

# Challenges of the Internet of Services

Stephan Fischer

**Abstract** The past decade was marked by a profound change in the business world. Globalization was already taking off in the 1990s, but it reached a new quality when people and companies got used to web-based collaboration across the globe. Started as a well-defined technical infrastructure, the Internet has become the world's encompassing communication infrastructure. Year by year, the network grew, more and more nodes were added, humans, machines, and businesses were linked, and finally the Internet boomed. It emerged into the world's business backbone.

## 1 Introduction

In 2005, Thomas L. Friedman coined the term of a “flat world” we are living in Friedman (2005). Since the 1990s, the globe has started to become flatter, caused by changes in the political landscape, business innovations, and web-based tools for collaboration. As these tools became mainstream, competition and collaboration became more equal on a global scale and hierarchies started to erode. A playing field was created that allowed for new forms of collaboration in real time, regardless of geography and distance. One of the well known results was outsourcing, which became a hot topic at this time. When Friedman revisited the topic in 2012, the narrative of a flat world seemed to have reached an ending point (Friedman 2012). Today's CEOs rarely talk about “outsourcing” anymore, says Friedman. The business world has become so integrated that products are engineered, built, and marketed through truly global supply chains using the most efficient resources wherever they are available in the world. More and more of today's products are “made in the world”, as Friedman puts it.

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S. Fischer (✉)  
SAP AG, SAP Research, Walldorf, Germany  
e-mail: [S.Fischer@sap.com](mailto:S.Fischer@sap.com)

The growing importance of services will lead to a similar development in the service sector. In Germany, as in most industrial nations, the service sector is growing fast and will be a main source of further industrialization and globalization. In Germany, around 73 % of the economic value creation was generated from the service sector in 2009 (going up from 62 % in 1991). In the same year, around 73 % of all employees worked for the service sector (going up from 59 % in 1991).<sup>1</sup> This increase is accompanied by changes in the quality of services and their provisioning, and IT plays a critical role in making the change happen. More and more companies offer products combined with services such as monitoring or maintenance services. Some companies focus mainly on offering a service, e.g. renting out machine tools. It is a logical idea to offer these services through the Internet. This includes web services and other automated services as well as traditional business services.

We only see a very first glimpse of how the future of the web-based service economy will look like, but evidence matures that an Internet of Services is emerging. Enterprises will use the Internet to build and provide huge numbers of new kinds of services that go beyond booking flights or purchasing books. Services that are available on the Web separately will be combined and linked with one another resulting in aggregated value added services.<sup>2</sup> Using web technologies, services will become more widely and easily available. Enterprises will open their business processes to others to form value networks which will be, in the end, a necessity for success in most markets. The Internet of Services is expected to ensure profitability and further growth of the service sector. It is, so to say, *the* instrument of globalization of the upcoming decade.

However, the Internet of Services has not become reality yet – at least not in the full scale researchers have envisioned it. What challenges do we face regarding the rise of the web-based service economy? This paper will review this question from different angles: Research, daily life, IT trends as well as concrete projects that translate the Internet of Services vision into prototypes and field tests.

## 2 Landscapes of a Web-Based Service Economy

In 2005, Thomas L. Friedman felt that the Internet became the central globalization engine and foundation of the “flat world”. He then looked back and identified ten “flatteners”. These are innovations that helped to remove barriers for global collaboration. With regard to the emerging Internet of Services we might not know the exact flatteners of service-oriented challenges; however, we can use this idea to discuss areas where the new flatteners might come from.

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<sup>1</sup><http://www.bmwi.de/BMWi/Navigation/Wirtschaft/dienstleistungswirtschaft,did=239886.html>

<sup>2</sup>This is the Internet of Services vision that lies behind the THESEUS research program and the TEXO use case that developed an integrated platform for providing, managing and combining Internet-based services; see <http://www.theseus-program.de/en/about.php>

When taking a bird's-eye view, the world of web-based services is not flat. It is rather structured along larger players that seem to dominate the business, complemented by larger ecosystems, loose networks, or smaller gated communities. It is a long known imperative to maintain openness and fairness in the Internet, politically as well as economically.<sup>3</sup> One challenge of the service sector is to ensure low entrance barriers with access to platforms, reliable and secure infrastructures, and standards. But there are several more areas that need to be looked at when discussing the Internet of Services.

