

Setting Up Personal Cloud Server Tonido @ Department of Computer Studies, CSIBER and Integration with Moodle Server - A Case Study

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Abstract— Cloud computing represents a real paradigm shift in the way softwares are developed, deployed and used. Cloud computing, which is based on utility computing has a remarkable contribution in realizing long held dream of utility computing in achieving the development of infinitely scalable and universally available systems as, with cloud computing user can start very small and become big very fast limited only by his/her needs, which means cloud computing is revolutionary even if the technology it is based on is evolutionary. There is a handful of free open source cloud softwares available which guide an end user from setting up of file server to drive mapping and file synchronization. All these utilities are bundled into a single software module. The authors have performed a survey of different open source softwares currently available on Internet and have performed their relative comparisons. A private file cloud server has been installed in the Department of Computer Studies, CSIBER, Kolhapur, MS, India. For sharing and synchronizing files Tonido cloud software is employed. The security has been implemented using role based authentication wherein all inter and intra department communications are modeled by assigning different roles to the users of the system. The drive mapping is achieved at admin and user level using free add-ons available for Tonido. The folder changes are monitored periodically and notification messages are sent to appropriate users instantly. The cloud server enables stream-lining various house-keeping chores such as uploading notices, syllabi for students and also helps in keeping all the documents centralized, structured and updated. The system has rendered the whole process automatic and there is very little chance for committing any mistake which results in extremely effective communication system between users of different categories. At the OS level, security trimming is performed by programmatically editing requisite registry entries using Group Policy Editor, Microsoft management console program at runtime depending on the user logged in and mapping user credentials to the corresponding drives accessible only to that user. Finally, the Tonido server is integrated with institute's Moodle server and the data is synchronized with the help of an interface e application implemented in Java.

Keywords- Cloud Computing, Drive Mapping, File Sharing, Moodle, Open Source, Private Cloud, File Synchronization.

I. INTRODUCTION

Cloud computing is changing the IT. More and more companies take advantage of the benefits that cloud can provide, and the request for cloud professional is continuously increasing. Actually, cloud computing is driving a change in the nature of jobs too, both in the IT department and in other parts of the enterprise as well. One of the most evident effect of the shift to cloud is that it enables delivering the infrastructure to support the next generation workflows and processes, quite a strategic role with big responsibilities. An interesting 2011 study from CA Technologies shows that 71% of CIOs who adopted cloud computing, compared to only 44% of non-cloud adopting CIOs. Greater opportunities are arriving for Enterprise Architects, Cloud Service Managers, Cloud Capacity Planners, Business Architects. In many cases, the managers and professionals working with cloud will be in charge of.

The job market is getting broader and more diverse for software engineers too, in a world where even smart phone games take advantage of cloud storage. Cloud Computing Architect is placed in a critical role to drive the architect/design and implementation for cloud-based solutions. Cloud Computing Systems Engineer has become a member of the system engineering team and will support an initiative to transition internal services to a cloud computing environment. Cloud Alliance Manager focuses on the overall, ongoing management of cloud computing service provider partnerships. Cloud computing will get even more important in the future, where massive storage capacity and calculating capacity will be

required by Big Data a field that many IT Executives agrees on being a major trend in 2014. According to ECPI University' Kenton Searce, "cloud computing is a bigger focus for organizations of all sizes". TriNet's Jason Langhoff sees "a continued shift to cloud-based computing and tech workers versed in cloud related tools and architectures will be at an advantage".

