Enabling the Web of Services

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Enabling the Web of Services

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Abstract

We address how the large and diverse high value services market can be encouraged to come into being exploiting digital methods as its prime method of communication and value generation. The challenges that need to be met to develop basic technologies for constructing and managing dynamic, networked services, alongside the economic and social understanding that will enable efficient service markets to come into existence are outlined.

1 Introduction

The future wealth of both the developed and emerging world will be based on taking advantage of the migration of 20% of that economy, high value services, to a fully digitally mediated environment. While most high value services are enabled – in fact could not exist – without sophisticated information systems and the infrastructure that supports them, they by no means take full advantage of these systems. The 'knowledge economy' is now a fundamental part of Western economies and economists project rapid convergence of emerging economies with the West, implying that high value services will soon represent 35% of global economic activity by value. The sustainability and economic benefits of this move are attracting goverment attention and there is an immediate need to address the techno-social problems which will limit the speed and scope of adoption of these methods.

For ten years or more, 'web' based services have been predicted to dominate the information systems enabled service infrastructure market – but this has not happened and despite the excitement Web 2.0 is not having a significant impact in the many markets that should benefit from a composable, scalable and trusted service infrastructure. This is unsurprising since current service oriented web technologies are dominated by simple software (GoogleApps, SalesForce,...), commercial mediation (Amazon and Ebay for example) and social networking offerings. The lack of infrastructure (technical, virtual, market and especially governance) provides one explanation as to why the IS enabled services market is currently very small, but also points to a significant opportunity for any player or government who can establish the structures – technical and social for such a market to exist.

The fundamental question that must be answered is *why IS based service markets have not emerged from the primordial soup of web components, service oriented architectures, given the apparently obvious economic imperative to reduce costs through automation?* From a research perspective this presents two fundamental challenges: what needs to change to initiate a mass migration of these services onto an information systems infrastructure and how do providers gain economic benefit from the move?

We have identified multiple barriers to the development and growth of a global information systems infrastructure capable of supporting high value services, including: poor coordination systems; a lack of integration of functional and operational information; an inability to predict response of these complicated systems; little if any testing or independent quality validation regime; current economic models that are not robust; the difficulty of discovering providers; a desire to specialise or customise services; the ephemeral nature of the IP of 'pure coordination'; and a perception of risk in exploiting new providers and new modes of interaction. Resolving each of these barriers provides a significant research and economic challenge, along with an opportunity that is difficult to overestimate.

These barriers are not *simply* technical. There is a complex interaction between technical, social, economic and legislative concerns. That demand a multi-disciplinary approach to research and development, and one that can only be developed though a broad collaboration of the various stakeholders.A focus on service description and search, compliance prediction, validation, test and governance, along with service remediation technologies will a business with a strategy for a sustainably profitable position in these new markets.

2 Towards a Services Web

A complex service system consists of many interacting services, delivered by both machine and human. Sourcing the components that make up that system is a complex and time consuming task. The problems inherent in specification, construction, validation and trust – all of which are critical elements in most high margin service systems – represent high barriers to entry for new or small organisations, restricting innovation and the potential for cost reduction. The primary goal of services web research is to develop and demonstrate the technologies that would enable a marketplace of service components to be established, services integration businesses that can draw upon a pool of potential components and sub-components within that marketplace, and related high value services (such a functionality and data escrow) that would exist on Cloud infrastructure being developed.

There are 5 identifiable research themes which must be simultaneously addressed:

1. Service quality and guarantee : mechanisms for design analysis and requirements specification for complex composed services that can form industrial standards;

2. User needs : service specification and discovery, and requirements expression;

3. Governance and intellectual property : the resolution of disputes and the protection of IP (whether that be information or technology);

4. Economics : the allocation of value and the necessary theory and subsequent analytics to enable both value based pricing of atomic service transactions and the composition and co-ordination of the sub-transactions that must occur in order for that value to be realised;

5. Remediation : methodologies for coping with failure within complex service systems.

Many of the mathematical and computational technologies needed to develop these high margin services already exist, but their integration and human-economic interfaces are lacking.

