

# A Study of Constructing Knowledge Ontology of Customer's Questions in Telecom Corporation

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## Abstract

Due to represent the semi-structure of domain knowledge, many studies are starting to research on ontology building and seldom implementing an overall structure of their domain knowledge. Recently, there are many corporations using knowledge management (KM) to improve their business model, but most of them are not using knowledge ontology. In this case, it needs some vocabularies to represent domain knowledge and sharing information; hence, we bring out some concepts of construct knowledge ontology model. For building knowledge ontology efficiently and realizing knowledge ontology in this physical environment, we attempt to use ontology building tools such as protégé software to implement our study. In this paper, we also propose a methodology to develop ontology with real case study. An example of ontology can be found in Telecom Corporation of customer's questions. This will be used to illustrate the concept of development of knowledge ontology through using Protégé.

**Keywords:** Domain Knowledge, Knowledge

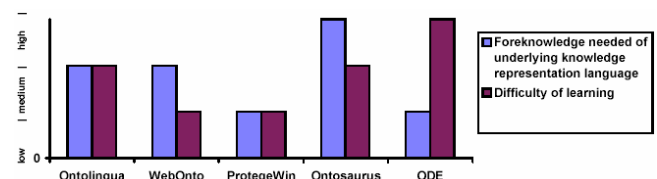
**Management, Knowledge Ontology**

## 1. Introduction

Today knowledge management is viewed as one of the most important fields for academic research and industrial implementation. In recent work, there are many studies are discussing with knowledge management and most of them focusing on developing knowledge management

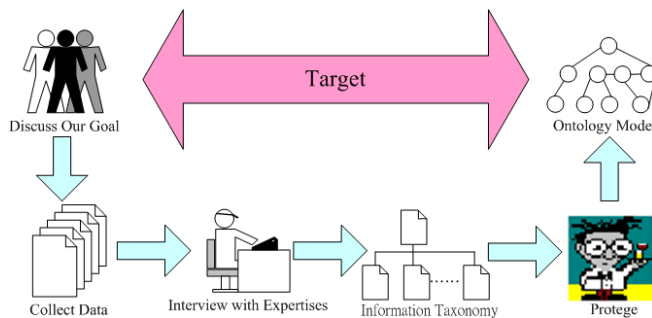
model. Although there are plenty of methods to develop KM model, the ontology is the most efficiency way of them [1, 2]. Ontology defines some vocabularies to represent domain knowledge and shares information in that domain. People or software agent can understand the meaning of ontology and reuse ontology [2]. In this research, we develop a methodology to implement ontology and use it to build domain knowledge such as customer's Q&A, travel planning and so on. Knowledge ontology is a set of rules with vocabularies, semantic interconnection inference and logic. It also represents domain knowledge in our ontology.

A number of tools have been invented to build ontology, assisting developer to implement knowledge ontology [9]. These tools contain much information about the real world and how it operates. These tools are Ontolingua, WebOnto, Protégé, OntoSaurus, ODE, KADS22, etc. In order to build knowledge ontology efficiently and realize it in this physical environment, we will evaluate the difficulty of these tools and adopt ontology building software to implement our system. According [9] and Figure 1.1, the difficulty of learning and foreknowledge needed of underlying knowledge representation language show the Protégé is the best building tool.



**Figure 1.1: Evaluation of ontology building tools**

Therefore, we propose knowledge ontology through using Protégé software. Besides, we had interviewed several specialists in telecom corporate of Customer Relationship Management Department and collected some customer frequently asking questions. Then, we have categorized these questions and tried to build its ontology. We also invent a taxonomy methodology and discuss it with these experts. This research process could be drawn as Figure1.2.



**Figure 1.2: Research process**

More specifically, in Section 2 of this paper, we discuss the related work of knowledge management and construct ontology framework. In Section 3, we interview with some experts and develop information taxonomy. Next in Section 4, we will start to investigate how to integrate information into Protégé. Finally, we draw some conclusion on future research.