A. Significance of Cloud Computing to Institutions

IT plays important role in education. Cloud Computing is a new technology in the world of IT which emerged recently and began to spread rapidly. Cloud computing is an Internet-based computing services on-demand. Cloud computing has enabled realization of a paperless society. Migration from paper to digital world requires a big leap of faith. For the institutions having information technology infrastructure (wired or wireless) it is easy to implement cloud computing. During reviewing of many instances of using cloud computing in academic institutions, this paper emphasizes that the adoption of cloud computing in academic institutions is useful and sometimes necessary to overcome many of challenges and barriers. The presentation shows that the cloud computing technology enhances the performance in academic institutions as well as cloud computing plays significant role to reduction of costs. As the adoption of cloud computing in academic institutions is still low, this paper provides the factors that affect the adoption of cloud computing in the academic institutions. Successful transition to cloud computing in academic institutions depends on well definition for transition

strategies. This paper provides suggestion for transition strategies into cloud computing in academic institutions.

There are significant advantages associated with storing information off-site on a server that could be located anywhere. The few remarkable advantages are enumerated below:

- **Centralized Data** : Eliminates or minimizes the need for carrying around devices, such as thumb drives or CDs and addresses the issues related to losing the device, breaking the CD, or not having your information load properly.
- **Easy access** : Lesson plans, labs, grades, notes, PowerPoint slides – just about anything digital that is used in teaching is easily uploaded and accessed anytime.
- **Stability**: Cloud computing is now to the point of being a very stable technology that one can rely on.
- **Security**: Data, content, information, images – anything that is stored in the cloud usually requires authentication (ID and password, for example) – so it is not easily accessible by anyone
- **Shareability**: One can share some or all files stored in the cloud. No more obtaining an extra thumb drive or burning another CD or DVD. Just a link to the file(s) destination needs to be sent.
- **Trackability**: Cloud computing will save multiple revisions and versions of a document so that one can chronologically trace back the evolution of an item.
- **Collaboration**: One can set-up various student groups to work on projects and assignments in the cloud.

With cloud computing redundancy, there is no longer the need to both save files digitally as well as in paper format. Cloud computing systems are regularly backed-up, so the chances of losing content are quite small. And, no more file cabinets means more classroom space for you and your students!

The advantages of cloud computing far outweigh any disadvantages. From the administrative perspective:

- Staff and teacher time spent printing, filing, and distributing can be better used on more educationally-directed activities that impact student learning.
- Cost savings in terms of buying, leasing, and maintaining photocopiers and printers, ink cartridges, and paper.
- Return-on-investment by not needing to invest in purchasing, housing, and maintaining servers, software, and related IT items, such as thumb drives, and CD-ROMs.
- Greater efficiencies as teachers and staff can easily access documentation anytime, anywhere without needing to rely on someone being at their desk to sign-out a paper file.
- Streamlined workflow: Workflow can be tracked using various analytical tools to see how often files are accessed, busiest times of the day and days of the week, etc.
- Short learning curve: It does not take long – a few hours (if that) – to learn how to manage digital documents in the cloud.

B. Protocols Used by Cloud

Under the hood Cloud relies on Web Distributed Authoring and Versioning (WebDAV), Web Distributed Authoring and Versioning (SOAP) and Representational State Transfer

(REST) for its major functionality. WebDAV is an extension of the Hypertext Transfer Protocol (HTTP) that allows clients to perform remote Web content authoring operations. The WebDAV protocol makes the Web a readable and writable medium. REST is a software architecture style consisting of guidelines and best practices for creating scalable web services. A web service is any piece of software that makes itself available over the internet and uses a standardized XML messaging system. Web service can be accessed from anywhere Independent of platform, infrastructure, OS and device.

During their survey of open source cloud softwares, the authors found Tonido cloud software to be rich in features incorporating all functionalities commonly required by any educational institution.

The prominent features of Tonido, components of Tonido personal cloud application and implementation procedure are discussed below:

II. TONIDO PRIVATE CLOUD

Tonido is Private, Highly Scalable, Self - Hosted Cloud Storage/Sync Solution. Tonido Cloud is software that allows user to provide own private cloud storage and sync solution to employees, customers and clients across the organization. Figure.1 depicts the comparison of Tonido personal cloud architecture with other cloud services.

