Formation of Knowledge Sharing System for Asia-Pacific Countries by Using Modern Information Techniques

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Abstract: This paper describes the establishment of an e-Learning platform for Asia-Pacific countries where teachers and researchers of this region can share their knowledge and collaborate in education and research activities in order to face the challenges of the rapidly changing world. In the first part of the paper, the present e-Learning status, scopes and constraints in the Asia-Pacific region have been briefly discussed. In the later part, the technical issues regarding the development and implementation of the knowledge sharing system (Knowledge Integration Servers System for E-Learning: KISSEL) is explained. From the test results and feedbacks from the teachers' communities in the project member countries, it has been found that the KISSEL is useful for the improvement of education and research activities in Asia-Pacific countries.

Keywords: e-Learning, Knowledge-sharing, KISSEL, Data Synchronization

1. Introduction

The term e-Learning caught the attention of the educators for the first time in the 1990's when the Internet started to spread very quickly. Although it has a relatively short history of about two decades, it has become an important issue in universities, research organizations, high schools etc. In relation to e-learning/education, there are some commonly used terms, i.e., online learning/education, distance learning/education, web based learning/training, computer based training/learning/education. There are quite a few definitions of e-Learning. Hence, it is difficult to find a concrete definition of e-Learning. In this paper, let us consider that e-Learning is "The use of new multimedia technologies and the Internet to improve the quality of learning by facilitating access to resources and services as well as remote exchanges and collaboration" [1]. So an important characteristic of e-Learning is the interactivity with the learners. Interactive multimedia technologies are engrossing. It provides the opportunity for deep involvement, which captures and holds learner interest.

As far as the level of e-Learning in Asia-Pacific countries is concerned, they are still backward compared to developed countries. The KISSEL project, which was started by a research group of Ibaraki University, Japan, is a new approach for the improvement of e-Learning in these countries. The term KISSEL stands for "Knowledge Integration Servers System for **E-Learning**" and it is a knowledge sharing system which is designed to cater to teachers' communities in Asia-Pacific countries [2]. The reason why the target area is restricted to Asia-Pacific countries is that the degree of the development of ICT infrastructure and also the e-learning environment is similar in these countries and the knowledge to be shared is similar in character. KISSEL is developed to provide resources (especially in the form of multimedia e-Learning contents), tools and techniques needed for student-teacher communication and self-learning. The aim of this paper is to report technical aspects of the development of KISSEL project and its functionalities.

2. KISSEL : Knowledge Integration Servers System For E-Learning

2.1. Present e-Learning status in Asia-Pacific region

The e-Learning is still at the beginning phase in developing Asia-Pacific countries. Due to the underdeveloped economy, these countries could not yet establish a reliable ICT infrastructure which is one of the basic requirements for an effective e-learning system. Hence, most of the learners in these countries are not yet familiar with the term "e-Learning". There are a few major issues like national strategy, connectivity, accreditation, acceptability, quality of the learning materials, and relevant contents that have to be considered for any e-learning program [3]. Another critical concern raised on the e-Learning activities is the cost perspective. Learners of the developing countries have financial constraints to participate in the program which is too costly for them. They have limited scopes to get the learning facilities as it relates with high-tech equipment, in many cases. So, for the developing countries, they need to reframe the strategy of e-Learning to make it familiar in the communities more effectively. The aim of the KISSEL project is to encourage teachers in Asia-Pacific countries to set up communities of e-Learning among themselves and to share knowledge in the form of e-learning

materials. Even though, e-Learning has not yet been properly introduced to the people in this region, the majority of the teachers in these countries believe that the e-learning method will contribute in realizing better education systems in their countries. In recent years, all the governments in this region are investing in ICT to improve the quality of works in all sectors, especially in the education and training sectors. Schoolnet, skool and e-Village projects in Sri Lanka [4, 5], e-book project for school students in Bangladesh [6] etc., are examples of such efforts.