We will review five landscapes that belong to the emerging world of web-based services or are tightly interconnected with it:

1. The scientific world that discovers the Internet and web-based services as appealing objects of research.
2. Our daily life that is penetrated with new technologies that will spread into the business world.
3. Today's IT trends that already contain traces of the upcoming world of web-based services.
4. The applied industrial research that builds on these trends and prepares the Internet of Services with prototypes, standards and platforms.
5. Innovation projects that translate research results into tangible software pilots for testing the market and evaluating first steps of a roadmap to the Internet of Services.

### 3 Research Focus

We started with the notion that today's Internet emerged from a well-designed infrastructure into something new and much more complex, namely a business platform and mission-critical infrastructure.<sup>4</sup> This development is mirrored by the research questions about the Internet. In the 1990s, most Internet research focused on technical artifacts such as new protocols and components.<sup>5</sup>

Around 2000, the notion changed. In his famous book "Linked", the physicist and network scientist Albert-László Barabási noted that a growing number of researchers asked a then unexpected question: What is it that we have created with the Internet (Barabási 2003)? Obviously the Internet went beyond the original scope it was designed for. This question caught the interest of researchers and is still a source of a growing body of knowledge about the Internet. New disciplines like Web Science or Network Science developed, with contributions from computer

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<sup>3</sup>Most recently stated by Google's co-founder Sergej Brin who blamed Facebook for inhibiting innovation due to its closed networks (Katz 2012).

<sup>4</sup>Some authors use the term Societal Operation Platform (Couturier et al. 2011).

<sup>5</sup>This tradition is still followed by larger research programs working on advancements of the Future Internet.

science, mathematics, physics, economics and many more fields. Today, there are several lively research communities that chose the Internet as their scientific object.

The Service Science can be counted among these research disciplines although it originated from ideas that are not directly connected to the Internet. In 2006, Henry Chesbrough and Jim Spohrer introduced this discipline by publishing the famous research manifesto for service science (Chesbrough and Spohrer 2006). They saw the increasing importance of the service sector for growth and prosperity and proposed a new, interdisciplinary research on services in order to better understand services and advance service innovation. Using Information and Communication Technology (ICT) and the Internet is only one aspect of the service economy, but an important one. Chesbrough and Spohrer identified ICT as the critical enabler of today's service innovations.<sup>6</sup> Service Science shares two important aspects with other disciplines that conduct research on the Internet. First, all these disciplines tackle grand challenges both from a societal and a technological perspective, best labeled with the term "complexity". "The past decade has seen a growing public fascination with the complex 'connectedness' of modern society", state David Easley and Jon Kleinberg in their rich book *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* (Easley and Kleinberg 2010). Albert-László Barabási identified the "data explosion" as a driving force for further research and mentions data coming from social media, sensors, business activities, or cell biology (Barabási 2003). Complexity, in his view, "takes a driving seat in science, engineering, and business" (Barabási 2003).

Due to the complexity of the Internet's networks, communities and business models, the Internet is seen as an adequate scientific object also by natural scientists. It is, so to speak, today's universe waiting to be explored. At the same time, research seems more and more headed towards creating business impact. This is a second aspect which all Internet sciences share: "Our children no longer want to become physicists and astronauts. They want to invent the next Facebook instead", says Barabási (2003). This mindset of tackling hard problems while heading towards business creativity is a great asset for understanding and realizing the Internet of Services.

## 4 Role of Everyday Experiences

The fascination of the Internet is not bound to the researchers or entrepreneurs. The Internet has become part of our daily life for a long time. We are using it to share news, pictures, and videos, communicate and socialize, and entertain ourselves. This influences the way we interact with technologies, which leads to changes in enterprise computing, supporting the rise of an Internet of Services.

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<sup>6</sup>The THESEUS research program in Germany, the Smart Services CRC in Australia and parts of the Future Internet research on European level are all based on the notion of a Service Science.