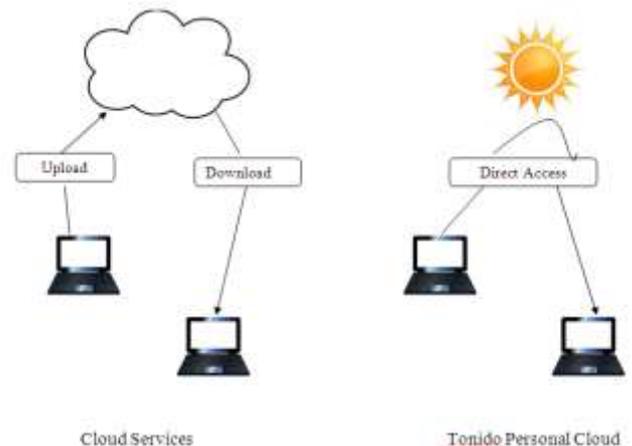


Figure 1. Comparison of Tonido personal cloud architecture with other cloud services.

A. Characteristic Features

- Access to important files wherever they are
- Share files with other users inside or outside the organization
- Sync files easily with other users
- Security and control of your valuable intellectual property
- Scalable from 10s to millions of users
- Mobile accessible
- Free of cost

B. Components of Tonido Personal Cloud Application

The following section reviews some commonly preferable open source private cloud softwares with large market share.

TABLE I. TONIDO CLOUD COMPONENTS

Tool	Features
Tonido Explorer	Browse, Upload, and Download files from anywhere using any device. Listen to ALL music via a web browser.
Tonido Sync	Allow users to synchronize files among multiple computers privately and secured with full control
Tonido Drive	Access to remote Tonido server as a native Windows drive

C. Implementation Procedure

1. First install Tonido server software on server machine URL: <http://mcasiber.tonidoid.com>
2. Client computer can access to Tonido server by browsing to <http://mcasiber.tonidoid.com> User can access to server data by authentic login and password.
3. Install mobile apps to access Tonido server
4. Install the Sync client software on the other computers to synchronize files with the Tonido server
5. Install the Drive client to mount files and folders from Tonido server as a network drive in Windows explorer

III. LITERATURE VIEW

Author Yadav has focused on the impact of cloud computing on the education system and how we can provide the quality education by using the above technology [1]. One of the latest technologies prevailing now days is Cloud Computing. By sharing IT services in the cloud, educational institution can outsource noncore services and better concentrate on offering students, teachers, faculty, and staff the essential tools to help them succeed.

Kumar et.al. have reported contribution of cloud computing in the field of education [2]. cloud computing can be utilized to improve education standards and activities. The end result will be to curb the above problems and instead, boost performance. This paper focused on educational cloud computing and how the universities and institutions are already taking advantage of it, not only in terms of cost but also efficiency security, reliability and portability.

Jain et.al, explained cloud computing, its key characteristics, deployment and service models, relationship between them [3]. Authors have focused on the role and challenges of cloud computing in higher education. Cloud computing services are a growing necessity for business organizations as well as for educational institutions. Although there are still several risks and challenges are associated with cloud but its potential benefits outweigh the risks.

Kshetri has highlighted the nature, origin, and implications of institutions and institutional changes in the context of cloud computing [4]. A goal of the reported work is also to gain insights into the mechanisms and forces that have brought about institutional changes in the cloud industry.

A. Open Source Private Cloud Software

Bittorrent Sync can be used to create personal cloud by configuring folder to act as a drop-off point so that client can sync all files to server [5].

PClouds is a personal cloud solution that makes sharing files between operating systems. It is easy to use app to create a personal cloud within the Apple ecosystem, bypassing iTunes. It also has a simple file management app for mobile devices. There are plans to build for other OSes [6].

An incredibly versatile tool, ownCloud is a free, open source application to build more than a Dropbox replacement to dump data [7]. Along with data storage, the app comes with a number of other features such as a way to manage calendar, to-do lists, a document editing tool and many more.

