# Cloud Computing for Animal Medical Care

● Hisato Minami ● Akira Imabayashi

**One ideal way of enjoying the benefits of cloud computing would be to build a social infrastructure of knowledge by storing knowledge in a cloud itself and offering it as a service in the same way as electricity and tap water. As one approach to building such social infrastructure, Fujitsu is working on applying cloud computing to the field of medical care for animals (companion animals). However there are problems in this field. For example, information about medical treatment is not recorded in a manner that allows it to be easily shared and there are no established systems for extracting information to deliver it to the persons concerned. We conducted a proof-of-concept experiment on a solution to these problems by means of utilizing data on a public cloud capable of centrally storing information and allowing it to be shared and utilized as required. Through this experiment, we showed how a cloud as social infrastructure can make social contributions and demonstrated an information-sharing model made possible only by a cloud serving as social infrastructure. This paper presents Fujitsu's activities to achieve these goals and related discussions.**

## 1. Introduction

As the activities of companies and individuals generate more and more information, so ICT has changed its forms. For example, when information processing speed was in close relation to corporate growth, mainframes were introduced in companies. Since the development of the Web made computers indispensable to people's lives, personal computers and tablet computers have made progress. Now, cloud computing, which has come to the front as a result of the development of network technology, can be seen as social infrastructure that serves society including companies and people. It does this by widely offering machine power essential to social activities in the same way as electricity and tap water that we use on a daily basis.[1)]

Still, this machine power is no more than an engine for information processing. What people desire is a way to obtain knowledge and wisdom that can be extracted as a result of information processing. Accordingly, to have clouds serve as social infrastructure integral to people's lives, one ideal way is for a cloud to be a "social infrastructure of knowledge" that stores knowledge and wisdom in itself, and that provides it as a service in the same way as electricity and tap water.

As one approach to making contributions to society by using cloud as a social infrastructure of knowledge, this paper presents examples of applying cloud computing to the field of medical care for companion animals (pets).

## 2. Changes in society surrounding companion animals and associated problems

Companion animals are becoming a more and more important part of our society from year

to year. The total number of dogs and cats kept as companion animals is now about 1.3 times the population of children under 15 years old in Japan and 40% of households are said to live with some kind of animal (**Figure 1**).[2)]

Changes in the awareness of owners also have an influence on the state of companion animals. In a questionnaire that NTT DOCOMO, Inc. conducted on its subscribers,[3)] in response to the question "What does your pet mean to you?" 63% of respondents answered "Family member." This suggests that owners have changed from viewing companion animals as a "pet" to viewing them a "family member" (**Figure 2**).

Meanwhile, there are also problems that have surfaced as human society and companion animals have come closer.

1) Increased risk of infectious diseases of animal origin

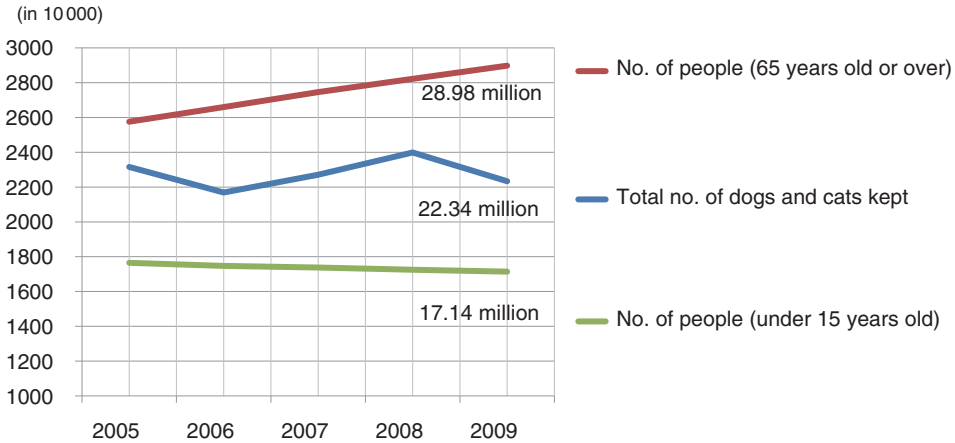
Infectious diseases of animal origin refer to infectious diseases caused by pathogens that infect or parasitize both humans and animals, and rabies and echinococcus are well-known examples. The recent tendency for owners to see companion animals as family members has led to an increase in the number of pet owners who come into close physical contact with their companion animals such as sharing the same table or bed.