2.1 The State of the Art

Technologies for composing concurrent components, cooperating across networks have been investigated and developed for more than twenty years. In the web services arena, 'mashups' (web based applications that combine data from two or more sources) are often used as exemplars of low cost, automatable services composition. This reflects the dominant philosophy within the information system (IS) enabled services world, that everything can be, and indeed should be, automated - in essence the MacDonalds view [52] of online service delivery. Tools that enable data exchange and choreography (such as WSDL[70], WSCL[69], BiZTalk[29] and AJAX[45]) are widely available but have failed to make a significant impact on complex networked services, especially business-to-business systems. While examples such as Googlemaps are often used to demonstrate the potential of such integration, their inherent simplicity and little if any structural dynamic make them difficult to apply to more complex business critical services, especially where components of those services may be dynamically sourced (based upon availability and cost for example), and some overall, complex quality of service must be maintained.

2.2 Technical Challenges

> *A service organization can only deliver a service after integrating (or outsourcing) investments in numerous assets, processes, people, and materials. Much like manufacturing a product composed of hundreds or thousands of components, services similarly*

consist of hundreds or thousands of components. However, unlike a product, service components are often not physical entities, but rather are a combination of processes, people skills, and materials that must be appropriately integrated to result in the 'planned' or 'designed' service.

Susan Meyer Goldstein, Robert Johnston, JoAnn Duffy and Jay Rao, The service concept: the missing link in service design research? Journal of Operations Management, Volume 20, Issue 2, April 2002, Pages 121-134

We have identified a number of reasons why large scale business critical service composition offerings are slow to emerge – these all require solutions that combine basic technology development (or re-use), and an understanding and integration with market dynamics and human application.

1. The inability of the customers to find the service (or component) they want – 'googling' to discover a service element with particular properties;

2. An inability of customers to specify what they want – while making simple demands on a service, such as it's functional interface are relatively easy to understand, trading off non functional specifications (availability, response times, quality of response, trust, IP obfuscation) at design and procure time are not trivial, especially when those service components may be delivered by multiple vendors;

3. A lack of trust that the solution will match the offer – new entrants into the sub-service market face problems gaining acceptance that their offering will continue to be available in the future, and worse still, that any data they might hold on behalf of a client will be retained if they go out of business;

4. A lack of comparability between different offerings – poor and inconsistent standards for the specification of functional and quality interfaces make it difficult to compare offerings;

5. The cost of co-ordinating solutions – while sourcing from multiple providers might enable a low unit cost per component, the cost of coordinating the solution rises;

6. An inability to validate and test solutions – even with static (i.e. all components and providers selected at design time) solutions, partially because of the opaque nature of the services and partially because testing strategies have not kept up with new distributed opportunities;

7. An inability to asses the risk of using proposed service – especially when new entrants into the service components marketplace are required to be part of the solutions;

8. An inability to assess the value of activities - as standalone components or parts of larger systems – customers don't know what they pay for something (and especially so when the QoS can be traded against cost), and suppliers do not know how to and what to charge;

9. customers and providers face challenges in demonstrating (possibly through prototypes) service innovations, partially because of cost, and partially because of the co-evolutionary nature of service offerings/innovation and their use.

As the challenges above are solved then we would expect to see the emergence of a new type of professional, the services integrator. These individuals would create value by dynamically linking atomic services and data together to coordinate new services within the ecosystem. We illustrate 'a day in the life' of such an individual in Figure 1.

```
8:00  receive several bids for work;
8:02  place out bids for analysis of viability to analysis team;
8:15  receive first bid analysis from yesterday;
8:16  place out bids to cost analysis teams using data from analysis;
8:20  receive final completion part of megaBid27;
8:21  send out for bid requests on megaBid27 completion quality;
8:40  receive first quotes on bids analyses;
8:41  assign three bids with deadline of 9am tomorrow;
9:00  recieve quality validation of megaBid23, schedule for delivery in 2 days, ontime;
9:20  delivery of component8 of megaBid21 is late, cancel contract with supplier;
9:21  reschedule component8 only offer to high reliability fast turnround suppliers;
9:23  receive bids on work for component8;
9:24  assign work to 2 bidders on first complete gets all;
9:30  receive outline design and value analysis on megaBid30;
9:35  place offer on work for megaBid30;
...
```

Figure 1: A Day in the life of a services integrator.