## 2. Related work

This section describes the ontology method and discusses how to realize it in real environment. After this, we illustrate the software of Protégé briefly.

### 2.1 Ontology Methodology

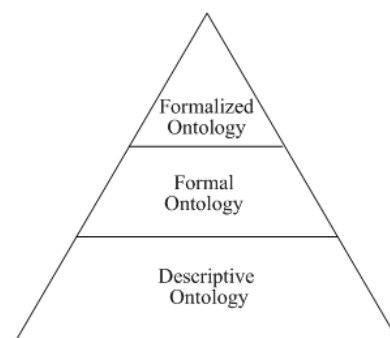
In recent years, the development of ontology has been recognized in artificial intelligence, software reuse, and information technology. Ontology has been viewed as an important and nature means of representing real environment in the world [1]. Actually, many researches believe that the use of ontology will dramatically change the way of system design [1, 2, 3].

Before discussing the methodology for the construction of ontology, the authors need to explain various definitions of the term “ontology”:

- ◆ “An ontology is an explicit specification of a conceptualization” claimed by Gruber (1995)
- ◆ “A (AI-) ontology is a theory of what entities can exist in the mind of a knowledgeable agent” by Wielinga and Schreiber(1993)
- ◆ “Ontology for a body of knowledge concerning a particular task or domain describes taxonomy of concepts for that task or domain that define the semantic interpretation of the knowledge” by Alberts (1993)

To summarize those definitions of ontology, it can be treated as conceptual, knowledgeable and taxonomy methodology. Ontology is also agreement of knowledge sharing.

In [3, 4] had divided ontology into three categories: descriptive, formal and formalized ontology. Each of those ontology can be contained two guises: domain-dependent and domain-independent. Descriptive ontology collects information about many entities. Formal ontology will filter, codify and organize the result of descriptive ontology. The formalized ontology relates to evaluation of the adequacy of the various formalisms and to the problem of their reciprocal translations [3]. Therefore, the taxonomy of ontology can be showed in Figure 2.1



**Figure 2.1: Taxonomy of ontology**

The recently usage of ontology represents conceptual model and entrenches in many information systems [5]. Ontology is sometimes equated with hierarchies of real environment objects and not limited to conservative object definitions. To specify a conceptual model needs to state axioms that do constrain the possible interpretation for the defined some terms.

## 2.2 Application of Protégé

In order to implement an ontology methodology into information system, the academic researchers start to invent software package such as Protégé [6]. Protégé was invented and developed by Stanford Medical Informatics at the Stanford University School of Medicine. It also supports by several agencies of Stanford University.

The Protégé is an ontology development tool and supporting multi operational platforms such as windows, Mac OS and UNIX. The Figure 2.2 is the initial screen of Protégé. Applications developed with Protégé are used in problem-analysis, decision-making and ontology establish in a specify domain. All of Protégé's commands can be operated in GUI (graphical user interface). Protégé is currently being used in clinical medicine and the biomedical sciences [6]. But it also can be used in any field where the concepts can be modeled as a class hierarchy.

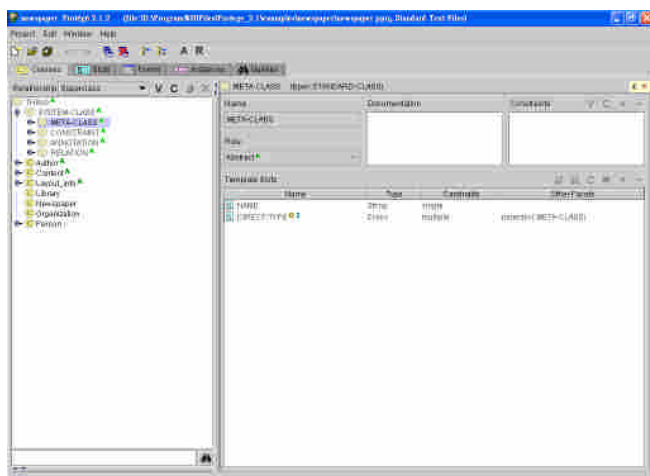


Figure 2.2: The interface of Protégé software

## 3. Developing ontology for knowledge representation

Ontology is a formal, explicit specification of a shared conceptualization. The following points present a set of terms used in ontology design for building ontology [7, 8] :