The various changes the Internet has undergone or initiated have often been described as a pendulum swinging back and forth between the consumer market and business-to-business (B2B) models. This surely influences how services will be handled online. Initially, the pendulum of the Internet started to swing in the early 1990s and was primarily targeted at end users by granting them easy access to now structured content. Following this innovation, the pendulum swung back the other way by focusing on business-to-business segments, for instance e-commerce, and facilitating as well as digitizing easy shopping experiences. Then, the quick emergence of social networking sites illustrated the pendulum's next swing, again towards customers: Facebook and Twitter are just two examples of this dramatic change that took place (Hagemann Snabe and Couturier 2011).

As pointed out by IT experts and developers, the spotlight of the Internet is shifting again. One of the major trends for the Future Internet includes the comprehensive alignment of people and processes. Accordingly, existing social networks will smoothly merge with business networks, opening up new possibilities for individuals and enterprises. A fundamental change will transform social networks to multilayered structures that extend their reach beyond the ability to connect with friends and can be used as real business platforms; for business users, the friendship relationship will be extended to cover also project-based work, skills and competencies, hierarchies, as well as customer and partner contacts (Hagemann Snabe and Couturier 2011).

In the future, enterprises will open their business processes to others to form value networks when barriers for developing, providing and managing services are removed (Couturier et al. 2011). This might lead to “flash companies” that are built from freelancers and small service providers to fulfill a project goal (Petrie 2010).

Driven by the ubiquity of mobile phones, smart phones and their integration into our daily lives, the development processes for business applications will be speeded up drastically, from 2 years to 2 months, and will primarily target end users. This “economy of apps” will support the third trend that both Internet and the real world will become one entity. The Internet will be characterized by collaboration and interconnections of services and things. Seen from the end user perspective, the Internet of Services will be at the horizon when the Internet will be an omnipresent fact of life that permeates virtually every human activity.<sup>7</sup>

## 5 IT and Business Trends

Between the scientific endeavors and the daily life of consumers lies a middle ground handled by engineers and business executives. The radiuses of action for both groups are bound by the technologies at hand and the markets of today. However, both technology and markets are evolving fast. SAP has identified four

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<sup>7</sup>See Couturier et al. (2011) for an account of the even broader term Future Internet.

major IT trends that drive new technologies and business innovations: (1) Cloud Computing, (2) Business Networks, (3) Big Data Analytics, (4) Mobility (Sikka 2012). They are all connected to the Internet of Services. In the following, we will elucidate how each of the four areas plays a vital role in materializing the vision of the Internet of Services.<sup>8</sup>

**Cloud Computing** Cloud Computing and Virtualization have become established concepts used for operating data centers and building new kinds of business software. The main advantage is that cloud offerings can be consumed almost instantly by enterprises that are highly elastic. Enterprises can start small and scale globally quickly if needed. This marks a paradigm shift in the way applications and IT services are developed, sold, deployed, maintained, and consumed. At the same time, the Cloud Computing concept can serve as a blueprint for providing any other technical service – be it global connectivity to smart phones and machines, integration services, brokering between service providers, and many more.

**Business Networks** Business Networks are becoming an additional focus of enterprise systems. All enterprises operate within a complex network of relationships. These networks include short-term and long-term relationships, some of them enabled through automated processes, others built on human collaboration. Today's enterprise software captures only a small part of these relationships. Future business network technology, based on a common foundation of core services (for example, sign-up or identity management), will enable businesses to discover their existing business relationships easily, and to self-organize into multiple short-term and long-term collaborations. Many-to-many connections between enterprises and multiparty collaborations will lead to new applications and value-added services provided by a network of companies. Future platforms that are open and global will support broad ecosystems of partners to drive great innovations. The challenge of the Internet of Services is to find ways to establish trusted networks of service providers and support them to easily find, combine, and operate services which are linked to a common platform.

**Big Data** Big Data Analytics evolved into a promising topic for enterprise computing. More and more data is being produced, and more of it is relevant for enterprises. New sources of data emerged complementing data coming from within a company or from networks of a few businesses. Organizations are seeing the value in all kinds of new data sources, from logs and machine-generated data to unstructured data such as e-mail and tweets. Across all industries, in-memory computing is simultaneously enabling new use cases, including forward-looking analytics and simulations that provide businesses with the right data and analytics to react in real time when the unexpected happens.

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<sup>8</sup>The following is adapted from Sikka (2012).