2.3 Research required

The networked services space can be visualised as in Figure 2. This identifies five primary areas of endeavour:

1. Infrastructure
   - how do we establish[37] guarantees?
   - how is transport achieved?
   - how is coordination[53] established?
   - how is robustness[60] of solution demonstrated;
2. Properties of proposed services -
   - how is the service designed[51] and how do we establish and communicate the facts that it has the correct properties (essentially the service concept [56, 21, 16, 49, 20, 50, 31])?
   - how do we undertake the analysis of the service properties[22, 58] and how are the established?
   - how are measurements of service performance undertaken[74], and by whom?
   - how do we recover[11, 13, 14, 32, 15] a service solution on the fly?
   - how is the offering optimized[58] and to what end?
3. Economic
   - why is anything worth[39] anything?
   - why gets what value and why?
   - how is evolution allowed versus protection of IP[76, 35]?
   - when can a partially completed service be moved and what value follows it?

- what is the cost of customization to meet a particular customer needs?
- how are service parameters[58] negotiated to meet providers capabilities, customer requirements and how are those needs moved 'down the stack'?

4. User needs

   - how do they search for particular services, moving beyond the keyword?
   - how do they specify their requirements?
   - how is it demonstrated[74] that a service meets their requirements?
   - how and who moves to make a service match requirements?
   - how do we match user requirements (pull) with provider capabilities (push)?

5. Governance

   - Control of exchange[39] of value?
   - Quality specification and verification?
   - Protection of IP for co-ordinators, service providers, customers...?
   - how owns IP in a customized service?
   - Security and privacy for all of the parties. (for example the oDesk screenshot and webcam based governance and compliance model)

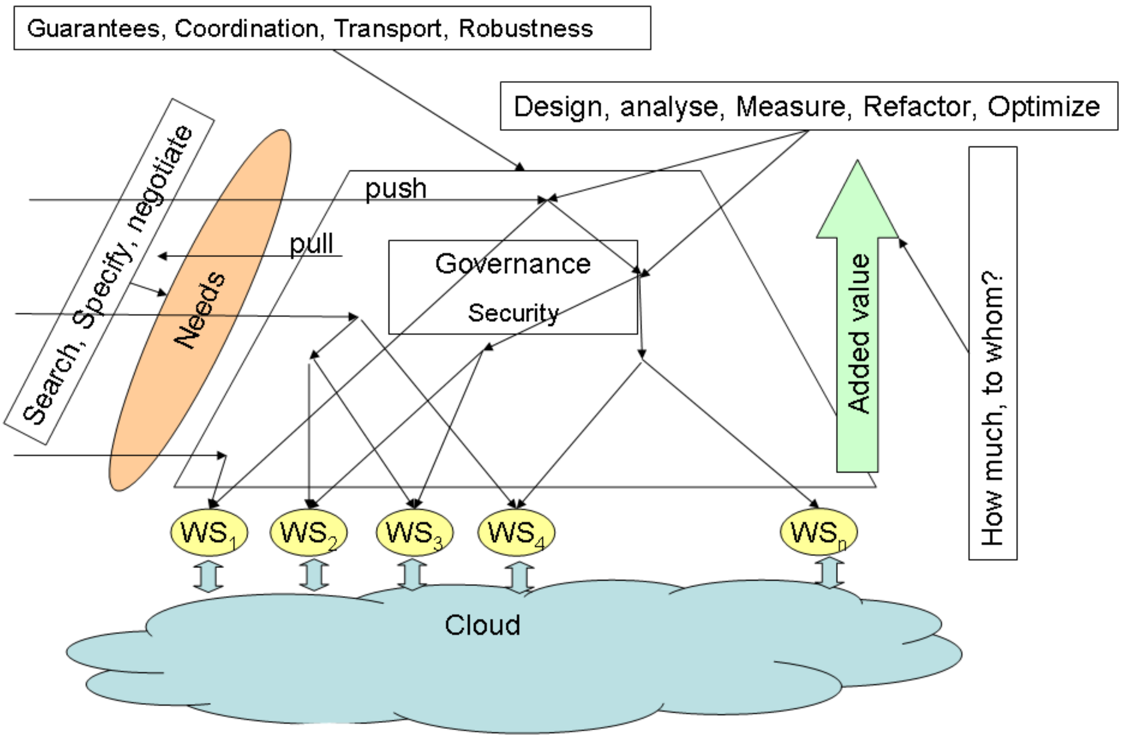

Figure 2: Using web services to form networked service - with research problems for each of the areas.