2.2. Overview of KISSEL

The basic idea of KISSEL is to set up a server system, which works as a web portal, where teachers can have the opportunity to have their own network among themselves. The point is that the server works as a platform not only for exchanging their idea but also for sharing their modern techniques and useful teaching materials for e-Learning. One of the reasons why this system concerns about teachers is that they are always keeping contact with students. Therefore, they can become the best interface to transfer ICT to the young generation. Teachers should first gain or have interest in the use of ICT. The teachers should help each other to promote their skills for ICT. In order to do this, we note the role of teachers' community.

Figure 1. Basic structure of KISSEL

KISSEL is composed of several server machines which are settled in different countries in the Asia-Pacific region. They work cooperatively. Figure 1 illustrates how KISSEL works. There are two parts in each of the KISSEL servers, i.e. the international sector and the local sector. The local sector is designed and developed by the hosting country in their native language or in English. The local sector is freely used for domestic proposes. The contents of the local sector which are worth sharing in the other countries are translated into English and are put in the international sector [7]. We believe that the native language is best suited in education because it can teach or reaches the students more closely rather than a foreign language such as English. But in order to share knowledge internationally, there should be a common language. Hence, English has been chosen as the language of the international sector, because it is taught as the second language in most of these countries. The contents of the international sector of each KISSEL servers is being copied automatically (see Section 3.4). The content newly uploaded to an international sector of one KISSEL server is reflected to all KISSEL servers by the mirroring function of KISSEL. In such a way, data sharing is being carried out between teachers' communities is Asia-Pacific countries.

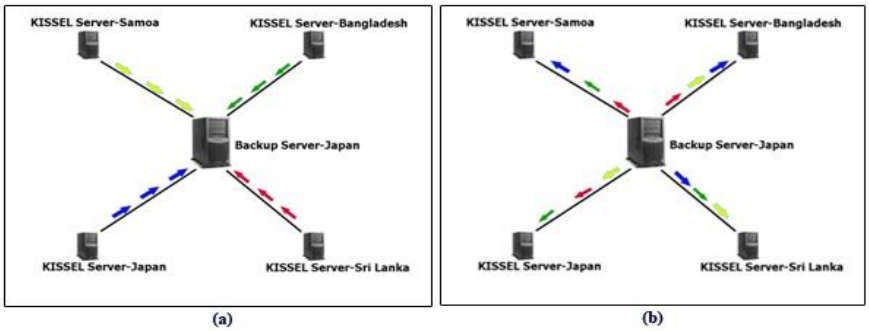

Figure 2. Synchronization process between servers (a) From local servers to Backup server, (b) backup server to local servers

Presently, KISSEL servers are settled in Japan, Sri Lanka, Bangladesh and Vietnam. In near future, KISSEL servers will be installed in some other countries in Asia-Pacific region. Multimedia learning materials such as videos, audios, animations etc., are mainly focused in the KISSEL project. Dealing with the heavy e-Learning materials in the KISSEL system, the available Internet bandwidth and the ICT infrastructure in these countries are main things to be considered in this study.

2.3. Why a new system is needed?

By character, KISSEL is similar to the so called "Contentment Management Systems, CMS" as well as the "Social Networking Services, SNS". Therefore, a question may arise here, "why a new different system is needed? ...why don't we use a platform that is already established?" The answers are the followings:

(1) The aim of KISSEL is not to produce uncertain relationships between many and unspecified people directly over the Internet but to produce connections between certain teacher's communities which already exist in Asia-Pacific countries,
(2) One of the visions of KISSEL project is to share knowledge and experiences in education which are already accumulated in these countries in the forms of their native languages,

Therefore, a special device and mechanism is needed which enables cooperation of teachers' communities in different countries. Alongside (1) and (2), the following factors are also noted. Firstly, the visionary group of KISSEL aims at establishing a user-friendly system so that even the people who lack in ICT capabilities can use the system without difficulties. Secondly, the system should be secure from any Internet attacks. Thirdly, it should be failsafe designed. There are several cooperative KISSEL servers in different countries that if one or more of those get in problem, the others can work as back-ups.