Seafile, another open source solution, sells itself as a file syncing and online collaboration tool [8]. There are two kinds: Open Source and Business. The application features a rich online file editor, version control, multi-platform file syncing and more.

Similar to OwnCloud, the aim of Cozy is to give a way to maintain user data using web apps [9]. In the developers own words, "Cozy allows user to turn server in a kind of personal Google App Engine." The developers encourage users to develop it further, hoping to connect many different services and utilities to it.

AeroFS is an open source app that is aimed at corporate users, offering collaboration tools as part of their package [10]. They also offer a free version for personal use, which supports up to 3 users. The service prides itself on its fast syncing speeds, with no limit on the data transferred. Implementation needs installing the AeroFS client into the device which is to be placed in sync circle.

SparkleShare used in order to maintain users data [11]. This means that user will get full version history of files as well as the other good stuff that comes with git. Git is a free and open source distributed version control system designed to handle everything from small to very large projects with speed and efficiency. SparkleShare is an excellent solution for documents that require going through a lot of changes. It may not do so well with very large files though.

Similar to SparkleShare and obvious from its name, git-annex also uses git to manage files but "without checking the file contents into git" [12]. This means it is more suitable for larger files that git is used to handling. The app is mainly in command line but for those who aren't keen on this, there is an easy-to-use alternative version."

IV. PROPOSED MODEL

A. Design Framework

The cloud infrastructure connecting the department internally and with the various external entities is depicted in Figure 2.

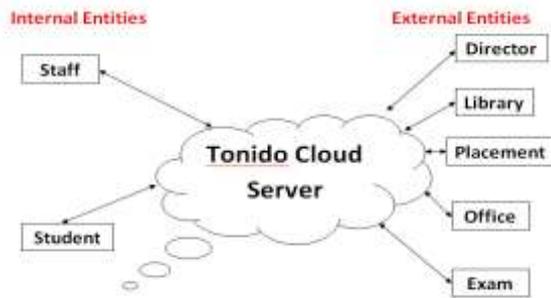


Figure 2. Cloud Infrastructure of Institute

Figure 3. shows the partial folder structure on the cloud file server for organizing different data according to different user levels and department hierarchy. The corresponding access control list is depicted in Figure 4.

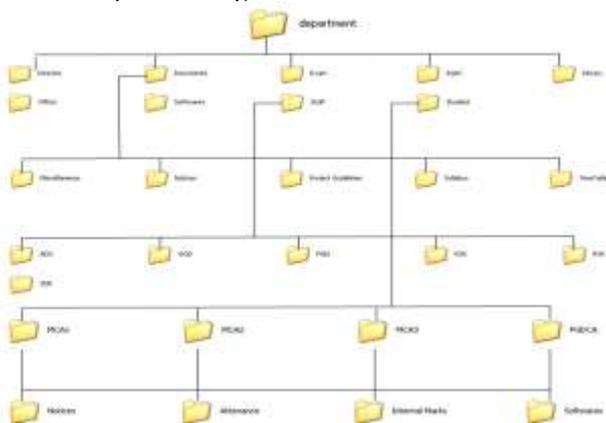


Figure 3. Partial Folder Structure of Cloud Server

Role	Folders Accessible
Director	Director
Librarian	Library
COE	Exam
IQAC	IQAC Coordinator
HOD	HOD
RVK	RVK Documents Softwares Miscellaneous
MCA1	MCA1 Documents Miscellaneous
MCA2	MCA2 Documents Miscellaneous
MCA3	MCA3 Documents Miscellaneous
PGDCA	PGDCA Documents Miscellaneous

Figure 4. Different Roles in the Department and their Access Levels

Figure 5 shows sequence of workflow originating as a result of uploading a document on a private file cloud server. The notification message is received by an end user immediately after a successful login.

