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# Expanding Use of Web API
## ─ Vast Potential of Mashup ─

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## 1 What Is a Mashup?

### 1-1 Emergence of the Mashup

At present, Google, Amazon and other major commercial sites provide their information services, such as map database information on Google Maps, to users in a Web API (application programming interface) format. Users can use such information in combination with other information on their own sites, such as on personal blogs. Moreover, users can develop original applications with relative ease and provide new value-added information services.[18]

This software development technique to combine Web APIs is called "mashup".[5,6] In recent years, the use of mashups has been gaining attention in the IT field. Against this background is the fact that the personal use of Web APIs provided by major providers, such as Google Maps, has increased rapidly in portal sites utilizing SNS (social network service) blogs (SNS).[8,16]

"Mashup" is a term that originated in the music world, and it means disc jockeys' technique of creating a "new" song by using the instrumental track from one song and the vocal track from another song or by mixing together two or more tracks. In the IT world, it means, by extension, combining multiple applications.

The term has been drawing attention in the field of software development since 2007, when Yahoo announced Pipes, a mashup tool for use by individual users. At present, backed by expanding use of Web APIs by individual users, moves to develop business applications by utilizing mashups' data linkage function have been steadily increasing.

Applying this technique to a business information system or business application is sometimes called an "enterprise mashup." Thanks to the emergence of the data linkage technique, the pattern of software development and software-based service provision may undergo drastic changes, and this, in turn, may lead to the development of various new business applications by users. This is because, thanks to mashup technology, it has become possible for users to quickly and easily develop and release convenient functions by combining existing software components available on the Web, even if they do not have the knowledge to develop sophisticated software.[18]

### 1-2 Examples of Mashups

To illustrate such possibilities, take, for example, an idea to establish a home-delivered pizza shop on the Internet.[2] Suppose there is a small pizza shop that is famous for making delicious pizzas. Let's say that it is a family-run shop and is therefore unable to deliver pizzas. Upon receiving an order, the shop can make delicious pizzas on time, but it cannot deliver them.

Meanwhile, another person gets the idea to open a virtual pizza shop on the Internet. Functions necessary for a virtual pizza shop are "delivery service" and "settlement service" in addition to "making pizzas at a specified time in accordance with an order." The delivery and settlement services are to be provided by delivery companies and financial companies. Therefore, by simply making "request for" and "response to" data via the Internet, it is possible "to receive orders from customers," "to place orders with a pizza shop having a pizza oven," "to ask a delivery company to pick up the pizza on time," "to have the pizza delivered," and "to make settlement." Needless to say, the "response" has to be backed by actual pizza making. So, this actual service of making pizzas is to be provided by the above pizza shop reputed for its yummy pizzas but unable to deliver them.

By combining "requests" and "responses" in this way, it is possible to operate a new virtual pizza shop that has an added value of "capable of delivering to
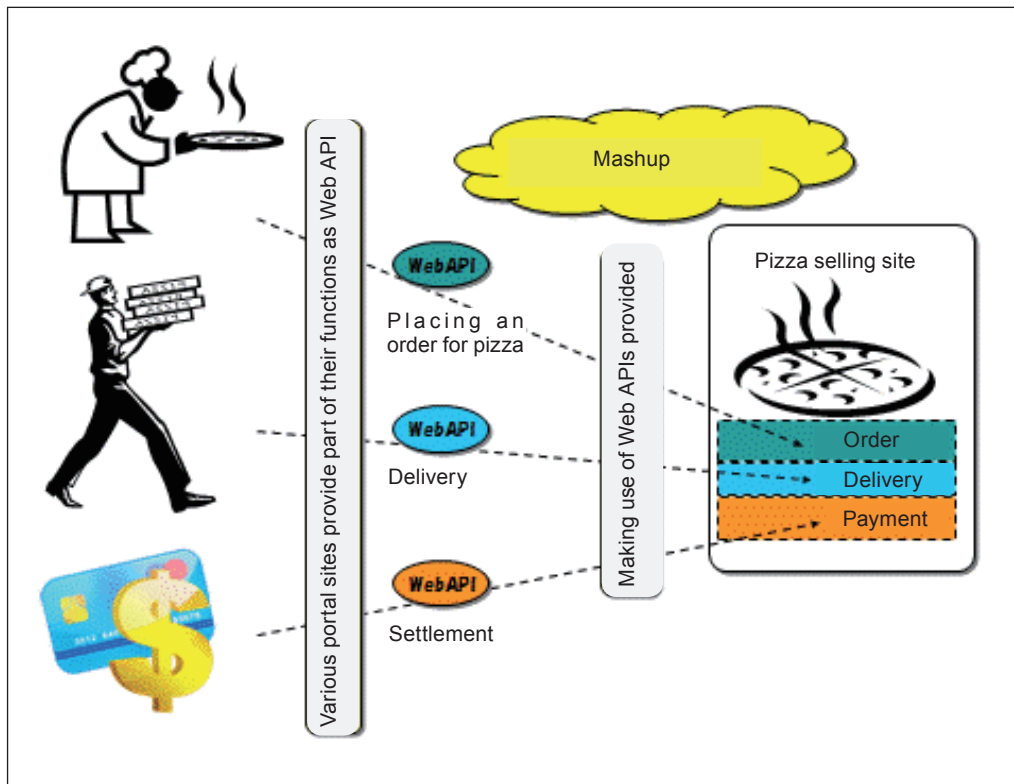
**Figure 1 :** Virtual Pizza Shop by Mashup