2.4. Management of KISSEL servers

As KISSEL is operating internationally, several levels of user categories were introduced depending on their accessibilities (Fig. 3).

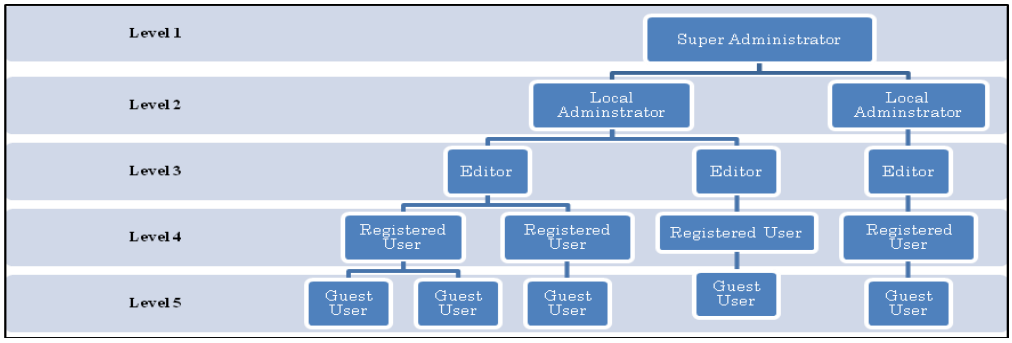

Figure 3. User levels in KISSEL

a). Super Administrator
This user is in charge of the backup server (master server) in Japan (see Section 3.3) and hence the overall system. Super administrator (Level 1) is capable of performing all the functionalities of the system including server management, backup management and so on. Also, he is responsible for the maintenance of the operational level.

b). Local Administrator
The local administrators are in charge of the administration of the servers in their countries. The local administrators are capable of performing tasks such as user management, content category management, learning materials management in the local servers etc. Also they are responsible to carry out system updates and to communicate with editors (Level 3) according to the instructions given by the super administrator.

c). Editor
Editor (Level 3) can upload learning materials and modify own materials.

d). Registered User
The user of this level can view the contents of the system and download them. Also they can put comments, feedbacks and rate the content.

e). Guest The guests can only view abstracts of contents.

3. Development And Implementation of KISSEL

For implementation of the KISSEL system, the evolutionary development model [8] was adopted, which can realize incremental product releases, frequently delivery dynamic plans and processes to users.

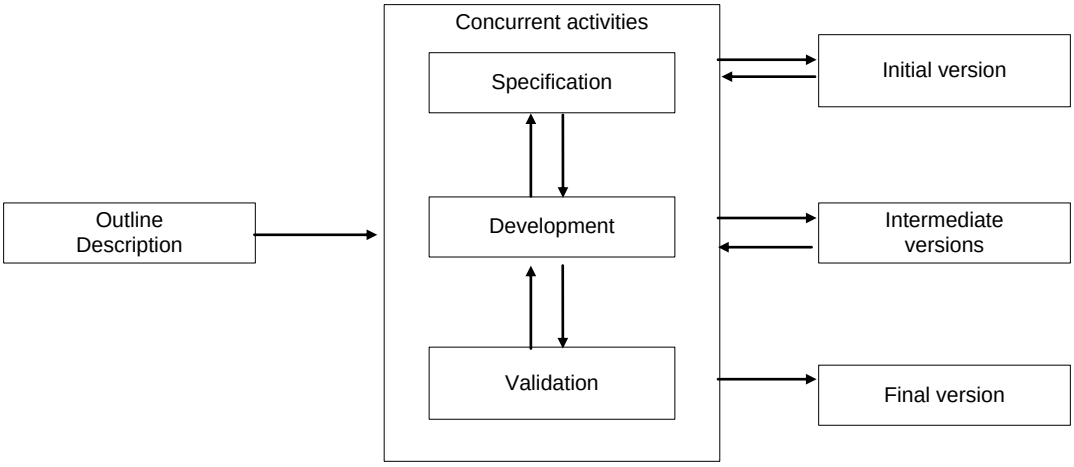

Figure 4. Data flow of the evolutionary model

Look at the Figure 4. The objective is to evolve a final system from an initial outline specification starting with well understood requirements and adding new features as proposed by the end users. Initial version of the system acts as a prototype to help to elicit requirements for the intermediate versions. This process will be repeated until a final system has been delivered.