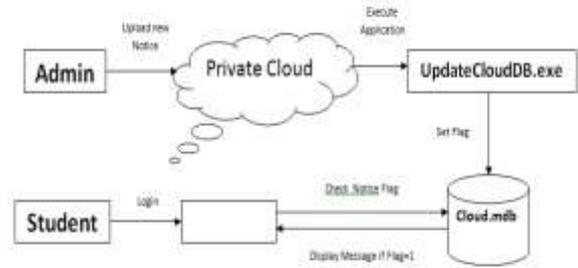


Figure 5. Workflow on Uploading a Document on a Cloud Server.

The sequence of events triggered when the document is uploaded on the file cloud server is depicted in Figure 6. Depending of the type of the document uploaded the document creation date and the corresponding flag is set in the institute's cloud database.

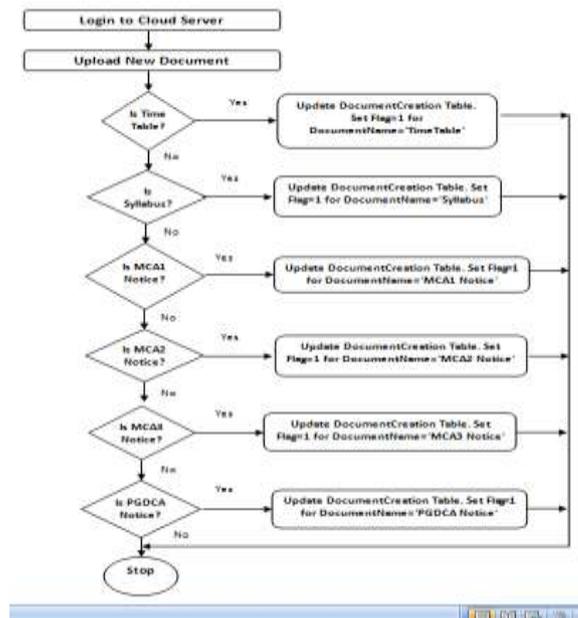


Figure 6. Control Flow Logic for Admin

The sequence of events triggered when the student logs in to the file cloud server is depicted in Figure 7. The application retrieves each document type in a database and checks the status of a flag. The task is common for time table and syllabus documents whereas attendance, internal marks are specific to students and appropriate notification messages will be displayed depending on the category of student being logged in.

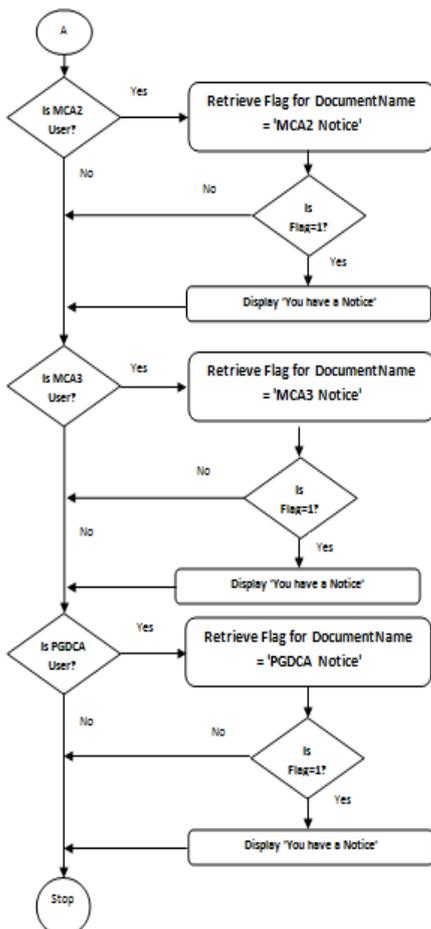
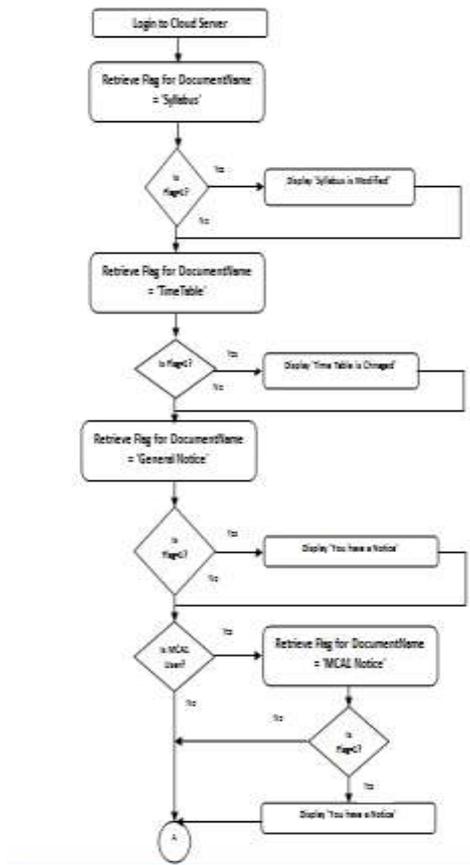