However, such behavior is dangerous in that owners may contract infectious diseases fatal to humans. Some infectious diseases go on to spread from person to person, and this poses a problem for the whole of society rather than pet owners alone.

To address this problem, research on disease occurrence (monitoring) to identify the route of any infection discovered and take measures to prevent its spread may be effective. There is no system in place to store data on animal infectious diseases in Japan, however, except for a certain type of information and measures to combat the risks are not adequate.

2) Medical care infrastructure linkage

As companion animals are being regarded more and more as family members, so owners' requirements for animal medical care are becoming more exacting every year. However, overall medical care infrastructure to fulfill these requirements is not sufficiently established. For example, informed consent (adequate explanation about and agreement to medical




Sources: Nationwide Survey on Actual Conditions of Dog and Cat Maintenance by the Japan Pet Food Association and long-term time-series data from the Statistical Handbook of Japan 2010 edited by the Statistical Research and Training Institute, published by the Statistics Bureau, Ministry of Internal Affairs and Communications

(Compiled: Anicom White Paper on Household Animals, Anicom Holdings, Inc.)

Figure 1
Changes in numbers of dogs, cats and people in Japan.

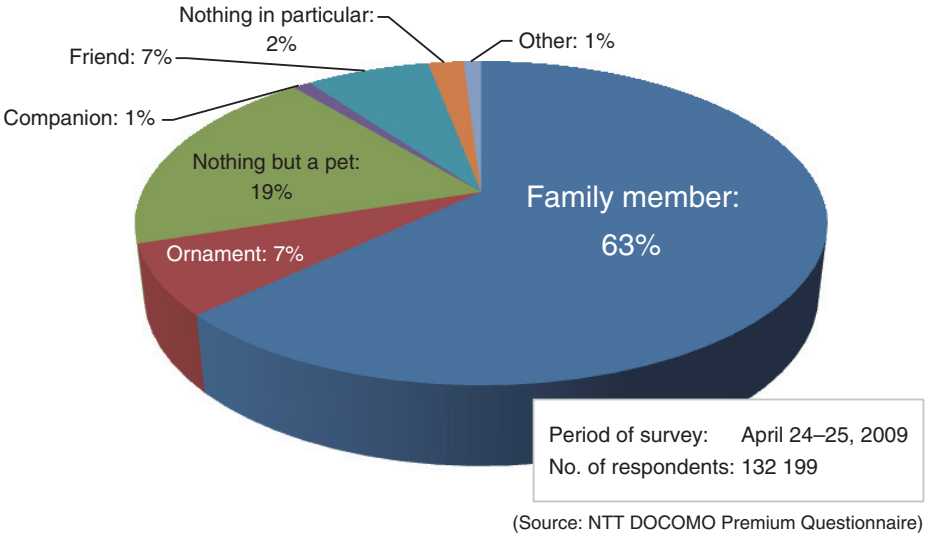



Figure 2
Question: "What does a pet mean to you?".

care) is increasingly considered as important in animal medical treatment as well. Nevertheless, the reality is that different hospitals use different formats for providing owners with information about medical examinations and treatment. In some cases, medical treatment information is not registered in medical records or, if it is, the information cannot be readily shared with third parties because the records are in paper format.

In addition, the increasing similarity between foods for humans and animals and changes in their living environments have made the states of diseases more complex. Accordingly, advanced facilities and expertise are required for treatments but not many hospitals can promptly introduce such facilities or expertise. In recent years, some general hospitals have appeared that are furnished with expensive equipment funded by major capital spending and staffed with many medical specialists. However, there are few such hospitals and not all pet owners can enjoy those services.