3.1. Three-Tier Architecture

In order to realize aimed functionalities of KISSEL, the three-tier architecture [9] is used.

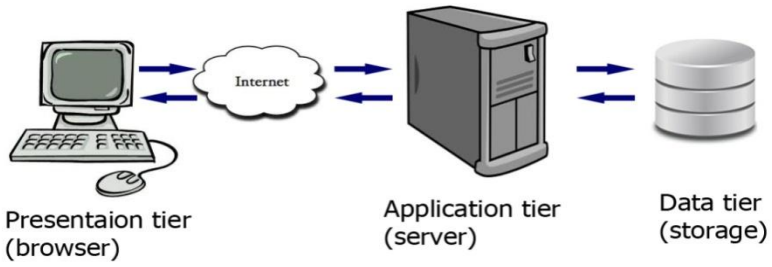

Figure 5 Three tier architecture of the KISSEL

The three tier architecture is composed of presentation tier, application tier and data tier. In the presentation tier, the user interface has to be built to display information to the user and to get input from the user. In this tier, the main concepts of the web application design facilities in the KISSEL system are adopted. The following tools and techniques are used for this purpose: HTML, JavaScript, Adobe Photoshop CS3, AJAX and CSS. Application tier works as an intermediary for data exchange between the presentation and data tiers. The KISSEL was designed to run on Linux based Apache web server with PHP (Personal Home Pages) as the general-purpose server-side scripting language. PHP 5.2 is used in KISSEL system and CentOS 5.6 is used as the server OS.Function of the data tier is to set the database back and forth. Written database queries and stored procedures are used to access the database or to perform any operation to the database. It will get the data from the application tier and send it to database or get the data from the database and send that to the application tier. In KISSEL, MySQL is used as the back-end database which is one of the most popular open source databases because of its high performance, high reliability and ease of use. Many of the world's largest and fastest-growing organizations including Facebook, Google, Adobe rely on MySQL to save time and money powering their high-volume websites, business-critical systems and packaged software [10].

3.2. One KISSEL Server Per Country

To overcome the bandwidth problem [11], the method "one server per country" has been adopted in the KISSEL project. Note that the local server work as a "cash sever". For example, the average bandwidth for international connection in Sri Lanka is nearly 963Kpbs. But within the university system inside the country optical-fiber links, it is ranging from 10 Mbps to 34Mbps, and it is 2 Mbps for links to universities at distant locations where optical fiber is not available [12]. So even large multimedia resources can be accessed very easily inside the country by using KISSEL server located in their own country.

3.3. KISSEL backup server (master server) in Japan

One backup server for KISSEL system has installed in Japan in addition to the Japanese local KISSEL servers. The aim of this backup server is

(1) To make the synchronization process more efficient,
(2) To act as an emergency restoration resource when a server fails in the system,
(3) To make it easy to add more KISSEL local server to the system.

3.4. Data Sharing Process

Data sharing of the KISSEL contents is done in following steps:

I. Contents are uploaded in native language/English in the local sector of the KISSEL local server.
II. The contents worth sharing internationally are uploaded to the international sector of the local server. This process is carried out by local administrator.
III. The newly added data of international sector of each local server is synchronized to the backup server (master server).

3.5. Optimized bandwidth usage

In order to select the best suited time period for the synchronization of KISSEL contents, daily bandwidth usage has to be investigated. Firstly, synchronization performance was analyzed between one local server in Japan and the backup server located in Ibaraki University, Japan. A video file (~35 MB) was used as the test data for this analysis. The synchronization process between these two servers was repeated once in every 30 minutes, and the speed acquired for this process was recorded (Fig. 6). As the servers were located in the same subnet of the campus LAN, this synchronization process affected the internal web traffic only. In the synchronization experiment, both download (from the backup server to the local server) and upload (from the local server to the backup server) speed were examined. The time was recorded in GMT in order to avoid the local time differences in similar synchronization experiments between the local servers in different countries and the backup sever in Japan. From Fig 6, it is clearly seen that there are no significant changes in both upload and download speeds. The average download speed was about 4.5 Mbps and the average upload speed was about 6 Mbps, which are very healthy for synchronization process. It has been found from the experiment that the synchronization can be carried out at any time of the day for two servers located in Japan.