Figure 7. Control Flow Logic for a Student

V. RESULTS AND ANALYSIS

The model discussed above is implemented in VB. The structure of the database employed for recording document creation and notification flag is shown in Figure 8. with Figure 9. showing the contents of DocumentMaster Table.



Figure 8. Structure of Database - cloud.mdb

DocumentCode	DocumentName
1	General Notice
2	MCA1 Notice
3	MCA2 Notice
4	MCA3 Notice
5	PGDCA Notice
6	Time Table
7	Syllabus

Figure 9. Contents of DocumentMaster Table

A. Installation of Tonido Cloud Server

Figure 10. shows a starting screen for implementing Tonido File Cloud server. Once the server is installed successfully, the end user can login into the Tonido File Cloud server using any web browser using the following URL.

URL to Access Cloud Server : mcasiber.tonidoid.com



Figure 10. Implementation of Tonido Cloud Server

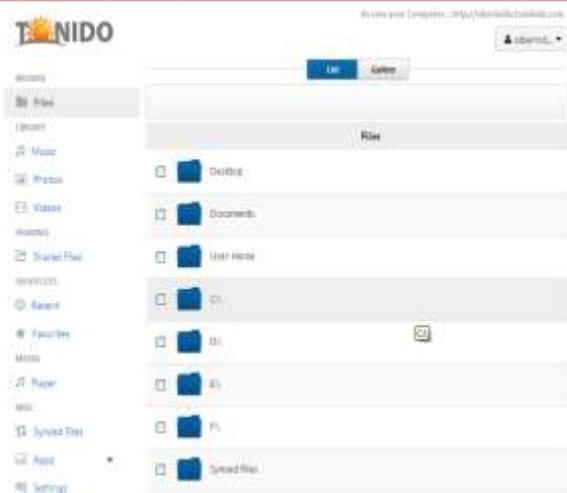


Figure 11. User Interface for Tonido Cloud Client

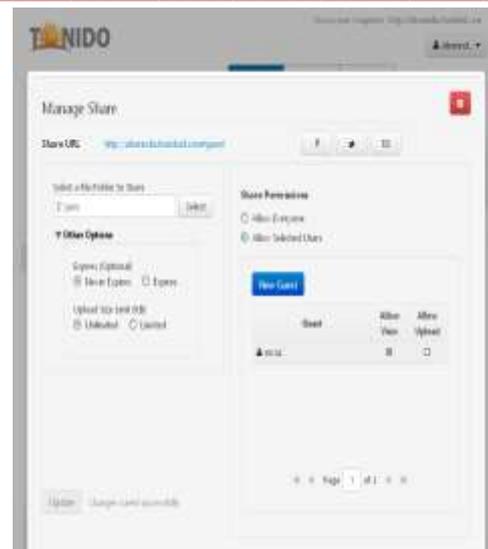


Figure 13. Managing Shares

B. Creating Guest Users and Managing Shares

Tonido provides an option for creating guest users and shared files accessible by only certain user/users. This option can be availed by selecting ‘Shared Files’ option in Tonido home page. Figure. 12 and 13 depict creating guest users and managing shares, respectively. The view permission is assigned to the MCA1 user for the folder E:\jars. Figure. 14 shows user interface for MCA1 user.