**Mobility** Mobile Computing was mentioned earlier. Its global adoption outpaced the adoption of any other technology in history. Business users will handle more and more tasks with mobile devices. This will lead to the availability of business applications in multiple forms on multiple devices, which is a challenge from a developer's point of view. At the same time, new kinds of applications and services will emerge, consisting of small and lightweight applications that are developed fast and directly address the needs of the end users. In combination with machine-to-machine communication, sensors, and smart items, completely new services will be offered, for example, location-based services in supermarkets, for logistics and asset management. Both enterprises and software vendors struggle with the fact that enterprise IT systems, mostly introduced for longer periods of time, are exposed to disruptive innovative technologies which have to be introduced to stay competitive in the market. SAP recognized this challenge and addressed it with a concept called *timeless software*, ensuring that the technology platforms in use are open for future extensions without disruption to enterprise applications (Friesen et al. 2012). Increasing the flexibility of traditional enterprise systems has long been discussed with regard to service-oriented architectures and the virtualization of IT infrastructures. The above mentioned trends add four dimensions that outline the service-oriented challenge: More and more IT-related services will be integrated into the paradigm of service-orientation. This is reflected in the term “everything as a service” (“XaaS”). At the same time, enterprise systems must learn to manage also with non-technical services and relationships between companies. The third dimension is the mobilization of enterprise computing, showing the need to reduce complexity of applications by bundling existing services for specific tasks rather than provide larger desktop-like user interfaces. These developments are accompanied by the need to enable enterprises to act safely in these new, flexible cloud-based environments and far-reaching collaboration in business eco-systems.

## 6 Results from Research Projects: The TEXO Case

We saw that today's IT and business trends already contain traces of the upcoming world of web-based services. How can these trends be translated into artifacts that support Internet-based forms of value creation? The TEXO use case as part of the THESEUS research program provided answers to this question by studying the technical challenges of the Internet of Services to prepare prototypes, standards and platforms, and to evaluate potential business models.<sup>9</sup> Funded by the German Federal Ministry for Economic Affairs and Energy, the THESEUS research program was conducted by a large consortium of enterprises and research organizations.

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<sup>9</sup>The following is adapted from Terzidis et al. (2011); for a detailed account of TEXO results see Kuhlmann et al. (2014).

The starting point of the project was the promise of web-based marketplaces that was up in the air at the beginning of the project (and still is). The main goal was to specify the opportunity of making services tradable goods by exploring the infrastructure for service marketplaces in the Internet. Guiding principles were automation, standardization and specialization as they are the three main levers that lead to an increase of productivity in industrial production. The question was how these principles can bring the service's economy to the next level by combining characteristics of the Internet, the SOA paradigm, semantic technologies, and the new ways of value co-creation known from Web 2.0.

An example of export services can illustrate concrete challenges of the Internet of Services. If you look at the business processes around export, you quickly realize that many services are involved. For the goods transfer, you need services like land and water logistics; you need insurances; you also need customs as public services and potentially certificates like the German TÜV. For the financial transfer, there are services provided by your bank, but also instruments like export credit guarantees. And of course, there are small and medium-sized enterprises (SME) at hand that support you in handling an export. The central question to be addressed is how far an offering of such services over the Web can go.

**Service Descriptions** One challenge is to find an appropriate understanding of the term “services”. The technical meaning refers to “web services”, “network services”, and so on. An additional business meaning refers to “professional services”, the “services industry”, etc. In the context of the Internet of Services the term “services” has to be used with both connotations. In the following, we will examine both connotations of the term “service”.

In order to form the Internet of Services, services have to be described in a way that the business dimension and the technology dimension come together. Enterprises have to describe the business aspect of a service while at the same time services have to be described in a way that computers can automatically understand and link services. This requires a language that can be processed automatically. The TEXO use case team came up with the *Unified Service Description Language (USDL)* which provides a uniform conception of services across all walks of life, including the mediation – the way in which you find and order services – delivery, and service-level agreements (Barros and Oberle 2012). TEXO brought USDL into a W3C incubator group to support standardization and adoption. In addition, the project provided a tool chain (editor, repository and marketplace) and made these tools available as open source solutions.