3 Conclusions

Many of the components of a networked services ecology are beginning to emerge:

- Atomic services - 'software as a service' and 'cloud' offerings are relatively common, in both business-business and business-consumer environments – although quality of service guarantees and risk sharing (for example Amazon's S3 offering) are poorly developed if they exist at all;
- Hybrid services in which both data and customised business process logic are maintained by the service provider on behalf of their customer (examples include Oracle and Salesforce.com) are becoming more common;
- Trust guarantors (escrow by any other name) are already well established in financial markets and are a common means of enabling access to markets by small-medium software providers (by guaranteeing access to source code in the case of commercial failure) and providers such as Paypal provide crude micro-escrow services to consumers.

What is missing is the *economic and technical* infrastructure that will enable networks of service components to be constructed and deployed quickly.

Finally, we expect to see the emergence of a new class of customer the 'service integrator' who require:

- the ability to find services to compose (discovery of services that are functionally, financially and qualitatively suitable for the services being constructed;
- tools that will enable these services to be composed quickly and correctly – business or individual critical services require more care than the 'typical' mashup;
- the ability to economically offer her customers QoS guarantees;
- the guarantee that their IP will be protected, respected and most importantly economically rewarded;
- Cloud infrastructure that works as they need when they need

In Figure 3 we illustrate the various points in the evolution of a high value services offering where value can be captured with the ecosystem:

1. market qualification: charging to check - conformance with interface and instrumentation, continuity (escrow) and governance requirements;
2. the migration of current services into the new networked ecosystem, qualifying the migrated offering;
3. the provision of design services that will enable new services to be prototyped, implemented and maintained;
4. the management of an auction based marketplace that will enable new service component providers to make their offerings available;
5. provide ongoing backup (escrow) services and infrastructure through transaction based charging models;

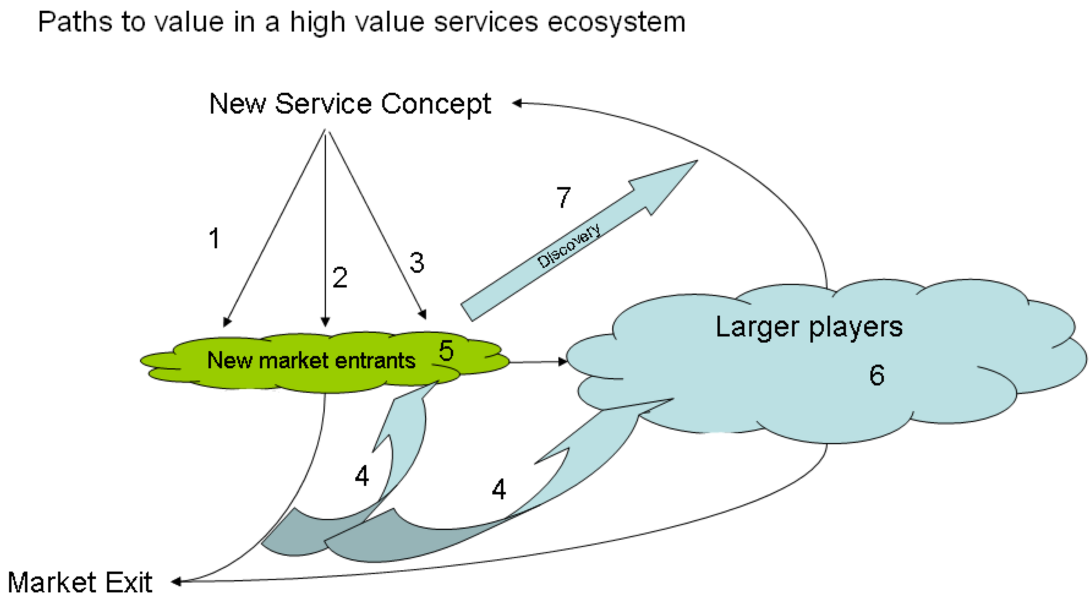

Figure 3: Multiple points at which value could be captured in a high value service ecosystem.

6. provision of cloud based storage and backup;
7. provide specialised discovery services to help with new service creation.

The economics of this value capture will change over time. In the early stages of the development of this ecosystem, earnings from escrow and other support services (on a per service or per transaction basis) are likely to be higher than in the mature setting. There is a natural transition from escrow provider to backup provider as the markets mature. Other paths to value are 'one offs', they may be worth capturing, but the major gains will come from a control of transactional (at either the level of the customer or the offering) charges within the market.

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