클라우드 시스템에서 소셜 시멘틱 웹 기반 협력 프레임 워크

Collaboration Framework based on Social Semantic Web for Cloud Systems

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요 약

클라우드 서비스는 비즈니스 향상을 위해 사용되며, 특히, 고객 관리에서는 고객 서비스 향상을 위한 툴로서 소셜 네트워크를 사용한다. 그러나 대부분의 클라우드 시스템은 시멘틱 구조를 지원하지 않기 때문에 소셜 네트워크 사이트의 중요한 정보는 비즈니스 정책을 위해 처리 및 사용이 어렵다. 본 연구에서는 클라우드 시스템에서 소셜 시멘틱 웹에 기반을 둔 협력 프레임 워크를 제안한다. 제안한 프레임 워크는 클라우드 소비자와 서비스 제공자를 위한 효율적인 협력시스템을 제공하기 위해, 소셜 시멘틱 웹 지원을 위한 요소들로 구성된다. 지식획득모듈은 소셜 에이전트가 수집한 데이터로부터 규칙을 추출하며, 이 규칙들은 협력 및 경영정책에 사용된다. 본 논문은 제안한 시멘틱 모델에서 소셜 네트워크 사이트 데이터의 처리 및 효율적인 협력을 위한 클라우드 서비스 제공자의 가상 그룹핑을 위해 사용될 패턴 추출에 대한 구현 결과를 보여준다

ABSTRACT

Cloud services are used for improving business. Moreover, customer relationship management(CRM) approaches use social networking as tools to enhance services to customers. However, most cloud systems do not support the semantic structures, and because of this, vital information from social network sites is still hard to process and use for business strategy. This paper proposes a collaboration framework based on social semantic web for cloud system. The proposed framework consists of components to support social semantic web to provide an efficient collaboration system for cloud consumers and service providers. The knowledge acquisition module extracts rules from data gathered by social agents and these rules are used for collaboration and business strategy. This paper showed the implementations of processing of social network site data in the proposed semantic model and pattern extraction which was used for the virtual grouping of cloud service providers for efficient collaboration.

☞ keyword : Social semantic web(소셜 시멘틱 웹); cloud computing(클라우드 컴퓨팅); collaboration system(협력시스템); association rule mining(연관규칙마이닝)

1. Introduction

The Cloud has emerged recently as a new computing paradigm for the provisioning of application services and computational resources via the Internet, and it provides an efficient way to share resources within organizations and promote business strategy. Application solutions in the Cloud, social network services [1] and cloud infrastructure [2] are popularly used as tools by business establishments to make work easier for employees and to improve collaboration with their business partners. Small business can also benefit from using cloud computing by not having the need of deploying physical infrastructure like file servers, e-mail servers, storage systems or computational resources. To further enhance the business service offerings, customer relationship management (CRM) systems have examined the ways of people and businesses are using social networking sites.

Social networks have become excellent tools for businesses by informing customers or consumers about their services, as well as to establish the means of communication with their customers. New emerging standards for business like Enterprise2.0[3] are using social network as a

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collaboration tool for business processes. Social network services (SNS) can help businesses use sales data, automate marketing decisions and inform consumers of appropriate services based on the data retrieved from the social network sites. However, Enterprise 2.0 lacks of automation of processing semantic information. Moreover, it is very difficult and time consuming to read, filter and analyze manually the information on social network sites. A semantic model for automation is necessary to gather the information and extract knowledge from the vast amount of data that can be found within the social network sites. This requires a semantic model and appropriate components for gathering of information in the social network sites.

This paper presents a collaboration framework design for cloud system based on semantic web. The proposed framework provides a semantic structure in gathering information from social network sites, and the service provisioning and resource management of a cloud system are integrated with the semantic model to process the information. Agents and system components are used to process the social information for service provisioning and provide efficient collaboration among the cloud service providers.