- **Taxonomy** consists of a set of terms that alongside their definitions and relations among them form ontology.
- **Concepts/Classes** are general, abstract or concrete notions within a domain of discourse. Ontology is formally describing a domain by describing its concepts.
- **Relations** represent “ a type of interaction between concepts of the domain”
- **Slots/Roles/Properties** represent the various features and attributes of a concept.
- **Facets** describe restrictions on slots.
- **Instances** represent elements.

One methodology proposed by Uschold and King is based on the experience gained within the Enterprise Ontology project. It provides guidelines for developing ontology as follows [2] :

- Identify purpose — why the ontology is being built and what its intended users are.
- Building the ontology
  - Ontology capture — a middle-out approach for identifying the most important concepts rather than most general or most particular ones, followed by generalization and specialization process in order to obtain the remainder of the hierarchy.
    - Identification of the key concepts and relationships in the domain of interest.
    - Production of precise unambiguous text definitions for such concepts and relationships.
    - Identification of the terms to refer to such

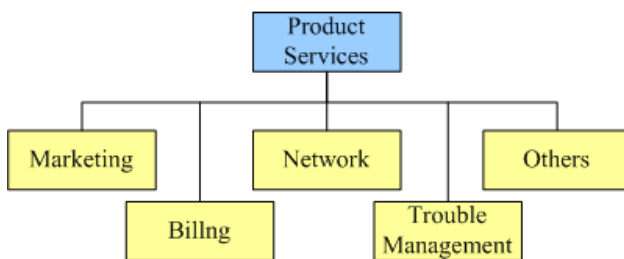
concepts and relationships.

- Coding — explicit representing the knowledge conceptualization captured at the sub-step above, in a formal language.
- Integrating existing ontology — during either or both of the capture and coding processes, there is the question of how and whether to use ontologies that already exist.

### 3.1 Interview with Telecom's specialists

Before constructing the ontology, we start to interview with employee of Telecom Corporate and collect various kinds of FAQs such as Product Services, Product Properties, Operation Guides, Operation Instructions and Other Issues. Each kind of FAQ has more than 30 questions, and then we try to understand their FAQ scenario and architecture from the interview.

Taking Product Services for example, there are 35 issues to describe this kind of FAQ and they have divided it into five parts. The issues can be shown in Table 3.1 without any classification. The user is also not easy to search from it; hence they have divided it as Figure 3.1. In Figure 3.1, it can be viewed as simple classification. The Telecom Corporate also built a website to represent it and tried to use this architecture to explain their FAQ of Product Services. But the result does not satisfy them. The suitable question cannot be found exactly because of their system.



