Is There a Market for Web Services?

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Abstract. Web services are expected to foster the creation of networks of specialists which expose their digital services over the internet for the dynamic discovery of services by other organizations. Given this vision, the question arises whether and how Web services will be traded in the future. Based on a longitudinal study of commercial Web services directories and registries, this paper analyzes the market structure, the role of intermediaries and the Web services offering. The study suggests that the Web services market faces a rather slow evolution with a significant shakeout in 2006. More recently, an increasing professionalization can be observed given that commercial Web services specialists emerge and Web services directories are relaunched. The paper draws conclusions on the future market development and discusses analogies to the newer mashup-oriented service directories.

Keywords: B2B intermediaries, electronic markets, infomediaries, Web services, Web services directories.

1   Introduction

Since the early days of the internet, the emerging technological capabilities have been expected to revolutionize not only the existing information system landscapes, but also the interactions between businesses. The falling interaction costs were said to promote the unbundling of functions and activities within organizations and across supply chains [1]. This eventually results in the creation of networks of specialists exposing their services over the internet for the dynamic discovery of services by other organizations, thus leading to a global electronic marketplace. At the core of this vision are electronic services, more specifically Web services, which expose reusable application functionality based on open internet standards and can be easily consumed by other organizations. Pure internet players like Google, eBay or Amazon have demonstrated how to successfully adopt Web services by exposing e-commerce functionality as Web services to their partner network. Although most industry experts recognize the potential of Web services [2], the idea of a global Web services directory, which was considered a key enabler of e-commerce in the dot.com era, seems to have failed with the shutdown of the Universal Business Registry in 2006. Recently, the vision of a global Web services market has regained popularity lately due to various factors: First and foremost, large software vendors are re-architecting their software platforms to reflect the paradigm of a service-oriented architecture

(SOA). These efforts are complemented by the establishment of large service catalogs, e.g. the IBM SOA Business Catalog or SAP's Enterprise Services Repository. Second, mashups are among the most promising Web 2.0 technologies. They are composite web applications which can be built reusing content from third parties via a public interface or APIs. Last but not least, a very active research community is exploring the semantic Web. They argue that it will be much easier to locate providers of particular services and establish (semi-)automated cooperation with them if semantics are explicitly added to Web service descriptions [3].

Given these latest developments, the interesting question is whether and how Web services will be traded in the future and how this market will be organized. Hence, this paper aims at reviewing the evolution of commercial Web services offerings and directories over the last 5 years in order to extract insights and conclusions for the further development of the global Web services market. Based on a longitudinal study, it investigates the following three questions:

- **Market structure:** Who are the market participants, i.e. buyers, sellers and intermediaries, and how has the market structure evolved over time?
- **Role of intermediaries:** What is the role of Web services directories and registries in match-making and facilitating market transactions?
- **Web services offering:** What are the characteristics of the Web services offered in terms of their functionality and granularity? What conclusions can be drawn related to the market attractiveness for business users?

This paper is organized as follows: The next section motivates our research approach and reviews related work. Section 3 analyzes the Web services ecosystem and draws comparisons with the conceptualization of electronic markets. Key findings of our longitudinal study are summarized in sections 4 and 5. While section 4 focuses on the market structure and the intermediating role of Web services directories, section 5 explores the provider side and the Web services offerings in more detail. Section 6 summarizes our conclusions on the evolving market for Web services.

2   Research Approach and Data Collection

Since empirical data related to the Web services market and the transaction volumes is not publicly available, our research is explorative in nature. It relies on data that a team of researchers at the University of St. Gallen, Switzerland, has collected over the last 5 years. Since 2002, we have been observing the emerging Web services registries and directories, among them the Universal Business Registry as well as commercial directories and registries. We analyzed them with regard to their specific role in bringing together buyers and sellers of commercial Web services. For selected directories, we periodically analyzed their Web services offering. In order to evaluate the attractiveness of the Web services offering from a user perspective, we conducted workshops with e-business experts from industrial companies to gather their feedback.