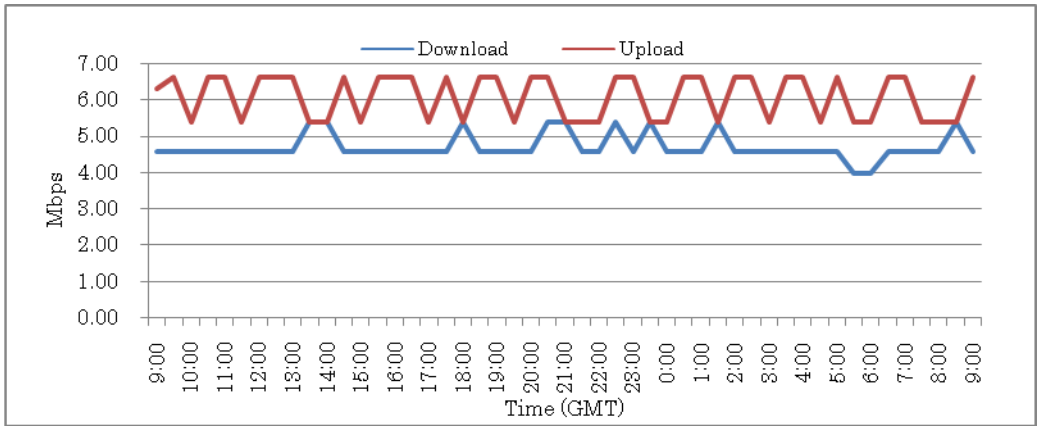

Figure 6. Synchronization speeds between the local server and the backup server in Japan

The similar experiment was carried out between a Sri Lankan local server which is located in the Open University, Sri Lanka and the backup server located in Ibaraki University, Japan. Theoretically maximum speed of 10Mbps is allocated

to the Open University [12]. But, due to the internal demand for the Internet and the network infrastructure, this amount of speed is not available. The same video file was used in this synchronization experiment. Figure 7 shows the results.

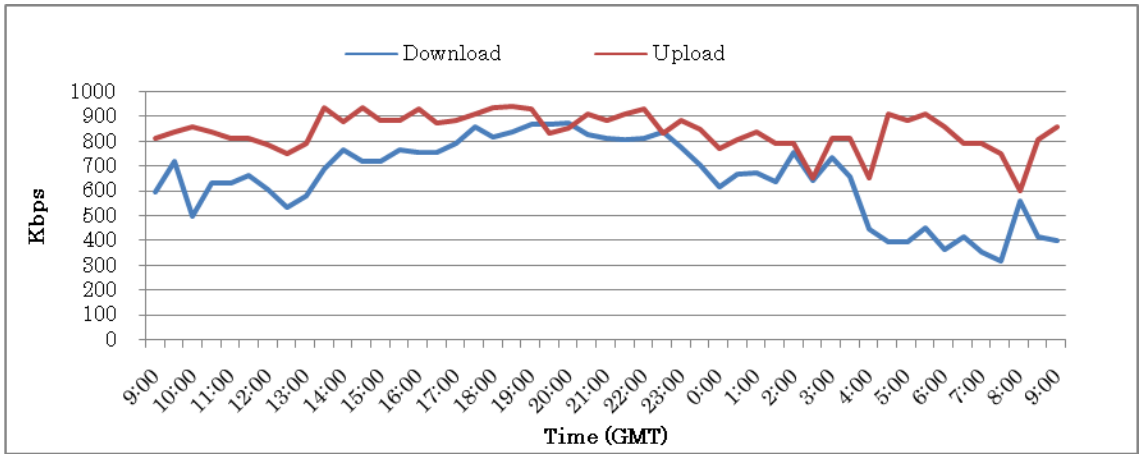

Figure 7. Synchronization speeds between Sri Lankan local server and the backup server in Japan