**Fig 3.1: Categories of FAQs in the raw data**

**Table 3.1 FAQ of Product Service**

Frequency Ask Questions of Product Service
1. Are we hand over the expense of usage of network and dial up activities in the same time?
2. Do you have premium on the website anytime?
3. Do you have updated news information on the website anytime?
4. How could I get the e-mail account of broadband of local LAN community?
5. How could we apply for stopping the service after setting up the broadband of local LAN community?
6. How could we apply for the network service of frame relay transmission?
7. How could we apply for the service of ISDN as the backup dedicated line?
8. How could we apply for the service of ISDN?
9. How could we apply the service of fixed connection?
10. How could we communicate with our e-commerce website's service persons?
11. How could we connect to Internet if there are many PCs at one time?
12. How do you charge the service of packet switched network and virtual private network?
13. How does charge for the service of VPDN?
14. How to apply for the service of VPDN?
15. How to discuss with other people on the questions of related product on e-commerce website?
16. How to set up the VPDN dial up activity?
17. If we are already having account, but we still want to join the broadband of local LAN community, can we join without any fee?
18. If we want to join the broadband of local LAN community, how could we do for that?
19. Is it necessary to apply for the broadband of local LAN community if we seldom use it connecting to Internet and paying little about it?
20. Is the existing dial up modem usable?
21. Is there having any real time news information on the website of enterprise e-commerce?
22. There are some interview records of leaders of large enterprise in our e-commerce website?
23. What can we do when forgetting the login password in ISDN dial up activities of monthly payment?
24. What is the critical success factor of establishing the packet switched network?
25. What is the web address and telephone number of the frame relay network transmission?
26. What kinds of facilities do we prepare when we use the transmission of frame relay network mechanism?
27. What's equipment is required to rent of the packet switched data network ?
28. What's the expense when applying the fixed connection? And how to arrange our budget?
29. What's the procedure of applying for the packet switched data network? And how to connect PACNET in the shorten time ?
30. What's the service of virtual private network? Can it contact with other providers?
31. Where can I find relevant terms of e-business on the website and how to inquire it?
32. Where could we look up the question of product usage, production application and the usage of website on e-commerce website?
33. Which ASP providers are collaborated with our e-commerce website?
34. Which brand of router is suggested if we want to apply for the connection to the router?
35. Which entries could provide us to apply for the product in e-commerce website?

### 3.2 Constructing Domain Ontology

According to those ontology methodologies of building ontology, we will follow Identify purpose, Ontology capture and Coding to accomplish parts of customer's queries of FAQs in Telecom Company for implementing domain ontology.

Ontology is useful method in creating FAQs models of knowledge represent in the domain of Telecom Company. Ontology are managed by translation and mapping between different types of entities and attributes. Various ontology for an entity describes its unique characteristics in context with the relationship acquired for a specific purpose or problem. By the following procedure we started to develop ontology for the FAQs using Protégé as the fundamental background knowledge for searching support. In this case, we will use the Product Service to illustrate process of constructing ontology.

From the Table 3.1, we use literatures [3, 7, 8] and discuss with Telecom Specialists, then conclude the result

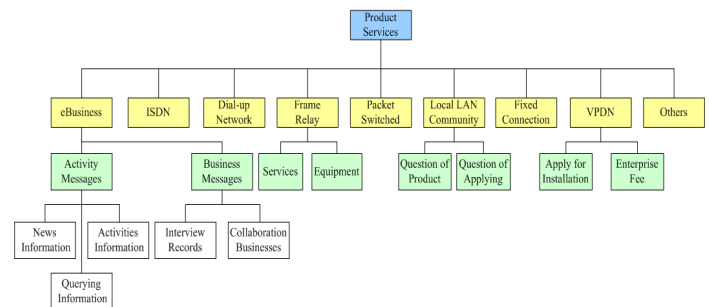
as Table 3.2. In Table 3.2, we divide the result into nine parts. They are e-Business, Local LAN Community, Frame Relay, Packet Switched, Fixed Connection, Dial-up Network, ISDN, VPDN and Others. Although each of them has several issues but it does not enough to illustrate our ontology framework.