3   The Market for Web Services

3.1   Web Services - The Business Perspective

Web services have been discussed from very different angles, with the most important streams of research focusing on either technical or business aspects. Whereas the technical research stream is mostly concerned with Web services standards and architectures [4-6], the business literature focuses on the emerging Web service-based business applications and their economic potential. Many business experts emphasize that Web services – in combination with an SOA – may resolve many of the existing conflicts in today's information system landscapes by offering a higher degree of standardization and interoperability combined with higher flexibility [1, 7]. Besides the significant reduction in systems integration costs, this will drive an increasing market demand for reusable Web services in the mid- to long-term: By replacing their proprietary information system landscape with an open, modular architecture, companies will increasingly leverage shared services, i.e. centrally managed, one-to-many services, and rely on the capabilities of third parties [8]. With Salesforce.com a prominent example exists for the rapidly growing market for "software as a service". As Amazon and eBay demonstrate, Web services also stimulate the external integration with business partners and are expected to increase the bundling of services from internal and external partners [2].

3.2   The Web Services Ecosystem as Electronic Market

From the very beginning, Web services have been associated with the idea of online service discovery [5, 9]. This is manifested by the integral role that directories storing service descriptions play in a Web services architecture. Directories allow providers to register new services and consumers to search for and locate services. In a centralized approach, they are hosted and managed by a trusted entity. Since directories establish many-to-many interactions between organizations that publish Web services and organizations which consume them, Web services ecosystems show typical characteristics of an electronic market. More specifically, they represent a case of cybermediation [10, 11], given that they create a wholly new market for digital services.

From the literature, a market represents a social arrangement which allows buyers and sellers to carry out a voluntary exchange of goods or services. Similar to a physical marketplace, an electronic market serves three main functions, namely to match buyers and sellers, to facilitate transactions and to provide the institutional infrastructure for business [10, 12]. Applied to the Web services ecosystem (cf. Fig. 1), sellers are all publishers of Web services, typically software vendors and service providers, but also companies exposing Web services to their customers and partners like UPS or e-Bay. The buying parties are the Web service consumers, i.e. individuals or organizations which use the service directly or add further value by orchestrating services for a specific business scenario. As in the case of a traditional market, an intermediary brings together buyers and sellers for business, a role that has also been called Value Added Service Supplier (VASS) [13]. In practice, service directories, registries or dedicated marketplaces for Web services have taken on this role. We denote them as Web services intermediaries and will explore their role in more detail.
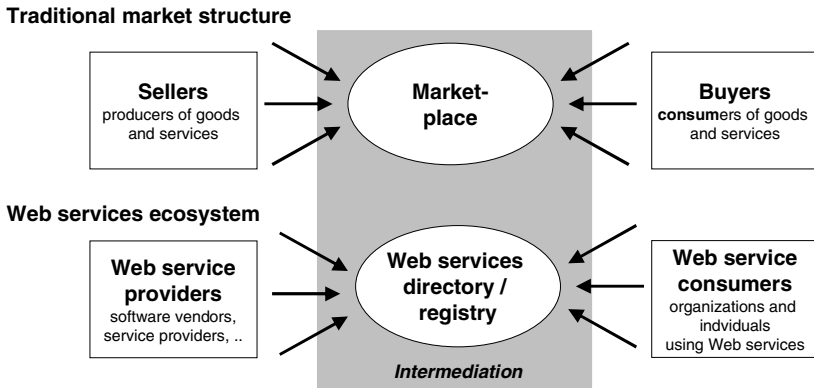
Traditional market structure