As pet owners' demands for medical care are increasing year after year, it has become urgently necessary to improve the medical care environment.

There has been a delay in addressing the problems mentioned in this section. Some reasons include the fact that medical treatment information on companion animals is not recorded in a form that readily allows it to be shared, and no system is in place to extract the information and deliver it to the people concerned.

In essence, a social infrastructure that centrally stores information about companion animals and makes it available as required is called for. This is where we think cloud technology can be applied.

## 3. Solving problems by data utilization

### 3.1 Demonstration experiment activities in field of companion animal medical care

One organization working on the problems that relate to companion animal medical care is Tokyo Jonan Regional Veterinary Medicine Promotional Association (hereafter TRVA). Of the various problems regarding companion animals, TRVA is seeking to solve those that relate to night-time animal treatment and advanced secondary treatment. To this end, it has established the TRVA After-Hours Emergency Veterinary Care Center and the

Veterinary Referral Center.

As more and more people tend to see their companion animals as family members, a medical treatment system with daytime veterinary hospitals alone is becoming insufficient for pet owners to feel secure about living with their animals. Under these circumstances, TRVA finds it necessary to build a safety net of regional veterinary medical care. This can be achieved by cooperation with medical care institutions in charge of night-time treatment or advanced medical treatment and between regional veterinary hospitals. Such safety net is in addition to the services provided by individual veterinary hospitals. TRVA refers to this type of medical care, which offers an environment in which pet owners and animals can live with a sense of security, as "animal medical care." It is medical care provided for pets that are like family members and that have a close relationship with humans.

To realize this animal medical care, Fujitsu conducted a proof-of-concept experiment that uses cloud computing to assist TRVA with medical examinations and treatments. In this way, we are working to solve the problems mentioned earlier. First, we placed the focus on the "information" generated on a daily basis in veterinary hospitals. Repeated studies were made on how to construct an environment in which veterinary hospitals can easily convert the information into data for storage and people engaged in medical treatment can take it out anytime. As a result, an infrastructure platform has been constructed that allows cloud computing to be used to input, convert into data, store, extract, aggregate, analyze and display medical treatment information, and allows it to be securely shared with the people concerned. This platform has been named "Animal Medical Care Cloud," and it functions as the core part of the safety net for regional veterinary medical care (**Figure 3**).

The main points of this approach are:

1) Information input interface
2) Information handling rules
3) Information processing and generation of knowledge and wisdom
4) Secure and flexible linking platform for utilization of information

## 3.2 Information input interface

On the frontline of animal medical treatment, new information is generated

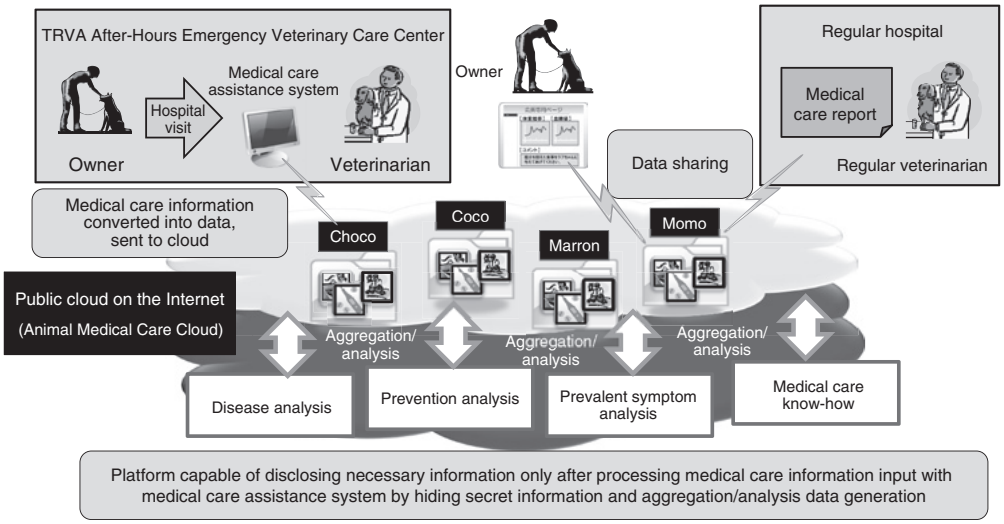



Figure 3
Overview of proof-of-concept experiment at TRVA After-Hours Emergency Veterinary Care Center.