**Table 3.2**

eBusiness
<ul style="list-style-type: none"> <li>Where can I find relevant terms of e-business on the website and how to inquire it?</li> <li>Is there having any real time news information on the website of enterprise e-commerce?</li> <li>Do you have updated news information on the website anytime?</li> <li>Do you have premium on the website anytime?</li> <li>There are some interview records of leaders of large enterprise in our e-commerce website?</li> <li>Which ASP providers are collaborated with our e-commerce website?</li> <li>Where could we look up the question of product usage, production application and the usage of website on e-commerce website?</li> <li>How could we communicate with our e-commerce website's service persons?</li> <li>How to discuss with other people on the questions of related product on e-commerce website?</li> <li>Which entries could provide us to apply for the product in e-commerce website?</li> </ul>
Local LAN Community
<ul style="list-style-type: none"> <li>How could we apply for stopping the service after setting up the broadband of local LAN community?</li> <li>If we are already having account, but we still want to join the broadband of local LAN community, can we join without any fee?</li> <li>If we want to join the broadband of local LAN community, how could we do for that?</li> <li>Is it necessary to apply for the broadband of local LAN community if we seldom use it connecting to Internet and paying little about it?</li> <li>How could I get the e-mail account of broadband of local LAN community?</li> </ul>
Frame Relay
<ul style="list-style-type: none"> <li>What kinds of facilities do we prepare when we use the transmission of frame relay network mechanism?</li> <li>What is the web address and telephone number of the frame relay network transmission?</li> <li>How do you charge the service of packet switched network and virtual private network?</li> </ul>
Packet Switched
<ul style="list-style-type: none"> <li>What's equipment is required to rent of the packet switched data network?</li> <li>What's the procedure of applying for the packet switched data network? And how to connect PACNET in the shorten time?</li> <li>What is the critical success factor of establishing the packet switched network?</li> </ul>
Fixed Connection
<ul style="list-style-type: none"> <li>What's the expense when applying the fixed connection? And how to arrange our budget?</li> <li>How could we apply the service of fixed connection?</li> <li>What can we do when forgetting the login password in ISDN dial up activities of monthly payment?</li> </ul>
Dial-up Network
<ul style="list-style-type: none"> <li>Is the existing dial up modem usable?</li> <li>Are we hand over the expense of usage of network and dial up activities in the same time?</li> </ul>
ISDN
<ul style="list-style-type: none"> <li>How could we apply for the service of ISDN as the backup dedicated line?</li> <li>How could we apply for the service of ISDN?</li> </ul>
VPDN
<ul style="list-style-type: none"> <li>How to apply for the service of VPDN?</li> <li>How does charge for the service of VPDN?</li> <li>How to set up the VPDN dial up activity?</li> <li>How could we apply for the network service of frame relay transmission?</li> </ul>
Others
<ul style="list-style-type: none"> <li>What's the service of virtual private network? Can it contact with other providers?</li> <li>Which brand of router is suggested if we want to apply for the connection to the router?</li> <li>How could we connect to Internet if there are many PCs at home at one time?</li> </ul>

Hence, we consider literatures [2, 3] and discuss with specialists to segment all issues. The Fig 3.2 shows part of the ontology taxonomy. From the interview with

experts of Telecom Company, we decided the nine classes of queries. The original FAQs (Fig 3.1) contain five classes less than classes of telecom ontology taxonomy. The main different is the aspect of classification by ontology design between Fig 3.1 and Fig 3.2. It's the resource of knowledge representation base on the outcomes of many times interviews with a number of experts in Telecom Company.



**Fig.3.2 Telecom ontology taxonomy**

The taxonomy represents the concept of telecom productions as classes and their parent-child relationships as "is-a" links, which allow inheritance from parent classes to child classes. Domain experts help us selecting the class that describes domain concepts, slots from attribute and property of concept, facet that describe the restriction of attribute, and instance made up from class. It has inheritance relationship between super and sub classes. Subclass might inherit the slot and its relationship from super class. We create this domain ontology by Protégé software for the ontology-driven searching.

## 4. System implement

This section applies the collecting data from domain experts and then implements it to protégé software. According to product service attributes, this paper combines the similar characteristics and then named it for a uniform name. For instance, we bring out 9 class catalogues for Product Service. Next, we continue to define the subclass、slot and facet. The following section defines the elements of this ontology.