Fig. 1. Traditional market structure vs. Web services ecosystems

Table 1. Overview of public Web services directories

Name and Link	Owner	Active	Status (Oct. 07)
Universal Business Registry (UBR) - *(Inactive)*	IBM, Microsoft, NTT Com, SAP	2002 – 2006	Discontinued in January 2006 with >50,000 entries ("the objective of the UDDI project was reached")
BindingPoint *(Inactive)*	Acclaim IT Solutions Ltd.	N/A – 2006	Discontinued in 2006 with >4000 services [14] ("market too slow to adopt Web services")
eSigma.com *www.esigma.com*	eSigma	2003 – today	159 Web services
RemoteMethods *www.remotemethods.com*	InfoGenius Inc.	1999 – today	Started as Web development directory; 337 Web services
StrikeIron *www.strikeiron.com*	StrikeIron	2002 – today	618 Web services in Global Directory; 74 Web services in StrikeIron Marketplace
WebServiceList *www.webservicelist.com*	IT Netix, Inc.	N/A – today	483 Web services
WebserviceX.NET *www.webservicex.net*	Generic Objects Techn. Ltd.	N/A – today	71 Web services
XMethods *www.xmethods.net*	XMethod	N/A – today	509 Web services

3.3   Historical Evolution

The publication of the first version of the UDDI specifications in 2000 inspired the launch of several Web services directories and registries (c.f. Table 1). In analogy to the DNS database, a public implementation of this UDDI specification was conceived as a master directory of e-commerce services. Four large software vendors, namely IBM, Microsoft, NTT Com and SAP, implemented nodes of this Universal Business Registry (UBR) which formed a global distributed business directory. Besides these four UBR nodes, a dozen other commercial Web services directories were launched in or around the period 2002/2003, most of them by internet startups. Even though the

UBR grew to more than 50,000 entries, it was discontinued in 2006. According to the official statement by the initiators, the goals of the UDDI project were achieved, since the public implementation had demonstrated the interoperability and robustness of the UDDI specifications [15]. In practice, the registry was of little use since many entries were bogus and not service-related [16]. Much like the UBR, BindingPoint, one of the larger Web services directories which replicated part of the UBR, went out of business in 2006 blaming the slow adoption of Web services as the key reason.

4 The Role of Web Services Intermediaries

4.1 Functions of Web Services Intermediaries

For the purpose of exploring the role of Web services directories in more detail, we build on the market function model suggested by [10] and [12]. As outlined in Fig. 2, this model can easily be complemented with the service lifecycle from the Web service provider and consumer perspective [17]. It is obvious that Web services directories are to support the matching of providers and sellers by storing service descriptions and assisting with service publishing and searching. This matching function of a directory is very similar to an electronic catalog. It might also be expected that Web services intermediaries assume functions related to the facilitation of transactions and the clarification of the institutional infrastructure for business, which in traditional markets is provided by governments and regulatory bodies. In order to further analyze how Web services intermediaries perform the sub functions of traditional markets, three of them have been selected using the following criteria: (1) They represent different types of intermediaries, i.e. from simple Web services listings to more advanced marketplaces; (2) due to their Web services offering they are expected to be the major players, and (3) all of them have survived the shakeout phase in 2006.

- RemoteMethods started in 1999 as a Web development directory. Today, the company operates a Web services directory which comprises service descriptions and pricing information as well as rating and review mechanisms.
- StrikeIron, located in Raleigh, North Carolina, was founded in 2002 and provides a global Web services directory as well as a marketplace. The company has developed a broad service portfolio related to hosting, monitoring and commercialization of Web services. StrikeIron has teamed up with small systems integrators as well as content providers, such as Dun & Bradstreet or MapQuest.
- X-Methods provides a flat listing of services from individuals and organizations. In addition to the browser interface, it offers programmatic interfaces to the registry.

The details of our analysis and a comparison with the public UDDI implementation in the Universal Business Registry can be found in the appendix.