2. Background and Related Works

2.1 Software-as-a-Service

Software-as-a-Service (SaaS) is a shift from software products to services [4], and nowadays, is popularly used to support business operations. SaaS is a delivery model for software applications using Internet as its medium and provides flexibility to both providers and customers [5]. On the customer side, SaaS eliminates complex configurations and time-consuming installations. A cloud service consumer only needs, at least, a standard web browser to access the software application. On the provider side, SaaS enables the reuse of a software application and supports many clients using a common infrastructure. A study in [6] shows that open, modulated, and standardized software will take a significant market share compared to the traditional commercial off-the-shelf (COTS) solutions. With SaaS, providers can also easily collect detailed information about defects, performance and usage trends to improve their services. Job requests from application services will be delayed if there are many clients accessing a service. Dynamic replication of services is proposed in [7] to support the increase of service demands from cloud consumers. Providing efficient negotiations in the Cloud [8] and selecting the appropriate cloud services [9] promote effective service provisioning for service consumers. Developers and researchers continue to introduce more solutions for business such as using social networks for customer relationship management (CRM) and efficient collaboration [1].

2.2 Social Network and Semantic Web

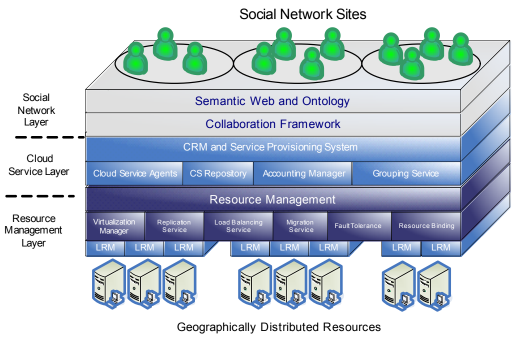
A social network is a social structure made up of individuals (or organizations) called “nodes” which are tied (connected) by one or more specific types of interdependency, such as friendship, kinship, common interest, financial exchange, dislike, sexual relationships, or relationships of beliefs, knowledge or prestige [10]. In its simplest form, a social network is a map of specified ties, such as friendship, between the nodes being studied. The nodes to which an individual is thus connected are the social contacts of that individual. These concepts are often displayed in a social network diagram, where nodes are the points and ties are the lines. The semantic web is a group of methods and technologies to allow machines to understand the meaning – or “semantics” – of information on the World Wide Web. The term was coined by World Wide Web Consortium (W3C) director Tim Berners-Lee [11]. He defined the Semantic Web as “a web of data that can be processed directly and indirectly by machines.” The Semantic Web is mainly used to describe the model and technologies proposed by the W3C [12]. These technologies include the Resource Description Framework (RDF), a variety of data interchange formats (e.g. RDF/XML, N3, Turtle, N-Triples), and notations such as RDF Schema (RDFS) and the Web Ontology Language (OWL), all of which are intended to provide a formal description of concepts, terms, and relationships within a given knowledge domain. Enterprise 2.0 is the use of “Web 2.0” technologies within an organization to enable or streamline business processes while enhancing collaboration - connecting people through the use of social-media tools. Enterprise 2.0 aims to help employees, customers and suppliers collaborate, share, and organize information.

In Social Semantic Desktop (SSD), web services and desktop applications provide a means to build the semantic bridges necessary for data exchange and application integration [13]. The SSD transforms the conventional desktop into a seamless, networked working environment, by loosening the borders between individual applications and the physical workspace of different users. The annotations from associated events and individuals are used for effective collaboration within the organization. In [14], the support from various components of semantic web is used to extract the necessary information from Weblogs. The previous works did not include the inter-organizational collaborations, especially, in the cloud environment. In our work, a social semantic collaboration framework for cloud system is proposed. Our work extends the SSD by using the proposed framework as a collaboration tool to other organizations to improve business strategy among organizations.

3. Cloud System using the Social Semantic Collaboration Framework

The proposed cloud architecture supports the information processing and knowledge extraction in social network sites for the service provisioning and collaboration of cloud service providers. In our previous work [15], service provisioning is define as various methods on how to automate the functionality of a cloud service like initializing, metering the use, finding, grouping, etc. The proposed social semantic collaboration framework for the cloud system is shown in the upper layer of Figure 1.