every day from diagnosis of affected animals or conversations with owners. To make such information available to people in the necessary formats when necessary, it must be converted into data by means of a tool and stored in a place accessible to people engaged in medical treatment. For this purpose, a medical treatment assistance SaaS tool capable of communicating with the cloud environment was constructed and provided in the proof-of-concept experiment.

One feature of this tool is its interface that does not affect medical practice processes. It was made as a result of having repeated discussions with veterinarians. Its characteristic of not imposing process burdens is an important point for stabilized and higher-speed distribution of information. Ultimately, an environment that reduces input burdens on veterinarians, such as input by tablet terminals, is thought to be a better way for this tool to be used.

It is also possible that different veterinarians need different medical treatment assistance tools for their practice. From the perspective of integrating large amounts of information into a cloud, preferably tools other than those provided by Fujitsu can also send data to the cloud. For that reason, communication between the tools and the cloud is achieved as communication to RESTful[note 1)] APIs. This system allows communication to the cloud, even if the tools provided by Fujitsu do not match the style of treatment of veterinarians, by having other tools access the Fujitsu cloud API.

As described above, the key to achieving a social infrastructure that offers knowledge and wisdom is how information, which constitutes its basis, can be obtained in large amounts. Accordingly, providing an environment that does not cause stress on information providers is important.

note 1) REST stands for Representational State Transfer and refers to simple Web-based interfaces and systems that use XML or HTTP. Being RESTful means conforming to the REST principles.

## 3.3 Information-handling rules

It has been explained earlier that information constitutes the basis of knowledge and wisdom. The information as it is includes pet owners' personal information and trade secrets of veterinary hospitals. These types of information are protected by law and naturally cannot be utilized without the necessary protection.

But can pet owners and veterinary hospitals agree to any and all such data being used as long as the types of information mentioned above are eliminated? The answer is probably that use of such information is unlikely to be approved for customary reasons. A system in which data may be used by the concerned parties without approval or prior notice only because it is not protected by law will not be accepted by society or people.

Accordingly, to construct a social infrastructure that offers knowledge and wisdom by utilizing information, it is essential to define guidelines for the use of such information in cooperation with information providers, and to construct a system for its use.

In the demonstration experiment with TRVA, as the first step in defining guidelines for use, a system and infrastructure have been constructed in which applications of information are clearly shown to pet owners coming to hospital and information is used based on certain policies.

## 3.4 Information processing and generation of knowledge and wisdom

Information cannot be utilized if it only exists as information. It must be processed into data for it to be available to people in the necessary formats when necessary. Information needs to be in electronic form before it can be sorted to allow only the necessary information to be extracted. **Figure 4** shows a concept of converting information into data for processing to allow it to be utilized. The processing hides personal information and trade secrets and data