Prepared by the STFC

distant places." In other words, the new virtual pizza shop can sell delicious pizzas from existing pizza shops to people in larger areas by simply manipulating data linkage. Figure 1 shows how the service is provided.

Previously, users had to follow these "requests" and "responses" procedures in sequence by themselves. However, if Web API is used, which will be described later, these procedures are automatically executed by computer software. This technology to link data that are the basis of information services provided by different entities by computer programming alone (which have to be backed by actual service provision) is called data linkage utilizing Web API. In this report, "mashup" will hereinafter be used to mean providing information services through data linkage utilizing Web API.

## 2 | Data Linkage by Web API

### 2-1 Release of Web API on the Internet

The information provided by mashup technology consists of Web APIs that mostly correspond to information resources. As the basic premise of the usage environment, we assume a general information-processing environment that allows communication of information on the Web via the Internet. These element technologies will be explained one by one.

Information resources are contents and data accumulated in the database. They are information contents and data of information services provided by Web APIs, or information processing application functions (for instance, information retrieval). These resources are premised to be provided via the Internet. For instance, the image data of large-scale maps is one of them.

Web API provides interface functions to utilize such information resources via a network. Such information is basically described in a computer language called XML (eXtensible Markup Language). By using this text format, the input and output necessary for processing can be distributed on the network, while the structure of data that forms the basis of information resources is expressed by tags. Information distribution can be flexibly realized by this framework. Figure 1 shows a virtual pizza shop realized by mashup technology. Figure 2 shows examples of XML documents that are used at the time of booking. Items such as "type of pizza," "delivery time," "name of the person who placed order," and "his/her name" are written in a prescribed format. In XML, these items are designated by tags such

```
POST/PizzaOrder/HTTP/1.1
Host:server.mashuppizza.com
Content-type:text/xml:charset="
Content-Length:xxxxx
{CR}{LF}

<?xml version="1.0" encoding="utf-8
<QueryOrder id="0001">
      <PizzaName>Margherita</PizzaName>
      <Time>12041030</Time>
<Price>1200JPY</Price>
      <PersonName>Akihi...uji...
      <Address> Kasumigaseki 1-2-3</Address>
</QueryOrder id="0001">
```

Type of pizza ordered
(Pizza shop)

Price (Payment information)
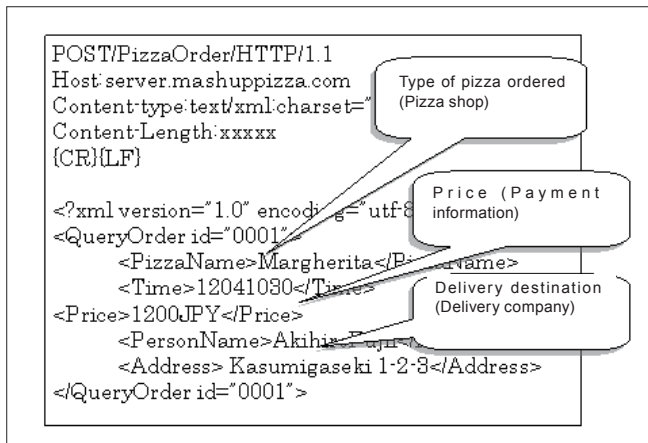
Delivery destination
(Delivery company)

**Figure 2 :** XML Schema on Order Slip of Pizza Shop

Prepared by the STFC

as "Pizza Name." In order to distribute information in XML format, it is necessary to prepare separate documents called "XML schema" defining the meaning of such tags, and share them.