Most of the components in the cloud service layer and resource management layer have the same functions as in our previous work [15]. In the social network layer, the social network sites are used as inputs for the Social Semantic Collaboration Framework (SSCF). The data from social network sites are processed to become knowledge and used in the proposed framework. Examples of input data are profile information and post messages from a social network sites. These messages are parsed by the social agent and



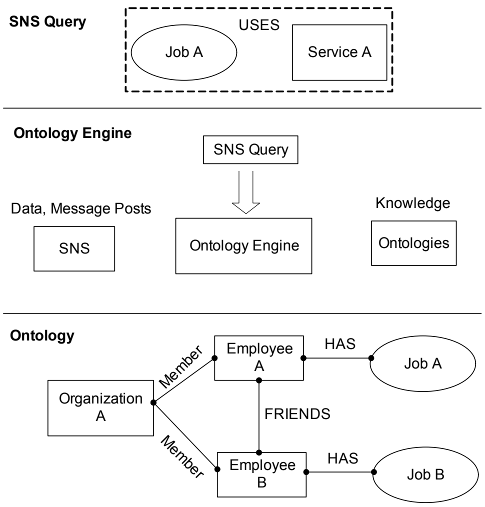
(Fig. 1) Collaboration Framework for Cloud System based on Social Semantic Web.

automatically form the ontology of the message.

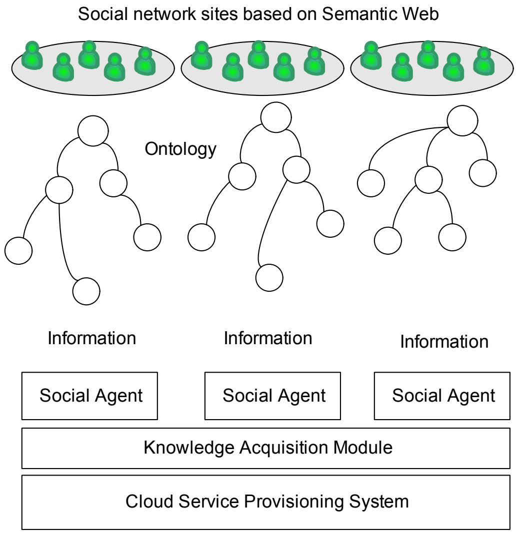
3.1 Social Semantic Collaboration Framework

The proposed collaboration framework extends the functionalities of a cloud system by using the social semantic web tools in extracting relevant information from social network sites. The following are the components of the proposed framework:

- Social network site (SNS) – post messages and profile information from SNS are used as data to be processed to the proposed framework.
- Semantic Web and Web 2.0 – technologies that SNS uses in gathering information and extracting knowledge.
- SNS Query – a form of query from cloud service provider to gather information from social network sites.
- RDF and Ontology Engine – technologies used to represent knowledge (RDF) and process ontology which is used for the service provisioning. The ontology engine uses the OWL to process the knowledge in the proposed framework.
- Social agents – gather information from the social network sites using SNS query and inform a cloud service agent of its knowledge from data analysis.
- Cloud service agents (CSA) – performs service provisioning to service consumers and collaboration



(Fig. 2) A SNS Query processed in the Ontology Engine and Ontology is an output from Ontology Engine.



(Fig. 3) Knowledge Acquisition Module for the service provisioning in SSCF.

to other service providers based on the analysis of a social agent.

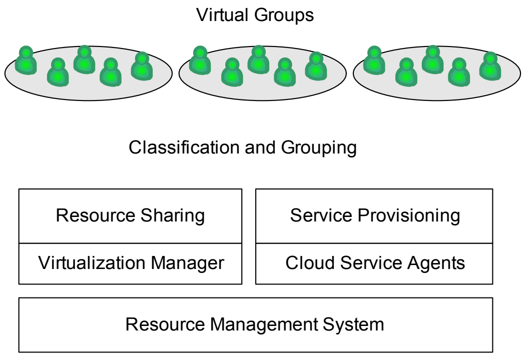
- Knowledge Acquisition Module – processes the information gathered by the social agent.