The standardization of describing services is essential for the aggregation of services on Internet-based marketplaces. This can best be illustrated with the export process example. The entire export process may be considered as a “service bundle”. This is already known from package tours that offer the airport transfer, the flight, the hotel, possibly a guided tour and so on. Similarly, there may be “all-inclusive” offers for an export to, say, Brazil, made up of many different components as mentioned above. The example illustrates how service ecosystems will complement traditional enterprise software in the future. Only if services can be combined easily



with several different other services, can the Internet of Services enable the full economic potential, especially for SMEs.

**Market Roles** The service-oriented architectures use the following three roles: service provider, service broker, and service consumer. Research has shown that the Internet of Services will need additional roles as bundling and channeling of added-value services, among others, require independent players. The TEXO use case assumes four additional roles: service host, service gateway, service aggregator, and channel makers (ensuring the utilization of services by end users).

The project team developed a prototypical tool chain that supports exactly these roles with tools for service engineering, search, matchmaking (including concepts for handling legal issues), bundling of services, brokerage, implementation and usage of service bundles including monitoring, e.g., SLA compliance.

**Experimentation and Consulting** Five projects with SMEs were conducted to test the concepts and gain more insights from the practice. The SMEs were provided with information and training about the concepts, methodologies and technologies developed within the TEXO use case. In order to facilitate their application and scenarios, TEXO provided a testing infrastructure called *TEXO Lab*. The SMEs used the TEXO Lab's infrastructure to test the relevant technology components in a controlled environment.

The SME projects provided valuable insights into service-oriented challenges that complement technological challenges. First, businesses must envision their own market role in the Internet of Services (Service provider or broker? Gateway or channel maker?) Second, the enterprises need to have clarity about which services they would like to offer or trade via the Internet. This demands a good understanding of the company's own processes. Third, the reach of the business activities of the enterprise must be sorted out. The current network of customers and partners need to be reviewed, new relationships explored. An example derived from the export scenario can illustrate this point: A service provider that is specialized in export service into a specific country could decide to offer export services also for additional countries. He probably will need to partner with other service providers extending his network to new geographies. The goal would be to bundle services from his own company with services from new partners with specific expertise in a region not covered by the own expertise. This needs a clear understanding of the service composition, and the possibilities for replacing parts of the service and a new value-add service.

Through the open and plural marketplace concept, TEXO empowers the genesis of new marketplaces and thus opens up new markets for small and medium-sized service providers. By providing a comprehensive service description language, an overview of evolving market roles, a tool environment covering the whole service lifecycle and an environment to test ideas for new service and experiment with business models, the TEXO use case created a blueprint of the Internet of Services.

## 7 Translation of Vision into Products and Services: The Business Web Initiative

Building on concepts and results of TEXO and other projects, SAP Research shaped a future product vision called Business Web. Although the general theme of supporting business networks is still present, the Business Web narrows down the vision of the Internet of Services to application scenarios which allows for testing aspects of the Internet of Services in real-world settings, with a focus on machine-to-machine communication leveraging Telco services. Scenarios include precision retailing (a mobile shopping assistant for end consumers), smart asset tracking (making ice cream cabinets smart), product maintenance, and small business webs for very small companies in emerging economies.

**Cloud-Based Business Environment** It is the goal of the Business Web to provide a cloud-based business environment enabling access to the necessary infrastructure, applications, content and connectivity to deliver end-to-end business applications and services optimized for mobility. The key motivation for SAP Research's Business Web is today's shift in the business software market as mentioned before when talking about today's IT trends. Enabled by Cloud Computing and enterprise mobility, a new kind of business application and service has emerged. Business applications follow the line of mobile apps and are becoming smaller, developed faster, and consumed mobile. Lightweight applications that address the end users will be a given for business software providers (B2B2C). New technologies provided by partners make it possible to integrate machines more easily and cost efficiently into business processes (B2M, M2M). In-memory technologies help in dealing with big data and offer real-time analytics.

An example can best illustrate the kind of applications and services the Business Web team works on. The example concerns traffic control and vehicle management at a major European port as well as supply chain visibility across different parties. It is the main objective of this project to optimize the loading and unloading of docks by avoiding traffic jams and reducing waiting time for truck drivers. The trucks are equipped with a telematics unit so that their location can be tracked during the transport. Information about the availability of appropriate loading docks and expected loading/unloading slots in the terminals are imported into the Business Web. The drivers can access this information on their mobile devices. They can optimize routes interactively and see when a dock is free for clearing the containers. The service is seamlessly integrated into the existing enterprise systems and brings the necessary information directly to the truck drivers' mobile phone. Due to the high number of users and the high volume of machine data, the service is dealing with big data combined from several sources and being analyzed in real time. This scenario is developed together with a major European port and is steered by Deutsche Telekom, SAP and selected partners.