It is seen from Fig.7 that the maximum download speed is 850 Kbps and the maximum upload speed is 935 Kbps. These values are about one fifth of the data transfer speed between the two KISSEL servers in Japan. Fig 7 shows that the download speed is comparably low between 04:00 to 14:00 GMT (10:30 to 20:30 in Sri Lankan local time) due to the heavy usage of the bandwidth for the university activities. The highest speed of synchronization was recorded between 18:00 to 23:00 GMT (00:30 to 05:30 in Sri Lankan local time). This can be understood that in Sri Lanka, the number of users (mostly students) in the university network in this period is very small and accordingly the download speed is relatively high. Regarding the upload speed, there were no significant differences in time. This is because most of the users only view and download contents and there are very few users who upload contents. Between 14:00 to 23:00 GMT (20:30 to 05:30 in Sri Lankan local time), the upload speed is slightly higher. So the best time period for data synchronization between Sri Lankan local server and the master server is 18:00 to 23:00 GMT. Using the same method, the bandwidth optimized time slot was indentified for each country. The Fig 8 and Fig 9 show results of synchronization experiments between local servers in Bangladesh (located at Rajshahi University of Engineering and Technology, Rajshahi, Bangladesh) and Vietnam (located at the University of Science, Ho Chi Minh City, Vietnam) and the master server respectively.

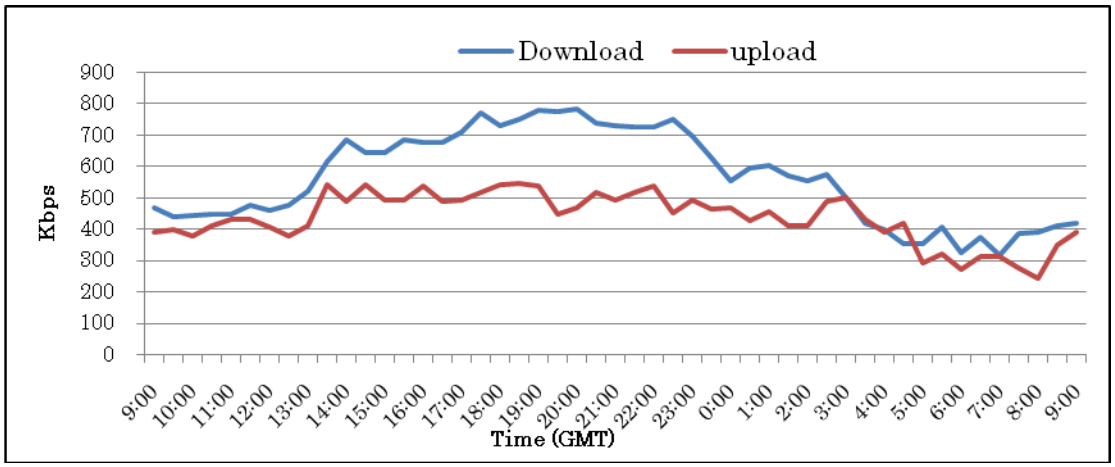

Figure 8. Synchronization speeds between Bangladeshi KISSEL server and master server