The SSCF uses the SNS Query which is defined by the cloud service providers to query the needed information. Figure 2 shows the processing of a SNS Query using the ontology engine. A SNS Query shown in Figure 2 is a query for *Job A* which is associated with *Service A*. The outputs are automatically formed by processing in the ontology engine. An example of an output from the SNS Query is shown at the bottom of Figure 2 which is the ontology of a specific SNS user (*Employee A*) with a link friend (*Employee B*) and both of them are members of *Organization A*. A user profile page that has *Job A* attribute in a social network site returns an ontology output. After gathering the ontology outputs, these are processed using a selected data analysis to extract important information. An example of data analysis is using association rule mining to extract the association patterns from the gathered ontology outputs. This information can be used to determine the trends of cloud services and triggers necessary actions based on the result of analysis. In this paper, the association rules are used to determine the associated services with the service of a cloud service provider which will be the basis of forming the virtual group with the selected cloud service providers.

3.2 Virtual Grouping of Cloud Service Provider in SSCF

The collaboration of cloud service providers is supported by the proposed framework. Figure 3 presents the knowledge extraction model of the framework for the cloud service provisioning using social agents and knowledge acquisition module.

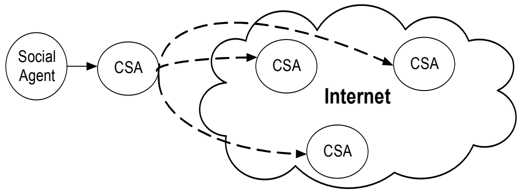
Figure 3 is the general procedure of the information gathering from social network sites which includes a data analysis for the service provisioning. The social network sites are based on the semantic web technology and these are sources of inputs for the knowledge acquisition module. At first, the information that will be used for collaboration is gathered by a social agent. The gathered data are preprocessed in the Ontology Engine and then the structured data are processed in the knowledge acquisition module. Based on the knowledge extracted from the data in the



(Fig. 4) Classification and grouping for resource sharing and service provisioning.

knowledge acquisition module, the social agent informs the cloud service agent which services are associated to their services. In [16], studies the procedures for trusts of the cloud providers. However, the trust and authentication is not tackled by this paper but focuses on how the extracted information will be used for collaboration. The knowledge acquisition module in Figure 3 can consist of several data mining functions to perform the extraction of knowledge. Rule patterns and classification of information as output from a data mining process are used in prediction and business strategy. The rules also can trigger specific action after it determines the outcome from the result of data mining. In Figure 4, the classification and grouping of the virtual groups is shown.

After the knowledge acquisition illustrated in Figure 3, the service provisioning identifies an individual or a group that will performs its provisioning of service. This includes the identification of possible individuals or group interested with the services to embed or advertise the services on their personal or group webpages. In the resource management, the service partitioning method promotes the efficient virtualization and management of resources. The resource management is consisted of several components to accomplish the distributed resource management [15]. Moreover, virtual groups can share resources which are managed by the virtualization manager shown in Figure 4. The groups use a resource binding in able to share resources. Organizations or social groups are provided with procedures of trusting, authenticating and security to the



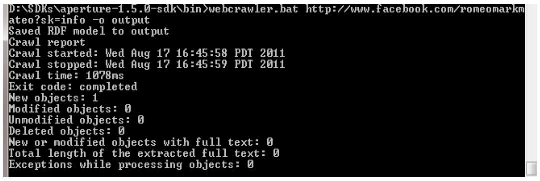
(Fig. 5) Collaboration of cloud service providers using the data analysis from social agent.

members of a group. Negotiations are performed by the cloud service agents before forming the virtual group illustrated in Figure 5.