**One-Stop Shopping Model** Although focusing on pilot applications like the smart logistics scenario, the Business Web initiative is deeply rooted in projects such as

TEXO and brings some central concepts of the Internet of Services into the new settings of the pilots. In general, the Business Web could eventually become a “go to enterprise cloud” for developers, partners, and service providers to rapidly build and deliver solutions, and especially get mobile connectivity everywhere as part of applications and services. There are two main characteristics the Business Web aims to bring forward: one-stop shop model and trusted network. One goal is to integrate services from different players including cloud providers, CSPs, application providers and content providers to form a standardized platform for mobile business and orchestrate end-to-end business processes completing the M2M value chain. Hence, the Business Web will be a platform where both web services and business services are bundled to hide complexity from the enterprise customers and end users. CSPs can use the Business Web to develop, deploy and operate M2M applications and services. Solution offerings might include M2M apps by verticals, cloud infrastructures, Mobile Network as a Service (MNaaS), real-time M2M intelligence, high performance billing via the cloud, and secure connectivity. This is complemented by SAP’s services and a wide spectrum of partnerships with developers, system integrators, Communication Service Providers, cloud services partners, hardware partners, content providers, and so on. In addition, the Business Web is envisioned as a trusted network of device, machine and service providers, creating a business network and a trusted platform for the development of M2M applications for a large developer ecosystem. Within the Business Web work, SAP Research will use the aforementioned scenarios to further develop the vision of the Internet of Services vision, for example by developing pilots and testing them in selected markets. This will ultimately result in a Business Web platform including a one-stop-shop model and a trusted network of service providers. Step by step, the focus will be widened from the current focus on M2M applications and services to larger parts of the Internet of Services vision.

## 8 Conclusion

We started with the vision of the Internet of Services and introduced the idea of “flatteners”. This idea served as a starting point and as a guiding metaphor for discussing service-oriented challenges. Thomas L. Friedman identified ten groups of flatteners of the globalizing world in his book *The World Is Flat* (Friedman 2005). They include a diverse group of innovations and historical milestones, such as the going-live of Google and other search engines, the Voice over Internet Protocol, Instant Messaging, and file sharing, blogs, and Wikipedia. The historical milestones include the end of the Cold War and China’s entrance in the World Trade Organization, which both enlarged the economic playing field and allowed for greater competition. Our short walk through five landscapes of the Internet of Services pointed us to challenges of bringing the web-based service economy to life. At the same time, structures became visible that provide us with a glimpse into the future. Reducing barriers can stir creativity, innovation and growth. Barriers include technological

challenges such as security, reliability, extendibility, and flexibility of infrastructures, both of enterprises and the Internet. Cloud Computing established a new paradigm of providing IT services online. Following the notions Infrastructure-as-a-Service, Platforms-as-a-Service and Software-as-a-Service, more and more ICT services will be offered online such as Mobile-Networks-as-a-Service envisioned by the Business Web initiative carried out by SAP. Additional barriers might include divergent national laws and business cultures, and lack of experience of small and medium companies to find the best market role in the web-based service economy, and to identify and shape market services on a global scale.

We do not know how the flatteners of the service economy will look. What we can be sure about is that innovations will most likely come from the following fields of action condensed from the discussion above: Research can play a decisive role by addressing the complexity that is inherent in the Internet and that made the Internet an appealing object of scientists. As current IT and business trends contain already traces of the Internet of Services, research can help in carving out future infrastructures, standards and best practices, and in both establishing platforms for experiments and developing pilot applications and services to test the markets. Facebook might be one flattener, as well as Cloud platforms, semantic technologies, the first marketplace using standardized service descriptions, and the one-stop-shop for M2M applications and services as envisioned by the Business Web initiative. There might be also political changes that result in new markets, greater competition or mind shifts towards services-orientation.