#### 4.1 Definition of ontology

According to the framework in the figure 3.3, this paper presents a definition of class, subclass and slots. First of all, class is composed by 9 catalogues in terms of suggestions that we interview the related employees of telecom corporate. Besides, these classes consist of eBusiness, Local LAN Community, VPDN, Frame Relay, Packet Switched, Fixed connection, ISDN, Dial-up Network and others. Taking eBusiness class for example, it contains all of the activities on e-business of Product Service. Table 4.1 is the class description of telecom ontology.

**Table 4.1: Class definition of telecom ontology**

Class	Description
E-Business	About e-commerce of Corporate
Local LAN Community	About local community network
VPDN	About Virtual Private Dial-up Network, VPDN
Frame Relay	About Frame Relay Transmission
Packet Switched	About Packet Switched Transmission
Fixed Connection	About Fixed Connection network
ISDN	About Integrated Service Digital Network, ISDN
Dial Up Network	About Dial Up network
Others	Other items

Then, we conclude the related characteristic of class and discriminate eight sub classes from Product Service. These subclasses are activity messages, business messages, question of product, question of applying, enterprise fee, service, apply for installation and equipment. Besides, the subclass of eBusiness consists of "Activity Messages" and "Business Messages". Then, Frame Relay class composes by "Services" and "Equipment". Similarly, Local LAN Community class consists of "Question of Product" and "Question of

Applying". Finally, the VPDN class composes of "Enterprise Fee" and "Apply for Installation". The facet of above subclass is "one to many" relation. These subclasses describe as table 4.2.

**Table 4.2: Sub Class definition of telecom ontology**

Sub Class	Description
Activity messages	About messages relates to corporate activities
Business messages	About messages relates to business activities
Question of Product	About the product question of local community network
Question of Applying	About applying question of local community network
Enterprise Fee	About the Expense Fee of VPDN
Apply for installation	About the questions in applying for installation on VPDN
Service	About service of frame relay transmission
Equipment	About equipment of frame relay transmission

Finally, this paper creates slots for each subclass. These slots also describe subclasses' attribute. Each subclass can be represented in Protégé with seven slots. These slots' definition can be described in table 4.3.

**Table 4.3: Slots definition of telecom ontology**

Slots	Description
Subject	About the topic
Keyword	To abstract some words to represent the subject
Text	The thorough descriptions of subject
Data Source	The document is stored in which catalog or path
Document ID	The document number
Published	Whom publish the document
Memo	To provide the messages we must pay attention



## 4.2 Query Examples

According to the telecom ontology framework, this paper use Definition of ontology to implements it by protégé software. We build the ontology example in Figure 4.1. In the left side is a tree shape of class and subclass. In the right side displays the slots of each class.

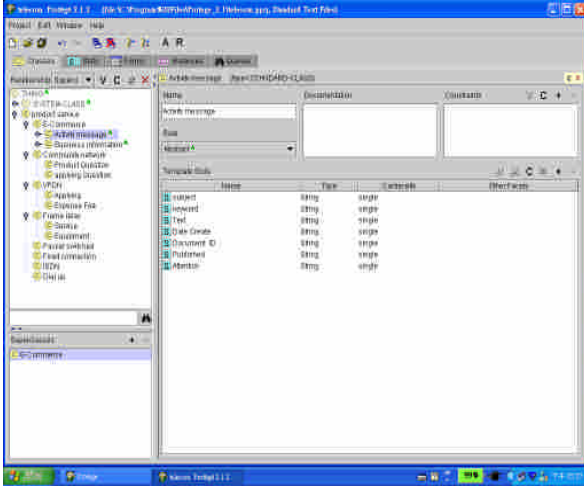


Figure 4.1: Class and Slots

### 4.2.1 System Display

This paper designs an example to simulate the real situation which occurs. Firstly, when telecom employee receiving a phone call about Querying the 「news information」 by customer, employee inputs the keyword 「news」 quickly and submit the request. This System will be response the results to the employee who submits the request. Then, employee will choose the proper answer to reply to the customer who asking the question with taking down the results.