4.2 Matching Web Service Providers and Consumers

Electronic markets are supposed to substantially decrease the search costs of buyers looking for a particular offering which suits their requirements. Although Web Services are defined by their WSDL interface, this specification is neither sufficient nor
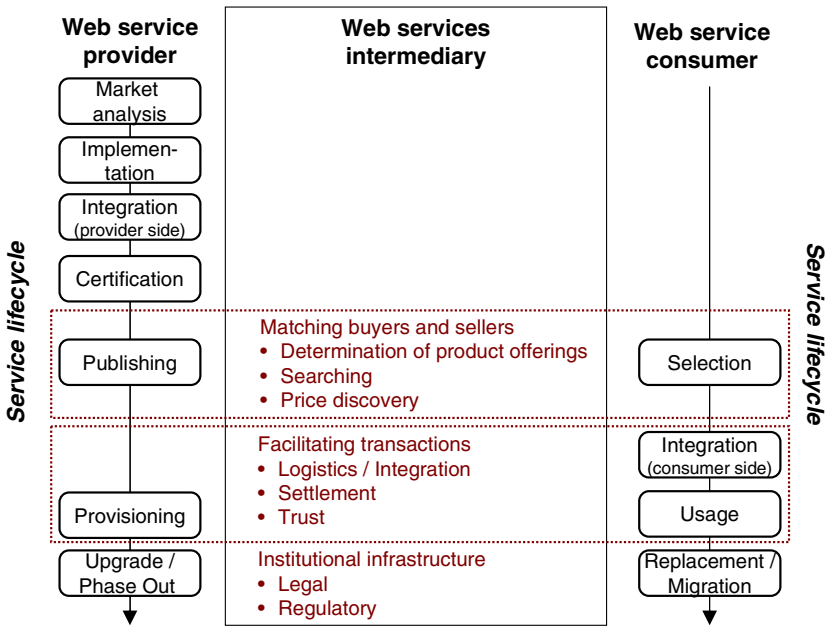
Web service provider   **Web services intermediary**   **Web service consumer**

Service lifecycle

Market analysis

Implemen- tation

Integration (provider side)

Certification

Publishing

Matching buyers and sellers
• Determination of product offerings
• Searching
• Price discovery

Selection

Facilitating transactions
• Logistics / Integration
• Settlement
• Trust

Integration (consumer side)

Provisioning

Usage

Upgrade / Phase Out

Institutional infrastructure
• Legal
• Regulatory

Replacement / Migration

Service lifecycle

Fig. 2. The functions of an intermediary in the Web services market

complete for discovering and consuming Web services. The UDDI specifications support the description and discovery of (1) businesses, organizations, and other Web service providers (businessEntity), (2) the Web services they make available (businessService), and (3) the technical interfaces (tModel) which may be used to access and manage those services. This corresponds to a large extent to the existing service description by the three intermediaries, which comprises publisher information, the service name, the description, and its technical interface. However, the level of detail and reliability varies widely. Whereas XMethods and RemoteMethods provide brief descriptions and link to the service provider for detailed information, the StrikeIron Marketplace delivers a comprehensive description including feature lists and example data documentation. Most interestingly and in contrast to the paradigm of an electronic market, not all intermediaries provide price transparency. Of the "pure" directories, only RemoteMethods displays prices. The StrikeIron Marketplace offers a harmonized subscription model for Web services from different providers, in which subscribers pay either a monthly or annual fee to gain access to and invoke Web services. This fee is based upon the number of actual invocations (from a few hundreds to several millions) the client uses.

Despite the fact that private UDDI registries allow for advanced categorization and identification schemes, the investigated Web services intermediaries use simplistic search and categorization mechanisms. Searching functionality is reduced to keyword search and simple category browsing with very basic predefined categories. Unlike in other electronic markets, we were not able to observe increasing personalization and customization of the Web services offerings. Besides browser access, discovery of

services is supported by programmatic interfaces: XMethods provides the most advanced options with SOAP interfaces, RSS feeds, WS-Inspection, DISCO documents and a UDDI Private Registry interface. A novel aspect of Web services directories is the trial and testing functionality which allow prospective buyers to invoke a service and review the response. This feature is provided by all intermediaries.