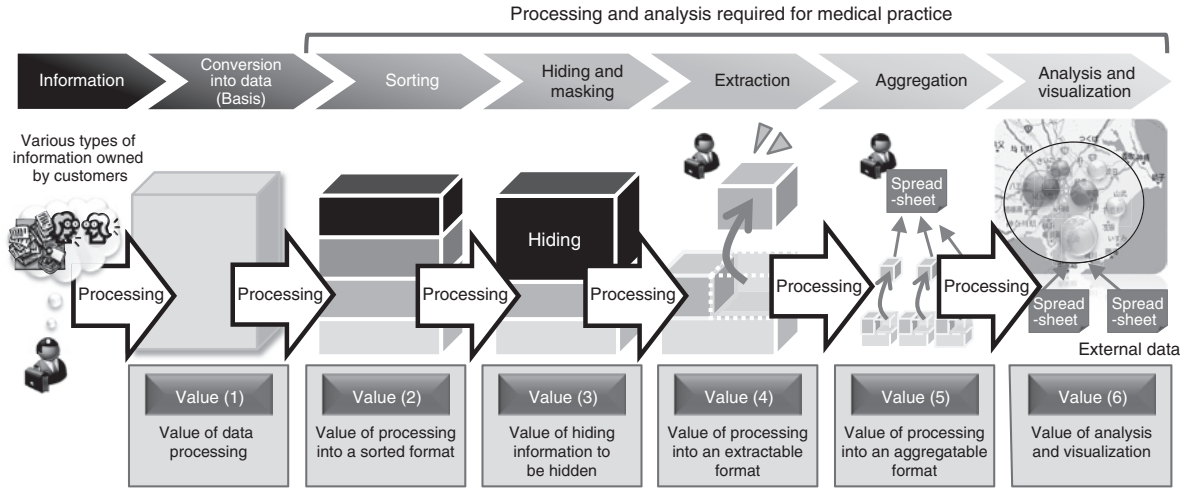



Figure 4
Concept of processing information for its utilization.

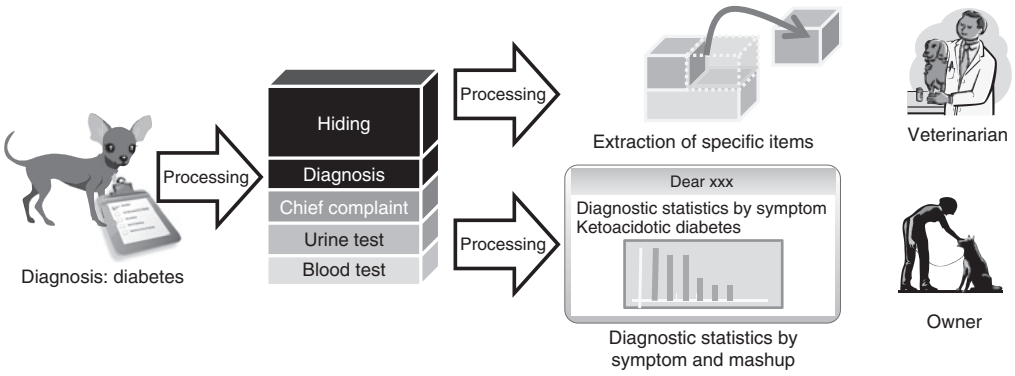



Figure 5
Example of processing medical record information of dog suffering from diabetes.

of customers who did not agree to the utilization are eliminated as well. This makes it possible to construct a data utilization environment that people can use with a sense of security.

Important factors for this processing include knowledge about practice in the target field and users' viewpoints.

The processing of medical treatment information about a dog affected with diabetes is used as an example (**Figure 5**). First, personal information and trade secrets are eliminated to generate a cluster of data to be utilized. Publishing the data in this state is not meaningful because the data are not processed into a format that allows them to be used by those engaged in medical practice or users.

When veterinarians view the medical treatment information of a dog affected with diabetes, they see if there is any possibility of complications. One typical case of canine diabetes complication is called "ketoacidotic diabetes," which often shows symptoms such as diarrhea and emesis and urine containing a chemical called ketone bodies.[4] Consequently, this information must be added, shown and processed to allow veterinarians to make decisions before it can be used in their practice.

When an owner views this data as medical treatment information for an affected animal, processing in the same way as for veterinarians

is not useful. For example, additionally offering diagnostic statistics classified by symptom and medical treatment information about the affected animal allows medical treatment to be more persuasive.

Actual provision of knowledge and wisdom cannot be achieved by simply passing on information. Processing the information is what makes knowledge and wisdom useful, and is where the source of value as a social infrastructure exists.