The virtual pizza shop communicates the "type of pizza" and "delivery time," i.e., the timing of actually making the ordered pizza, to a real pizza shop that has a pizza oven, and "delivery time" and "address" to the delivery company. Price, delivery destination and other information, which are structured by a series of tags defined by the XML schema, are delivered to separate Web APIs, which, in turn, send the information to different programs on separate computers connected to the Internet. The computers analyze the tagged information and execute necessary processing, such as delivery and settlement. In order for multiple business entities (in this particular case, the pizza-making shop, the delivery company, and the payment settlement company) to cooperate in providing the service described above, it is necessary to jointly operate the XML schema to realize a virtual pizza shop.

## 2-2 Mashup Tools and Development Examples

In order to do a mashup by using multiple Web APIs, a software development environment needs to combine more than one Web API.

For instance, Google makes its development environment, called "Google Web Toolkit," available to general users. Among other development environments are Pipes (Yahoo! Inc.), Mashup Center (IBM Corp.), and ToofTop (SAP AG). In Japan, the Intramart of NTT Data Corp. provides similar functionality10]. These development environments are equipped with graphical operation screens, making it

easy to combine available information resources via Web APIs.

Figure 3 shows a sample website we have prepared by using such tools. We calculated tidal information on the coastline in various parts of the country and released the calculated data via Web API and at the same time mashed up the data with a map formation data provided by Google Maps. The site also displays weather forecast information made available by a different information provider and mashed up with the map information. The site is on the Google App Engine, which is a cloud-computing environment provided by Google.

Another similar example is a site that provides information on environment problems by combining an API for collecting news articles and comments on environment problems and an API for obtaining area map information. There are also other interesting examples, such as the one that provides regional weather information services by combining map information and weather data, and the one that supports business trips by combining the function to display the results of path search and the information on accommodation provided by a travel agency.

It is not so difficult for people with programming experience at a university to do a mashup and release new services by utilizing such tools. In fact, many users have developed and released systems meeting their needs with relative ease (6).

## 2-3 Background Leading to the Development of Web API

The emergence of the mashup technique is attributed to the fact that the method to link data by using API on the Web has technically matured. Here, we would like to take a brief look back on the historical evolution of software engineering from the aspect of data and application linkage.

### 2-3-1 Contribution of Distributed Object-Oriented Technology

One of the important element technologies supporting mashups is the progress of Web API. The maturity of this technology is attributed to the progress of "distributed object-oriented technology," a software engineering technology. First, a software design development technology, which is called "objected orientation," was proposed in the 1960s, leading to a concept of software componentization
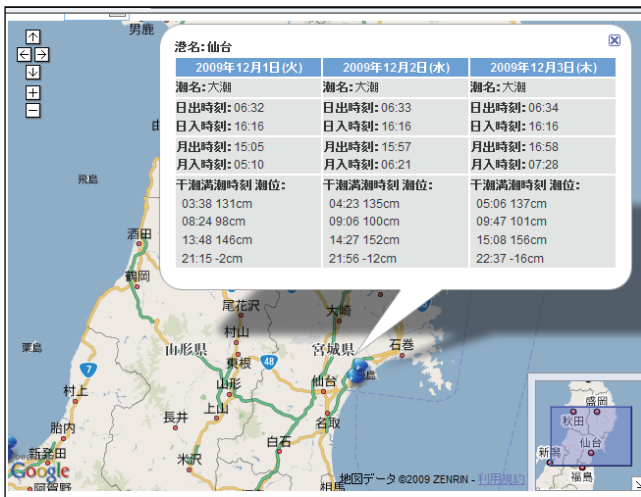
**Figure 3 :** Example of Mashup (Tidal Information and Map Information)8
Prepared by Computer System Development Co. by using Google Map

gaining ground. And, in addition to the object orientation, languages designed for use on networks were proposed. The Java language created in the 1980s is one of them. In the 1990s, methods to release information via the Internet were developed and they spread rapidly, leading to the general use of the Internet to share information resources via networks. Based on the concept of "software componentization for networking," a software development technology called "distributed object orientation" was proposed. In 1989, an international industry consortium called Object Management Group (OMG) was established with the aim of standardizing object-oriented technologies and promoting their diffusion. The OMG formulated a specification called CORBA (common object request broker architecture). CORBA is a design technique to develop software by combining software components distributed on networks.