4.3   Facilitation of Transactions and Institutional Infrastructure

Since XMethods and RemoteMethods take a decentralized approach and do not offer any transaction-related functionality, transactions have to be directly settled between providers and consumers. With regard to service quality, RemoteMethods announces at least information on the provider's service levels (uptime guarantees, downtime compensation, e-mail response time), support organization (serviced regions, phone coverage, office hours) and security-related aspects (backup frequency, secure delivery methods). However, the quality of the entries depends on the service provider and RemoteMethods, like XMethods, currently does not support real-time monitoring of Web service endpoints or functionality. In its role as cybermediary, the StrikeIron Marketplace takes a more active part in initiating and facilitating transactions between Web service providers and consumers. It establishes the contractual agreement between buying and selling parties, processes credit card payments and balances accounts with service providers. All service invocations and replies are resolved through the platform which provides authentication and authorization against a consumer's subscription and then forwards the request to the service provider. In addition, it offers service availability monitoring and usage metering. StrikeIron also facilitates systems integration at the Web service consumer's end: It provides tools, like the Web Services Analyzer, and offers pre-defined authentication mechanisms as well as out-of-the box integration. SOA Express for Excel enables users to drag and drop Web services operations and parameters into spreadsheets. Using the StrikeIron Marketplace API, software vendors are able to embed service invocations in their applications. As an example, Salesforce.com users can easily call StrikeIron's US Address Verification Service to correct and enhance customer address information.

  The institutional infrastructure specifies the laws, rules and regulations that govern market transactions, and provides mechanisms for their enforcement. Since this is most relevant during the transaction phase, StrikeIron is the only intermediary to define commercial agreements (here: one-time purchases, monthly and yearly subscriptions with a defined number of invocations) and the related sales conditions.

5   Web Services Offering

5.1   Type and Granularity of Services Offered

Since markets are more attractive if they comprise a large offering, the number of Web services provided by intermediaries is a simple indicator of market attractiveness. Hence, the number of services allows one to deduce the acceptance and popularity of an intermediary for locating web services. With 500 to 700 service entries and >100 service providers, XMethods and StrikeIron Global Directory offer the largest Web services catalogs. However, their attractiveness seems to be decreasing, as they

Table 2. Overview of Web services offering

	Remote-Methods	StrikeIron Global Directory	StrikeIron Marketplace	X-Methods
Number of Web services (own data collection)				
October 2005	N/A (246)*	N/A (1779)*	50 (155)*	555
October 2007	337 (344)*	618 (1037)*	74 (218)*	509
Trend	+40%	-42%	+41%	-8%
Number of Web services (according to [14])				
January 2006	322	N/A	207	490
Web services offering (own data collection based on classification by intermediary)				
Address, Location & Identity Verification	34.88%	2.41%	11.47%	-
Business & Finance	25.87%	37.51%	56.42%	-
Communications	6.10%	14.08%	0.92%	-
Consumer	0.00%	0.39%	1.83%	-
Government	0.00%	1.83%	0.92%	-
IT Services	0.00%	17.16%	0.46%	-
Media	2.62%	0.00%	0.00%	-
Miscelleaneous	9.30%	1.54%	3.21%	-
Utilities	7.85%	8.68%	1.83%	-
Value & Manipulation	13.37%	16.39%	22.94%	.
Number of Web service providers				
October 2007	N/A	326	29	189
* Depending on the realization of the directory, Web services and providers are only displayed according to predefined categories. The resulting numbers may include duplicates due to multiple categorizations.				

have been shrinking over the last two years. Even though RemoteMethods and StrikeIron's Marketplace are significantly smaller in terms of the number of entries, they have experienced moderate growth lately.

Table 2 depicts the main categories of Web services according to the classification of the intermediaries. Although Web services intermediaries claim to provide business-level services, many services are extremely fine granular and data-centric. This is reflected by the large portion of services in the categories 'communications', 'value and manipulation' and 'utilities'. These Web services offerings mainly comprised simple information services for the distribution of existing digital content, e.g. the transformation of simple text files in XML format or SMS, or conversion services, e.g. currency converters. Like 'Joke of the Day', many of these services were targeted at individual users or end consumer websites. In the meantime, Web service providers have come up with value propositions that are targeted at specific business requirements. Recent service offerings comprise small chunks of business logic for specific scenarios. The growing number of services in the categories 'business & finance' as well as 'address, location & identity verification' underpins this trend. Among them

are validation and verification services which enhance postal address, e-mail or phone information and may be useful in marketing campaigns, credit checking or death index services which can be easily integrated in ordering applications and facilitate real-time fraud detection. Another emerging focus area of service offerings is regulatory compliance, with the Patriot Act compliance service, safety and product recall services as examples. More advanced transformation and conversion services include a barcode reader service which detects and decodes barcodes from scanned documents. In addition, information services are increasingly customized as notification services that send out alerts as a reaction to specified events.

