components, having a fixed price. On the other hand, give the WS-* standards stack the WSM has great potential. Standards do not only allow defining and executing service interfaces and processes, but also, mutual agreements, and several QoS concerns, e.g., regarding security. Hence, the market behavior has great potential, much of which is not realized yet.

An immediate concern seems the quality of support offered by the providers. Analysis shows that no or little support is offered for service brokerage (discovery, negotiation, transaction handling, license management, documentation, quality assurance and support) and payment (payment models, billing). This is evidence that the reality underpinning the (global) Service Oriented Architecture still is far away.

5 Conclusions and Future Research

In this paper, we have investigated the structure of the market of software components (SCM) and web-services (WSM). We conclude that

(i) SCM and WSM lack a very essential aspect, namely customer-supplier interaction,

(ii) product descriptions are very often lacking, incomplete or unclear,

(iii) components realizing business-level functionality are sparse both in the SCM and WSM,

(iv) SCM and WSM are not transparent: many parties offer the same components, the parties are hard to locate, and it is difficult to compare parties and components.

(v) the market is polluted and not up-to-date, illustrated by many dead-links and non existing web services and incomplete/ wrong information,

(vi) additional value-adding facilities such as payment services and certification are seldom present for both SCMs and WSMs,

(vii) in contrast to SCM, WSM has great potential as it may build on top of existing standards,

(viii) SCM has much more product differentiation in comparison to WSM.

Hence, this study has shown that both SCM and WSM still have a long way to go and are far from mature in comparison to other electronic markets such as ChemConnect and Eumedix.

While analyzing the evolution of the WSM, similarities are recognized that were also observed earlier in the SCM in 1999-2000. For example, most of the web-services offered at the WSM are typically simple in nature (types 1-5). Also, the diversity of web-services is quite low. Similar product characteristics were also observed in the SCM in 1999-2000. In the meantime, the SCM has matured to the stadium in which simple business components are available and more serious business support will be available. In the future, we aim to conduct longitudinal research to monitor and assess WSM, so we can predict new developments in the market for reusable software components more faithfully.

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