### 4.2.2 Query Display

Taking the query function of protégé, for example, we have created 1 record of Activities Messages which contains several slots showing as figure 4.2.

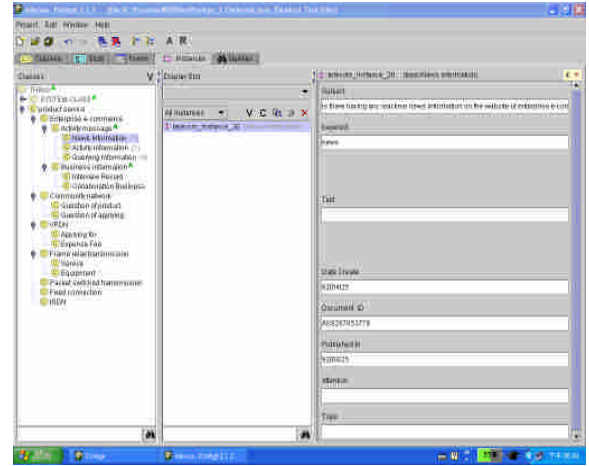


Figure 4.2: Activity message slots and instance

Because of the inherent relation among classes and subclasses, for instance, we could use the keyword function to query the terms of 「news」. Then, the results which are corresponding to the terms will display. Therefore, we might get the result as figure 4.3 and employee could justify the results whether is satisfying the purpose of customer. Finally, we could store the questions and results for knowledge sharing and reuse it in the future.

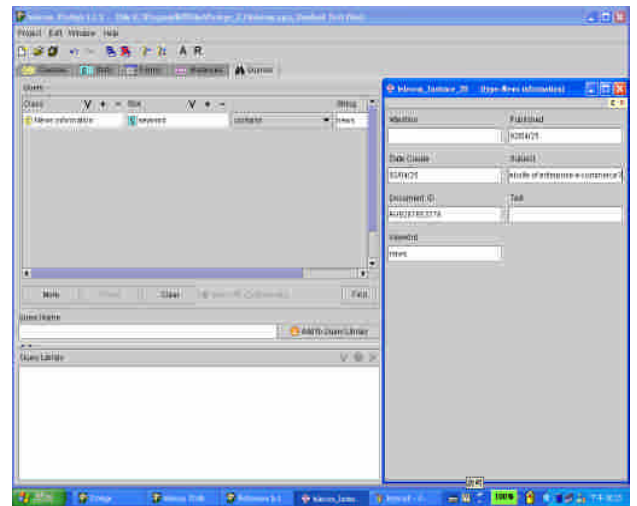


Figure 4.3: The Query condition and result

## 5. Conclusion

In this research, we try to construct a telecom ontology concept model of customers' Q&A. Then we construct this knowledge ontology by using Protégé software.

This ontology will contain facts and relationships between several categories of customer's questions. Hence, our objectives of this research are as following:

1. Analyzing what problems were suffered in the telecom company,
2. Proposing a conceptual ontology for customers' frequency questions domain,
3. Introducing our ontology of customer's Questions,
4. Implementing this conceptual ontology with Protégé software,
5. Illustrating the effective use of ontology through Protégé.

To support ontology effectively, discussion of its information support system for enterprise is necessary. The ontology is used by employees to navigate the information repository of an organization for the effective coordination. Hence this paper proposes a conceptual model of ontology and implements it by Protégé software. After investigating the ontology research, we successfully create a telecom ontology framework and advanced realize the definition \ methodology \ language and the creation process of ontology. This paper recreates the ontology framework contrast to the old ones which is implemented by traditional hierarchical framework. The efficiency seems to become more reliable. On the other hand, we realize that employees in telecom corporate are eager to the need of semantic querying. Therefore, this paper presents the telecom ontology and store the framework as the semantic document. It not only supports the exchange of documents across different platform but also improves the application of semantic web in the future.

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