### 3.5 Secure and flexible linking platform for utilization

Another problem was how to build a system where external data are taken in from other corporations when data are shared between TRVA and regular hospitals. Traditionally, constructing an intranet and SOA-based linking were techniques to achieve internal data linking. However, technical requirements for linkage across organizational boundaries are different from these.

The biggest challenge was to establish a linking technology. SOA mentioned above is a set of specifications in view of process-oriented linking such as remote procedure call (RPC), and is prone to unnecessary complexity when used for linking data over a wide area, as in this experiment. Accordingly, our team adopted a technique of using REST APIs to handle data. In a RESTful system, data owners, data storage locations and data resources themselves in a cloud all have unique addresses indicated by uniform resource identifiers (URIs). Linking data can be easily achieved by accessing the URIs by means of HTTP methods.

Needless to say, the state in which the above-mentioned APIs are published on the Internet poses a security risk. To deal with this problem, security had to be built on the premise of data management based on URIs as described earlier.

The technique that has been adopted is an authentication and authorization method in which data in a cloud are associated with owners (URIs) for management and published only to the parties (URIs) approved by the data owners. This management method allows data owners to publish data by assigning different publication levels to different parties, and can serve as a security mechanism for protecting non-public data. To prevent the ease of linking from being compromised by security, authentication linkage via OAuth[note 2)] has been adopted to realize single sign-on (SSO) at the API level.

A platform as mentioned above capable of achieving both security and linking has been realized by our team as a data utilization platform, and has been used for the present proof-of-concept experiment as well.

## 4. Contribution as social infrastructure

This section describes the effects on society brought about by providing a social infrastructure of knowledge.

First, a system can be offered that is capable of promptly dealing with social risks including the animal-derived infectious diseases mentioned earlier. No system of absorbing information on a large scale from the clinical level has been built in Japan. If the accumulated information becomes available for application to address or study them, dramatic progress will probably be made.

The second effect is the improved quality of veterinary services. Data linking between medical care centers such as TRVA and regional veterinary hospitals allows the veterinary hospitals to provide virtual general services. For example, a night emergency case can be primarily handled by a night-time emergency treatment center, and the data obtained can be used the next day by a veterinary hospital for treatment. As a result, a 24-hour service can

note 2) A protocol specification for authentication of more than one Web service by API.

be offered to the owner. If information about tests using advanced equipment can be shared, medical care that uses advanced equipment can be provided.

In this way, we believe that offering new value to society by taking advantage of ICT is a way for Fujitsu as a vendor to contribute to society.

## 5. Conclusion

The last part of this paper presents the challenges in the activities described up to now and the direction to head in for the future.

One urgent challenge is to sort the continuation models for constructing this type of social infrastructure. To build a social infrastructure, certain levels of information flow volume and quality are desired, and to ensure this we need a model capable of continuously offering benefits to information providers.

The proof-of-concept experiment has been conducted while seeking such models. When they have been sorted, a new form of service will be available in which social infrastructure participants mutually share benefits.

The most important thing to be aware of in this approach is the mutual sharing of benefit with customers and making contributions to society. This seems to be equally important as technology and models and special mention should be made.

## References

1) N. G. Carr: The Big Switch (Japanese translation). Shoeisha, 2008. (in Japanese).
2) Anicom Holdings, Inc.: White Paper on Household Animals 2010. (in Japanese). *http://www.anicom-page.com/hakusho/book/pdf/book_101120.pdf*
3) NTT DOCOMO: My docomo Premium Questionnaire Results, Questionnaire on Pets. (in Japanese). *http://www.mydocomo.com/web/pointyutai/fuyasu/enquete/result0905.html*
4) N. Komiyama: How to Take Care of Dogs and Dog Diseases. (in Japanese). *http://www.pet-hospital.org/dog-017.htm*

**Hisato Minami**
*Fujitsu Ltd.*
Mr. Minami is currently engaged in new business development, planning and commercialization in relation to cloud services.

**Akira Imabayashi**
*Fujitsu Ltd.*
Mr. Imabayashi is currently engaged in new business development, planning and commercialization in relation to cloud services.