In this way, the two basic concepts — the idea of compartmentalizing software and the network-mediated software — were established in the 1990s.

**2-3-2 Contribution of Web Service-Related Technologies**

When its concept was first proposed, the "distributed object-oriented technology" drew much attention. However, it was not widely utilized in the 1990s due mainly to the complexity of the development process and the slow processing speed of computers. The biggest reason was that, in CORBA, a unique communication means had to be implemented for object-to-object communications.

Meanwhile, a move to make use of communication methods widely used in the Internet world began around 2000. The W3C (World Wide Web Consortium) defined a standard called SOAP (simple object access protocol). Since SOAP uses HTTP (hypertext transfer protocol), a communication means generally used for the Web, it does not need to implement a unique communication means for object-to-object communications. The W3C defined SOAP as the core standard in the technical field of "Web services." The growth of the standard system concerning Web services has contributed to improving the environment for the usage of Web APIs. In order to realize a mashup, it is necessary for there to be a mutual exchange of information among Web APIs. Moreover, for such data linkage by Web APIs, it is necessary for there to be interoperable machine-to-machine interaction functions defined by "Web services." The adoption of SOAP for information exchanges among Web APIs has made it possible to link software in a more flexible way, leading to the increased use of mashups. In other words, it can be said that the componentization of application software and the use of application software have matured and that they have come within the reach of general users.

**2-4 Relationship between Mashup and Other Web 2.0-Related Technologies**

In this section, we would like to look at the relationship between mashups and other technical terms in the information and communication field. The mashup is recognized as one of the Web 2.0-related technologies. Web 2.0 has been a new way of utilizing the Web since the mid-2000s. Free encyclopedia "Wikipedia (Japanese edition)" explains the concept of "Web 2.0" as follows.

"(Web 2.0) is a concept put forward by Tim O'Reilly. Narrowly speaking, it refers to a change in the condition of Web utilization. Previously, the flow of information was one-sided, from fixed senders to fixed receivers, but now anyone can send information to anyone."

In what follows, we would like to outline the relationship between "mashup" and Web 2.0-related technical terms, such as SOA, SaaS, and Web services, to help explain the trend of the use of Web APIs, mainly mashup.

### 2-4-1 Position of Mashup in New Design Concept

Mashup is one of the specific methods for realizing a new design concept in the construction of information systems. In recent years, a design concept called SOA (service-oriented architecture) has been drawing attention in information systems for sharing services. SOA is "a basic software structure based on a service unit." Basically, users enjoy services provided by software by utilizing the Web or other computer interfaces. The important point in SOA is that the entities "utilizing" services do not necessarily need to be human beings. There may be cases where different computers utilize services offered by other computers through the Web or other general interfaces. The "distributed computing," which was described earlier, is one such example. In short, SOA defines distributed computing from the aspect of services. In order to realize SOA, flexible data linkage is essential, and mashup is one of the techniques to realize a SOA software design concept. However, although mashup is one of the main techniques to support SOA, it does not necessarily mean SOA itself.

### 2-4-2 Relationship between Mashup and Software Distribution Method

In developing a software system, the concept of SaaS (software as a service) is just as important as SOA. SaaS is a software distribution method for providing the functions that have conventionally been provided in packaged software, as services via the Internet and browsers. Users pay periodic fees in accordance with the volume of services or fixed fees, instead of purchasing the software license. The benefit of adopting SaaS is that it allows flexible construction of information systems and swift changes of systems to meet the demands of the times. SaaS is a method to provide software from the standpoint of user convenience based on the SOA design concept explained in the previous section. Therefore, many corporations have begun to adopt SaaS to support their information systems, in particular, for office document and format processing.

Web API is essential as an information resource interface to establish SaaS environments. Conversely, in software systems based on SaaS, it is possible to develop enhanced Web API environments that can be utilized in mashups. SaaS does not necessarily have to be combined with mashups. However, if the provision of software by SaaS spreads, it will increase the materials for information services that can be used in mashups. In other words, the mashup is one of the techniques used by vendors trying to develop SaaS environments and corporate information departments providing corporate information systems to produce effective applications.