In Figure 5, the collaboration is formed by the virtual groups. In this procedure, a social agent informs the CSA about its data analysis. Based on the association of services usage, the information is used to satisfy the consumer demands, e.g., a frequent rule pattern reflects that using a document processing application will also use a spreadsheet application. The social agent identifies the cloud service providers involved based on the data analysis to initialize the collaboration. In forming the virtual groups, negotiation among the chosen cloud service providers are done before they can collaborate. The cloud service agent sends proposals to each cloud service provider identified in the rule pattern.

3.3. Extracting Knowledge in SSCF using Association Rule Mining for Virtual Grouping

In [17], the problems and techniques in social analysis and mining from business applications are discussed. The data mining techniques should provide a critical perspective on business applications of social network analysis and mining. In our proposed framework, data are gathered from social network sites, and then these are processed using data mining techniques. Association rule mining is used to determine the frequently used services and its associations to other services usage. These frequent itemsets in the transactions of accessed services are extracted using the apriori algorithm. There are two steps of the apriori algorithm which are; 1) join step which generates the candidate patterns by providing all the combinations from



(A)

(B)

(Fig. 6) Crawling of Facebook profile page (A) and RDF output from crawling (B).

each itemset and 2) prune step which chooses the frequent pattern from the combination sets. The join step finds L_k, a set of candidate k-itemsets by joining L_k-1 with itself. The prune step generates C_k as superset of L_k, and all of the frequent k-itemsets are included in C_k. Choosing the frequent patterns are based on support count and selecting the rules uses a confidence value. The support count (*s_count*) determines the frequency of each pattern shown in Equation 1 where A and B are two items from L_k. The probability of AUB is shown in Equation 1. After the support count, the confidence is determined by getting the ratio of support count of each item (A) in an itemset (AUB) shown in Equation 2. The A->B is a rule extracted after calculating the confidence.

$$s\_count(A,B) = P(A \cup B) \tag{1}$$

$$confidence(A \rightarrow B) = \frac{s\_count(A \cup B)}{s\_count(A)} \tag{2}$$

After pruning, the rules are collected in R which will be used to determine the associations of cloud services and will be the basis of virtual grouping. Equation 3 presents the pruned rules (R) are used in virtual grouping represented by VG.

$$VG = f(R,S) \tag{3}$$

The f in Equation 3 is a function to select rules filtered by $S = \{s_1, s_2, \cdots, s_n\}$ where s_n is a cloud service and S are cloud services from a cloud service provider. If a rule contains services from the cloud service provider then this is used for the virtual grouping. The owners of associated cloud services are then identified. After identifying, the CSA will find the CSA of the identified cloud service provider and will try to form the virtual group illustrated in Figure 5. The rules are not limited in forming virtual groups, but also, these rules are used by experts and for decision making to improve services.

4. Implementation and Performance Evaluation

In our work, the group of cloud service providers used the technology of SSCF to enable collaboration by forming virtual groups. The result from the association rule mining reveals the frequent pattern of cloud consumer in using services which can also be used for business strategy. Virtual grouping offers an opportunity for cloud service providers to collaborate and form a contract so that it will be easy for cloud consumer to find related services.

4.1 Implementation

The SSCF was developed using the Java 2 SDK and the Aperture framework [18], and these were integrated in the cloud system of our previous work [15]. The Aperture is a Java framework for extracting and querying full-text content and metadata from various information systems (e.g. file systems, web sites, mail boxes) and the file formats (e.g. documents, images). We extended the Aperture framework by including the library classes of our SSCF. To find a cloud service, a user agent was utilized as an interface for the search. Jade Framework [21] was used to implement the agent communications. The structure of SNS query was used to gather information and the SSCF components gathered data by crawling social network sites like the Facebook.com. Figure 6A shows the crawling of information in a user's

(Table 1) Extracted association rules using Equation 3.