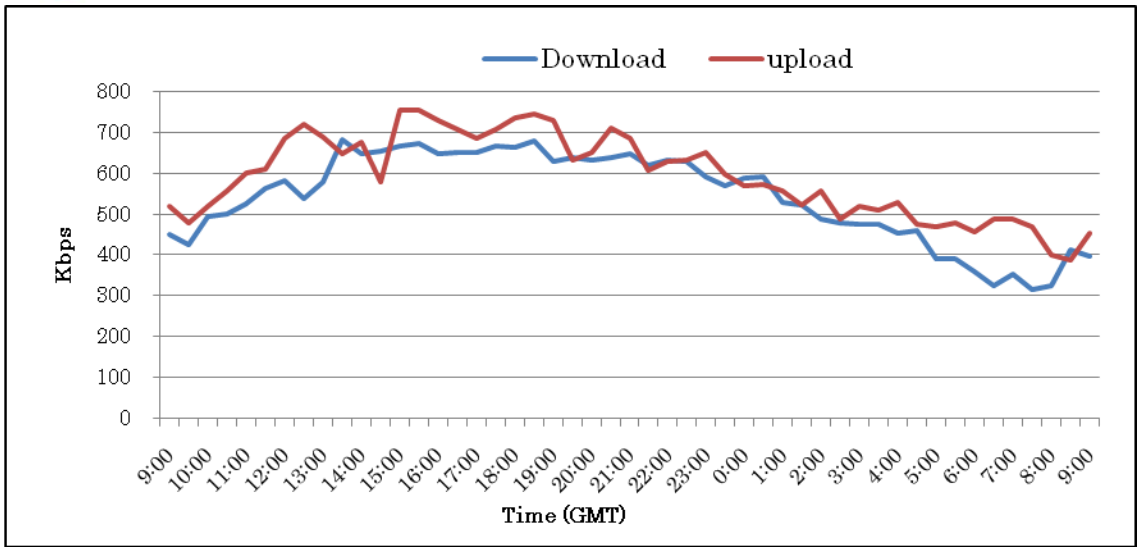

Figure 9. Synchronization speeds between Vietnamese KISSEL server and master server

3.6. Using rsync for synchronization

The *rsync* is a fast and versatile file copying tool available for *Linux* systems [13]. It can copy local contents, to/from another host over the remote shell, or by a remote *rsync* daemon. It contains a large number of options that control every aspects of its behavior and allows very flexible specification of files to be copied [13]. The *rsync* starts working just like other remote file copying methods. But later, *rsync* controls copying of only newly updated part of the file. This makes updates faster, especially over slower links like modems. The other file transfer methods, e.g. FTP, transfers the entire file even if only one byte is changed. Also *rsync* offers a lot of useful functionalities that FTP and other tools don't offer easily. Synchronization between KISSEL server in Sri Lanka (IP: 192.248.73.246) and backup server in Japan (IP: 157.80.97.117) can be carried out by installing the following shell command from 157.80.97.117. rsync –avz –e ssh rsyncuser@192.248.73.246:/home/content/ /home/content But, rsync is a secure shell command so it needs authentication for executing. This issue can be addressed by using the method of *public-key* [14] because the synchronization process between servers must be carried out periodically without human interaction. The automation of synchronization process was carried out by the combined use of *rsync* and *crontab* [15] , where the values determined by the method (see Section 3.5) was used as the synchronization time parameter. Thus, each server is synchronized with master server once a day.

3.7. Synchronization of KISSEL web interface

Although by the *rsync* method all the contents can be synchronized, a separate method must be carried out to replicate the *MySQL* back-end database that is used for KISSEL web-based interface [16], i.e., user management, server management, category managements etc. In this replication algorithm, the two databases in the two servers were compared to each other considering the Added, Modified and Deleted database entries. Firstly, these examinations are done in KISSEL master server, and a daily backup file for future usage is produced. Then, the fresh database from the KISSEL master server is replicated to the other local servers. In this replications, the amount of transferring data are much smaller than the total contents of KISSEL system. Therefore, the bandwidth problem does not occur in this process.

4. Conclusion

The test of KISSEL system performance was successfully carried out in Japan, Sri Lanka, Bangladesh and Vietnam. Also, introductory seminars and workshops on KISSEL have been carried out in the member countries by the members of the KISSEL group working in Japan and it has been found that KISSEL system is completed up to a satisfactory level for the users.

5. Acknowledgement

This work was supported by the Grants in Aid 20500825, the Grand in Aid 24650124 and the Grants in Aid 24300278, Ministry of Education, Culture Sports, Science and Technology, Japan

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