5.2 Web Service Providers

Our analysis suggests three different types of Web service providers which are interested in publishing Web services in public directories.

1. Individuals, in particular students or software developers, who offer their Web services to others at little or no cost;
2. Professional service providers which specialize in the provisioning of digital services based on a transaction-based pricing model.
3. Companies which offer complementary Web services to customers, e.g. logistics providers offering Web services for direct access to their online tracking systems.

With exception of the StrikeIron Marketplace, intermediaries address all three types of service providers. Interestingly, a large number of individual software developers or students publishes their latest solutions free of charge. From a business perspective, problems occur if these services are not maintained or the WSDL location shows significant downtime. Web services intermediaries targeting the commercial market react to this by rating service providers or, in the case of the StrikeIron Marketplace, by publishing only Web service from trusted providers. Although most Web services are still offered free of charge (in particular type 1 and 3 providers), our study suggests that an increasing number of specialist service providers are able to charge for the provisioning of their service. Prices range from < USD 1 per invocation (one-time purchase), to monthly and yearly fees of more than USD 10,000 (for a million or more invocations). Table 3 depicts some examples of these emerging service specialists.

Table 3. Specialist Web service providers (type 2 in Table 2)

Service provider	Sample services
CDYNE *www.cdyne.com*	Postal address, e-mail and phone verification; demographical data; death index
Dun & Bradstreet *www.dnb.com*	Company identification / information; credit information and credit reports
Fraudlabs *www.fraudlabs.com*	Credit card fraud detection; geolocation of IP addresses; ZIP code search
Xignite *www.xignite.com*	Financial data, e.g. interest rates, quotes; market news; SEC filings

6   Conclusions

6.1   Evolution of the Web Services Market

Despite the great enthusiasm about Web services, the Web service market faces a rather slow evolution with a significant shakeout in 2006. Similar to the evolution of electronic marketplaces, a consolidation of Web services directories has taken place lately, underpinned by the discontinuation of the public UDDI implementation. As of today, most Web services directories still focus on simplifying Web service search by providing an electronic catalog and complementing Web service descriptions with some testing functionality. This is a valuable role in view of the fragmentation of the Web services market. Given the brief service descriptions and the limited support for searching and price discovery, it is however questionable whether potential service consumers, in particular professional users, will be able to discover and use suitable service offerings. More sophisticated classification schemes which reflect the vocabulary of the target customers are, in combination with complete and reliable service descriptions, a prerequisite for the discovery of suitable Web services. More recently, an increasing professionalization can be observed given that commercial Web services specialists, such as Dun&Bradstreet or Xignite, emerge on the market.

Although our analysis does not suggest a clear trend for the future development of the Web services market, the market evolution will depend on a number of factors: Given that businesses are more prepared to adopt Web services today than they were five years ago, the market take-off will largely depend on the availability of Web services offerings which are of interest to business customers. As demonstrated, some specialists have already emerged and demonstrate how to establish transaction-based pricing models for data-centric Web services. In view of the increasing availability of digital content and real-time information, we expect a large growth in data service providers, in particular in the area of compliance, online validation and alerting. Whether Web services intermediaries are to play a role in the future will depend on their specific value proposition for their target community as well as on the sustainability of their business model. As long as the market is fragmented, intermediaries have an important role to play in facilitating interactions with a wider spectrum of trusted service providers. However, disintermediation is also a possible scenario, if the specialist Web services providers evolve into a handful of well-known "brands" and establish their own online sales channels.