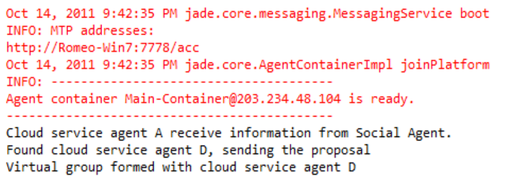
Association rules	S	C
App36 => App57	0.56	0.54
App10 => App36	0.70	0.72
App10 => App7	0.54	0.55
App10, App37 => App57	0.40	0.56
App36, App57 => App110	0.41	0.49

profile of a Facebook account.

The procedure in Figure 6A shows the crawling procedure on the Facebook where the information of profiles and attributes were selected based on the SNS query. The social agents were integrated with the crawling functions. The social agent also crawled the linked friends and family of a Facebook user. The termination of crawling was set manually. In this case, we selected all the information about the profile of a certain Facebook account. The profile data that were available for the web crawling were basic information, education, work and interests. These profile information were structured in RDF using the ontology engine shown in Figure 6B which provided the semantic structure of a Facebook profile. The gathered information was used as inputs for the data mining algorithm.

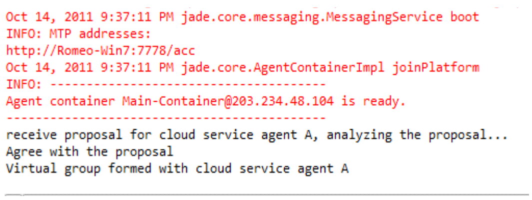
The knowledge extraction module uses a data mining algorithm to extract the information in the social network sites. We identified each user which services or applications he or she uses on his or her social network site account. We used the data from [19] which has 297,000 tuples and each Facebook user varies in number of applications installed. Each transaction is consisted with application IDs that a user installed in its account page. These data were crawled between 08/29/2007 and 02/14/2008. We assumed in our simulation that these data are application services related to business. Apriori algorithm was used to process the rule extraction in the data. After preparing the data, the configuration of Apriori algorithm was set with a minimum support count (S) of 0.4 and a confidence value (C) of 0.4. Table 1 presents the result of the association rule mining with its corresponding support and confidence values.

In Table 1, extracted rules using Equation 3 are shown,



```
Oct 14, 2011 9:42:35 PM jade.core.messaging.MessagingService boot
INFO: MTP addresses:
http://Romeo-Win7:7778/acc
Oct 14, 2011 9:42:35 PM jade.core.AgentContainerImpl joinPlatform
INFO: ----------------------------------------
Agent container Main-Container@203.234.48.104 is ready.
--------------------------------------------
Cloud service agent A receive information from Social Agent.
Found cloud service agent D, sending the proposal
Virtual group formed with cloud service agent D
```

(A)



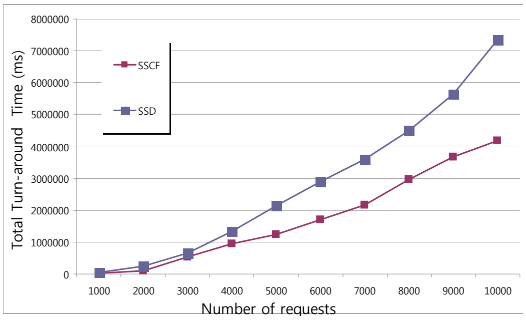
```
Oct 14, 2011 9:37:11 PM jade.core.messaging.MessagingService boot
INFO: MTP addresses:
http://Romeo-Win7:7778/acc
Oct 14, 2011 9:37:11 PM jade.core.AgentContainerImpl joinPlatform
INFO: ----------------------------------------
Agent container Main-Container@203.234.48.104 is ready.
--------------------------------------------
receive proposal for cloud service agent A, analyzing the proposal...
Agree with the proposal
Virtual group formed with cloud service agent A
```

(B)

(Fig. 7) Forming of virtual groups by negotiations from cloud service agent A (A) and cloud service agent D (B).

where => means the association of each item, e.g., If App36 is used and then App57 is also used with 0.56 support count and 0.54 confidence values. The association rule mining produced 46 rules and only 5 rules were identified with the application provided by the cloud service provider. A single rule was used to determine the associated services. These rules are used to form the virtual grouping by identifying the possible individual or group interested for collaboration. Figure 7 shows the implementation of negotiations in forming virtual groups.