## References

- A.L. Barabási, *Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life*. A Plume Book (Plume and B&T, New York, 2003)
- A. Barros, D. Oberle (eds.), *Handbook of Service Description: USDL and Its Methods* (Springer, Berlin/Heidelberg/New York, 2012)
- H. Chesbrough, J. Spohrer, A research manifesto for services science. *Commun. ACM Serv. Sci.* **49**(7), 35–40 (2006)
- H. Couturier, B. Neidecker-Lutz, V.A. Schmidt, D. Woods, *Understanding the Future Internet*. International Research Forum 2010 (Evolved Technologist Press, New York, 2011)
- D.A. Easley, J.M. Kleinberg, *Networks, Crowds, and Markets: Reasoning About a Highly Connected World* (Cambridge University Press, Cambridge, UK, 2010)
- T.L. Friedman, *The World Is Flat: A Brief History of the Twenty-first Century* (Farrar, Straus and Giroux, New York, 2005)
- T.L. Friedman, Made in the World. *The New York Times*, Jan 2012, [http://www.nytimes.com/2012/01/29/opinion/sunday/friedman-made-in-the-world.html?\\_r=0](http://www.nytimes.com/2012/01/29/opinion/sunday/friedman-made-in-the-world.html?_r=0)
- A. Friesen, W. Theilmann, M. Heller, J. Lemcke, C. Momm, On some challenges in business systems management and engineering for the networked enterprise of the future, in *Business System Management and Engineering: From Open Issues to Applications*, ed. by C.A. Ardagna, E. Damiani, L.A. Maciaszek, M. Missikoff, M. Parkin. Volume 7350 of Lecture Notes in Computer Science (Springer, Berlin/Heidelberg/New York, 2012), pp. 1–15
- J. Hagemann Snabe, H. Couturier, Future internet – the business web, in *Internet der Dienste*, ed. by L. Heuser, W. Wahlster (Springer, Berlin/Heidelberg/New York, 2011), pp. 49–54

- I. Katz, Web freedom faces greatest threat ever, warns Google's Sergey Brin. Exclusive: threats range from governments trying to control citizens to the rise of facebook and apple-style 'walled gardens'. The Guardian, 15th Apr 2012, <http://www.theguardian.com/technology/2012/apr/15/web-freedom-threat-google-brin>
- F. Kuhlmann, J. Hannemann, M. Traub, C. Böhme, S. Zillner, A. Cavallaro, S. Seifert, B. Decker, R. Traphöner, S. Kayser, U. Lindemann, S. Prasse, G. Marczynski, R. Grütznier, A. Fasse, D. Oberle, The THESEUS use cases, in *Towards the Internet of Services: The THESEUS Research Program*, ed. by W. Wahlster, H.J. Grallert, S. Wess, H. Friedrich, T. Widenka (Springer, Berlin/Heidelberg/New York, 2014)
- C.J. Petrie, Plenty of room outside the firm. IEEE Internet Comput. **14**(1), 92–96 (2010), <http://dblp.uni-trier.de/db/journals/internet/internet14.html#Petrie10>
- V. Sikka, SAP technology vision: leveraging technology innovation to reshape your business. Sap thought leadership paper: technology, SAP AG (2012), <http://www.sdn.sap.com/irj/scn/go/portal/prtroot/docs/library/uuid/00054fef-b324-2f10-7b88-9eba7efcb556?QuickLink=index&overridelayout=true>
- O. Terzidis, A. Fasse, B. Flügge, M. Heller, K. Kadner, D. Oberle, T. Sandfuchs, Texo: Wie Theseus das Internet der Dienste gestaltet – Perspektiven der Verwertung, in *Internet der Dienste*, ed. by L. Heuser, W. Wahlster (Springer, Berlin/Heidelberg/New York, 2011), pp. 141–160

## Further Reading

- U. Kubach, R. Ackermann, M. Ameling, V. Lotz, D. Oberle, V.A. Schmidt, Business Web: Cloud-basierte Flexibilisierung und Mobilisierung von Geschäftsprozessen, in *Smart Mobile Apps: Mit Business-Apps ins Zeitalter mobiler Geschäftsprozesse*, chapter 25 (Springer, Berlin/Heidelberg/New York, 2012), pp. 385–399

<http://www.springer.com/978-3-319-06754-4>

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