For example, a platform called J-SaaS has been developed under the initiative of the Ministry of Economy, Trade and Industry. Existing and new software can be used on this platform. Although the services provided on the platform so far have been mostly existing software, just in different packages, it is expected that more mashup-oriented Web APIs will be developed in the future.[12]

### 2-4-3 Relationship between Mashup and Web Services

As described in 2-3-2, the form of providing information services as Web API was standardized and matured in the technology system called "Web services." The system was standardized by an organization called W3C, which is headquartered in Boston, Mass.[1,9] In the Web service system, service functions are stratified and defined. Among them, what is particularly important for mashups is that the standard communication protocol SOAP for exchange of XML documents among Web APIs is defined by using HTTP (hyper text transfer protocol), a protocol normally used on the Internet. The advance in communication technology concerning XML documents, which was brought about by the development of SOAP, has led to the progress of data linkage technology utilizing Web APIs.

## 3 | Trends in Mashup Research and Development

### 3-1 Business software development trend

With regard to trends concerning mashups as business software, first of all, the use of Web APIs has increased rapidly among general users. With the kinds of Web APIs increasing, the environment to utilize them has matured. The mashup has come to be recognized as a practical software-development technique. However, the Web APIs used by many people are mostly those provided by major Internet service providers, such as Google. By using such Web APIs, many users have developed mashup sites.

ProgrammableWeb.com, a U.S. mashup portal site, has surveyed examples of mashup development.

ProgrammableWeb.com is a site for registering mashup sites combining APIs developed by users and existing APIs. It provides links to such mashup sites11]. The number of services built by using registered mashups increased from about 3,600 at the beginning of 2009 to more than 4,500 at the end of the year.

Figure 4 is a breakdown of examples of mashups developed by users. It shows which Web APIs were used for building mashups. It reveals that many of the mashups utilize the APIs released by corporate sites, such as Google and Amazon. About half of the mashups utilize Google maps, followed by Flickr, YouTube, Amazon, and Twitter. We are interested to know if Web APIs provided by providers other than the major ones will increase in the business field.

Next, we would like to give some specific examples of mashup services. First, there is a development example of trying to integrate electronic application systems to realize one-stop administrative services. It is designed to integrate various application services provided by different administrative agencies by utilizing mashups.[13]

There is also an example of providing catalogue information on machine parts. Huge amounts of a catalogue of a wide variety of machine parts are produced in print formats at their distribution stage. If product information is provided by utilizing Web APIs, it will be possible to retrieve catalogues of various purposes from a common merchandise database.[16] There are also sites that provide various services in Japanese.[17]

## 3-2 Research and Development for Mashup
### 3-2-1 Presentation examples at international academic meetings

Reports on the results of mashup research and development began to appear in around 2005. Documents[19,20] are examples of reports presented at a recent international academic conference. The documents discuss design concepts to flexibly develop business software by using mashups.

There are also examples of research on software development tools to support mashups. For instance, document[21] discusses a development support system to help business persons who are not familiar with Web programming skills to develop applications by using mashups.
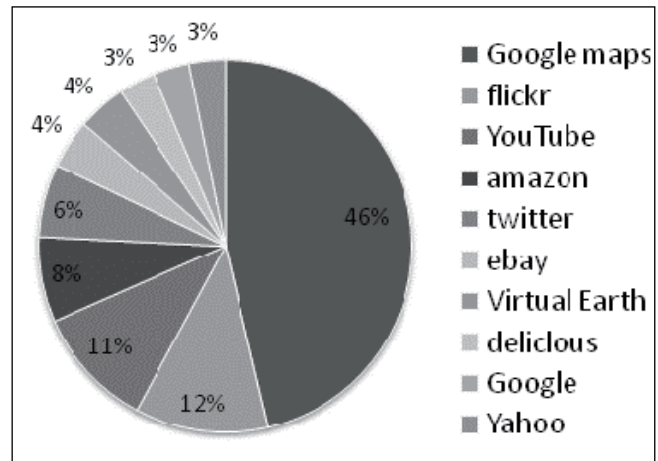


**Figure 4 :** Kinds of Mashups
Prepared by the STFC based on Reference[11]

### 3-2-2 R&D examples in Japan

Now, let me introduce some related research examples in Japan. It is said that, in mashup development, introducing an "aspect-oriented" approach, in addition to object-oriented software development technique, is effective in enhancing productivity. In fact, development environments incorporating such aspects have been proposed.[14]