The implementation of cloud service providers' negotiations and virtual grouping is shown in Figure 7. In Figure 7A, the CSA A received the information from the analysis of the social agent. The information contains the name and URL address of the cloud service agent that was identified in the association rule. After the CSA D received the proposal of CSA A, the proposal will be analyzed based on the configuration of a cloud service provider. In our implementation, we simply configured that the cloud service provider accepts all proposals. In Figure 7B, CSA D accepts the proposal and then forms the virtual group. Moreover, using virtual groups in the proposed framework can provide resource binding to improve the resource sharing and implement an efficient load balancing strategy.



(Fig. 8) Total turn-around time of requests using SSCF and SSD.

4.2 Performance Evaluation

The efficient collaboration of cloud service providers is acquired by using our proposed framework, and this can employ various strategies of collaboration, e. g., having an agreement of providing link pages to each other web page. In this method, it is easy for customers to associate his/her needed services.

To compare the performance from collaboration of cloud service providers, a discrete event simulation using simVO in [15] was done. The simulation environment was consisted of 100 nodes representing the cloud service providers and the virtual grouping was processed using the data from Section 4.1. The total turn-around throughput time from 1,000 to 10,000 client requests in Figure 8 was observed to measure the response time of using SSCF and SSD. A normal query without virtual grouping simply tried to find the cloud service within the network, and after it found a correct cloud service, the results were returned to the client. In SSCF, the information about related services with address of nodes were returned to the client and so for the next queries, it already has the node address of the related service.

In Figure 8, the collaboration of cloud service agents by forming the virtual groups produced faster response time to queries. Table 2 shows the comparison of proposed framework to other previous works.

Table 2 shows the comparison of SSCF to other existing frameworks. The collaboration in SSD [13] was performed manually by annotating the events and individuals within the organization. In [14], the social network data were automatically analyzed. The LJminer uses a SNA to provide automation of the semantic analysis, however, it is only used for personal recommender. Our work extended the functionalities in [13] by supporting the collaboration among businesses based on the result of analysis from the knowledge acquisition module where inter-organization is enabled. The OntoWiki [22] provides an inter-organization but is only applicable for public use. In Table 2, only the SSCF supports the collaboration within inter-organization for businesses because of the agent-based negotiations and virtual grouping of cloud service providers provides a customizable collaboration specifically for businesses.

(Table 2) Comparison to other existing frameworks.

Framework	Data Analysis	Application	Collaboration
SSCF	Association rule mining	Business	Inter-organizations
SDD [13]	Annotation	Private Business	Intra-organization
LJMiner [14]	Social network analysis	Private	Personal Recommender
OntoWiki [21]	Wiki	Public	Inter-organizations

5. Conclusions and Future Work

Cloud computing is an emerging computing paradigm and apparently, there will be a need for new technologies and innovations to exploit. It is hard to acquire the collaboration from the business area, especially for large companies. But, there are already initiatives and research projects like in [20] which provide collaboration for small and medium enterprises (SME). This paper presented a collaboration framework design for cloud system based on a social semantic web. The proposed framework provided a semantic structure for the data gathering from social network sites where the service provisioning and resource management for the cloud system were integrated with the semantic structure. Moreover, the social agents and cloud system components were used to process the social information for service provisioning and improved the resource sharing of virtual groups in the cloud system. This paper presented an implementation of the proposed framework by crawling a social network site, processing the data based on semantic structure, and mining the transactions using association rule mining for knowledge extraction. The extracted rules were used for virtual grouping and collaboration among cloud service providers. Moreover, shown in Figure 8, the collaboration of cloud service agents produced faster response time by providing additional information to clients about the other cloud services within its group.

This paper presented the design of the collaboration framework based on social semantic web and the future work will include the appropriate algorithms which are necessary for the knowledge extraction module. Moreover, for effective negotiations, we will also study the efficient negotiations for cloud service providers.

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