From our longitudinal study, we find that the role of intermediaries is evolving and that the existing intermediaries have taken different evolution paths: Whereas at the one extreme X-Methods provides a flat listing of Web services targeted at the large technical community, in particular the many individual software developers, StrikeIron and RemoteMethods are actively focusing on the business users and commercial Web services market. RemoteMethods positions itself as "the source for finding reliable Web Service Providers (WSP)", i.e. a neutral platform providing review and rating mechanisms as well as price and service transparency; StrikeIron has established a transaction-based remuneration model as so-called Web Services Marketplace and assumes the role of a cybermediary providing targeted services to both Web service consumers and providers. In order to develop their Web services offering and to increase their attractiveness as a sales channel, StrikeIron supports service

providers with co-marketing efforts, flexible pricing mechanisms, billing and account management. For Web service consumers, StrikeIron acts as a single point of contact, which facilitates transactions with multiple service providers and provides a reliable institutional infrastructure for conducting business.

6.2 Related Work

To our knowledge, only two other studies exist in this field: [14] analyze the market structure for software components and compare it to the Web services market. [18] review the existing approaches toward Web service discovery based on an analysis of Web services directories and Web services search engines. Comparing our findings with these two studies, we find that our conclusions on the structure and maturity of the Web services market are very consistent with theirs. However, we have seen that applying the learnings and concepts from electronic markets research to the particular field of Web services leads to further insights and valuable conclusions.

6.3 Outlook

Whereas our study focuses on the Web services directories which have been established around 2002, a number of newer service registries, such Programmable-Web.com and Mashable.com, have emerged recently. These registries are mashup-oriented, focusing on presentation-oriented services which are embedded in websites or portals, and introduce newer Web 2.0 styles services based on APP, Atom, RSS or REST. By aggregating and visualizing digital content from multiple sources, they complement the investigated Web services that are mostly data oriented and directly invoked by business applications. The interesting question remains whether analogies can be drawn from the evolution of the Web services market. Given the enormous growth of mashup registries over the last months, market take off is even more enthusiastic than in the case of the Web services directories. Consequently, a certain shake-out of mashup-oriented services can be expected for the future. However, it might also be argued that market development will be more quickly given that service providers and users are much more experienced than in the early days of the Internet.

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Appendix: The Functions of Intermediaries in the Web Services Market

	Global UDDI directories	RemoteMethods	StrikeIron Global Directory	StrikeIron Marketplace	X-Methods
1a. Matching Web Service providers and consumers					
Service description	businessService: Service key Name Description Categories	Name Short description Link to service provider	Name Short description Link to service provider	Name Short description Features Benefits	Name Short description Endpoints Detailed description Implementation
Service interface and documentation	WSDL tModel	WSDL	WSDL	WSDL Example Data Documentation	WSDL WSDL Analyzer RPC Profile Usage notes
Price discovery	-	Price Quantity Setup fee	-	Three price models (one time purchase, monthly or yearly subscriptions)	-
Web services listing	Sorted by categories, providers and t-models	Sorted by categories What's hot / What's new	Sorted by categories	Sorted by categories My services personalized	Recent listings Full service list
Service discovery	Web frontend; UDDI API	Web frontend (category listing, keyword search)	Web frontend (category listing, keyword search)	Web frontend (category listing, keyword search); Marketplace API	Web frontend (listing) SOAP interfaces RSS feeds WS-Inspection DISCO documents UDDI Private Registry
Testing	-	Link to service provider if trial or demo available	-	Try it feature Web Services Analyzer for Windows User Trials	Try it feature

Service quality	-	Reviewing and rating system Error reporting Service quality: uptime guarantee, downtime compensation, backup frequency	-	Online monitoring of performance and uptime	-
Provider description	businessEntity: Name Contacts Descriptions Identifiers Categories	Name Address and e-mail Description Link to provider	Name e-mail Link to provider	Name *Remark:* *StrikeIron acts as mediator between service consumer and provider*	Name e-mail URL Description
2. Facilitation of Transactions					
Settlement	-	-	-	Online subscription with credit card payment	-
Integration	-	-	-	Authentication options; Marketplace API SOA Express for Excel Sample code area & integration guides	Available clients: Proxy libraries, applications providing an interface to the service, source code fragments
Support	-	Support e-mail e-mail response time Support phone coverage Availability of free phone support; Serviced regions;	e-mail	Support site & e-mail	-
3. Institutional Infrastructure					
Legal or regulatory agreements	-	-	-	Commercial agreements and sales conditions	-