The good point about mashups is that even people who do not have high programming skills can construct functions to meet their needs. At present, in order to develop services, it is necessary to have professional knowledge about developing software by mashup and the ability to make free use of development tools. For this reason, proposals have been made for the development of simpler mashup development technique and modularizing technique to make coding simple.[15]

### 3-2-3 Research Projects in EU

We would like to introduce R&D examples in Europe. Service Centric Software Engineering (SecSE) is a research project implemented by the European Union for four years ending in 2008. The project was carried out with the aim of developing effective techniques and tools to support the development and use of services and service-centric applications. The overall budget for the project was €15.2 million (about ¥1.98 billion), with €9.2 million (about ¥1.2 billion) of them funded by the European Commission.[2]

In March 2008, a successor project called FAST was initiated under the FP7 (seventh framework program for research and technological development). The project will be carried on until the end of March 2011.

Its overall budget is €5.5 million (about ¥720 million), with €3.5 million of them provided by the FP7.[22]

The European projects mentioned here are attempts not only to simply utilize Web APIs but also to develop platforms for linking services of multiple corporations. They are aimed at developing better software development techniques, including mashups, by looking at the future direction of software development from the perspective of "service."

# 4 | Future Trends Concerning Enterprise Mashup

## 4-1 Effective range of mashup

Mashup is drawing attention from the perspective of developing flexible information services, especially in a corporate information system, which is called an "enterprise mashup." Here, we would like to look at the potential of Web mashups, in particular from the aspect of corporate information system.

From the perspective of a corporate information system, the effectiveness of mashup is explained as follows. Figure 5 shows needs for information-providing services. The horizontal axis lists the candidates of necessary information services and the vertical axis shows potential utilization of respective services. Needs for information services have an elongated tail that can be approximated by an exponential function. In reality, however, since it is difficult to measure potential needs and therefore difficult to draw a continuous curve line, Figure 5 is just a conceptual diagram.

Generally speaking, information services provided by corporations are frequently used by many people. This corresponds to the leftmost range in Figure 5. On the other hand, it is said that building functions to provide new information services by mashup may correspond to potential needs for information services in the central range in Figure 5. Recent Web technologies, such as Web API and mashup, are believed to expand their applications in organizational information service provision at relatively low costs.

## 4-2 Supply and provision of services in corporate information system

Figure 6 divides the possibility of the use of mashups in a corporate information system into four areas from the aspect of supply and provision of services. Here, we would like to examine the possibility of in-house use of mashups by corporations based on document.[6]

Area 1: Provision of outside services to outside users (customers)
Business area where corporations provide outside information to outside users by adding some value, on the basis that existing services are being provided by Web API, etc. through SaaS platform.
Area 2: Provision of inside services to outside users
Providing corporations' valid information services to outside users. Disclosure of information to affiliated companies via the Internet has already been implemented on a trial basis. For instance, it may be possible to provide inventory information on products the company trades to counterpart companies. Providing such information as mashup-able Web API may increase in the future.
Area 3: Provision of inside services to in-house users
This refers, for instance, to a system to efficiently convey technical information on in-house products to sales personnel. In fact, start-up information vendors advocating enterprise mashups have already begun to propose such a system.
Area 4: Provision of outside services to in-house users
If an environment is established where external resources, such as Web API, are abundantly provided, the use of external resources that are provided in the form of Web API will increase in order to enhance in-house information services.

Of the classified areas above, the use of Area 1 and Area 4, in particular, is said to expand, because the needs for them are increasing for the following
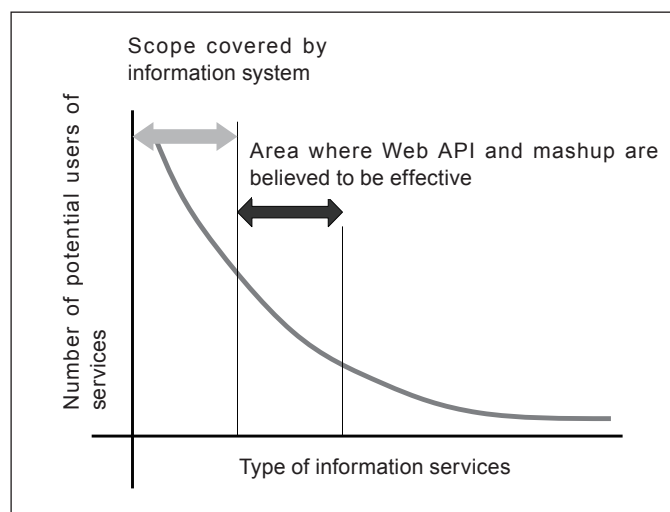


**Figure 5 :** Effective Range of Web API and Mashup

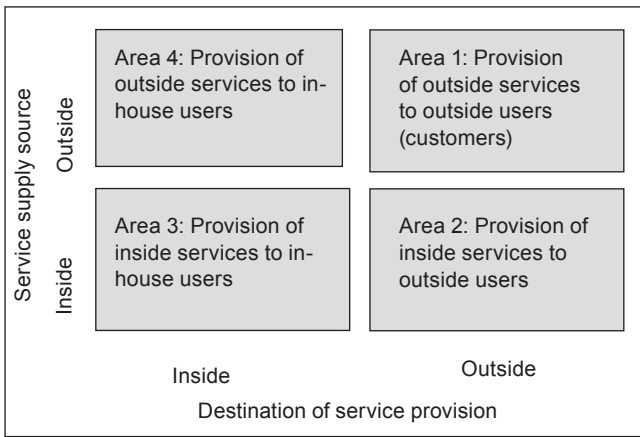Prepared by the STFC based on Reference[23]

**Figure 6 :** Relationship between supply and provision of services

Prepared by the STFC based on Reference[6]

reasons. For one thing, there is a strong need to flexibly and effectively utilize existing in-house IT resources. Corporations have accumulated information in relational databases for various purposes. Among such information are client information, product information and trading records. Since such information can be easily accessed from inside by Web API, it may lead to a new way of utilizing information by using mashup applications.

Meanwhile, corporations' use of information services available on the Internet is expected to further increase in the future. This is because there are attractive services for corporate activity and because corporations want to actively utilize such services. Moreover, if information accumulated individual-by-individual and sector-by-sector also proves useful for other people, it will open the way for providing such information to a wide range of users. Besides the information services provided through corporate information systems, there are also databases that are used by limited individuals or departments to conduct business activities. Making such databases available to others may lead to a new way of in-house use of information.

Whether it is data linkage or service linkage, it goes without saying that there must be certain rules for linkage. When using a Web API, it is necessary for persons involved to define common rules on the XML scheme of the targeted area.

## 6 | Conclusion

In this report, we have described the spread of the use of Web APIs, explained mashups, a technique to combine them, and talked about the trend of advanced software engineering.

At present, the modes of use of information systems that are collectively referred to as Web 2.0 or cloud computing has been expanding, and information system design concepts, such as SOA and SaaS, have become widely used in the field of software development. Under such circumstances, it is important to be able to link data and services flexibly via the Internet. Mashup is a technology to realize this via Web API. The term "mashup" may be nothing but a passing keyword in the field of IT. This is because a framework to effectively link different organizations' data via the Web has matured. Since this is expected to become a new trend in the development and operation of corporate information systems, trends in software technology merit attention. If a mashup-like technique comes to be utilized in the business field, its advantage of being able to provide new functions in a short period of time at low cost will prove to be effective in increasing business efficiency, especially for small and medium-sized enterprises.[6,18]

In order to create added value by linking data, it is necessary to accumulate valuable data and make them available in such forms as Web API. Therefore, as a measure to promote the creation of new services by mashup, it is first necessary to encourage data accumulation in individual business areas. It is true that databases have been constructed for various purposes. However, in order to link them with new services, it is necessary to promote a wide use of such databases by releasing them in a recyclable way.

Moreover, in order for a data linkage to function effectively in a specific business area, "linkage rules" that can be commonly used in the business area must be in place. In the case of using mashup technology, the rule is XML schema definition. For instance, in order to implement EDI (electronic data interchange) for the distribution of products of a certain field, it is necessary to develop XML schema for shared use by companies involved. For expanded use of XML schema, it is effective to provide supports to business bodies' data-linkage and service-linkage attempts, in addition to implementing deregulation measures on open information. In doing so, for the sake of technical innovation in this field, it is important for the process of the development and utilization of schemas to be open.

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## Profile
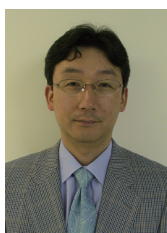
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http://www.housei.ac.jp/

Dr. Eng.. After work in the research of distributed computing and communications protocols, Dr. Fujii carried out a project to build an e-commerce system. He is currently interested in the influence that innovations in information and communications technologies have on business and policy.

(Original Japanese version: published in January 2010)