Figure 14. User Interface for MCA1 User.

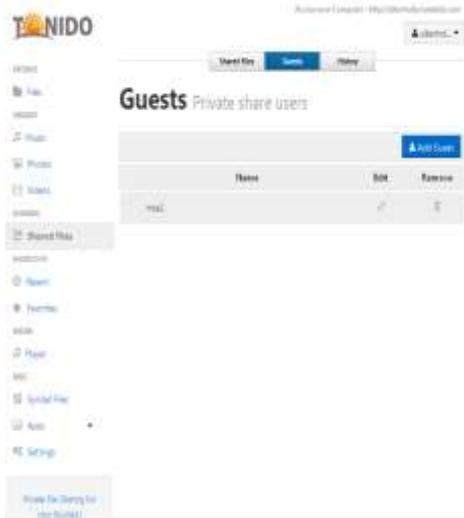


Figure 12. Creating Guest Users

C. Network Drive Mapping

Another feature which comes extremely handy for file sharing is mapping a network drive to a Tonido Cloud Server file system, so that the files can be managed by simple drag and drop operations. The drive mapping can be automated every time Windows starts by right-clicking on the TonidoDrive icon in the system tray and selecting the option. Figure. 15. shows the Tonido cloud server file system being mounted on drive F, using Tonido Drive Tool.



Figure 15. Mounting Tonido Drive

D. Mounting Shared File System On tonido Drive

Tonido inherently does not provide a feature for mounting shared file system on a network drive. But an add-on to Tonido viz., DirectNetDrive is available which enables this task. But DirectNetDrive requires a WebDAV address which can be obtained by clicking the shared folder and selecting ‘WebDAV’ option from the shortcut menu. The WebDAV address for MCA1 user is shown in Figure 16. The DirectNetDrive user interface and corresponding drive mapping of user MCA1 to virtual X drive are shown in Figure. 17 and 18, respectively.



Figure 16. WebDAV Address for MCA1 User

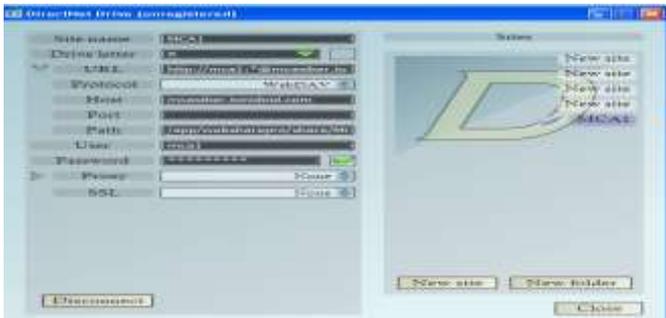


Figure 17. Direct NetDrive User Interface for Mounting Shared File System



Figure 18. Mounting Shared File System on Direct NetDrive

At the OS level, security trimming is performed by programmatically editing requisite registry entries using Group Policy Editor, Microsoft management console program at runtime depending on the user logged in and mapping user credentials to the corresponding drives accessible only to that user. The Group Policy Object Editor stores registry-based configuration settings in two Registry.pol files, stored in folders under the <drive>:\Windows\System32\GroupPolicy\ folder. One file contains computer settings and the other file contains user settings. The Group Policy Object Editor saves the settings to these files on exit, and imports the settings on startup. A Registry.pol file is a text file that consists of a header and a body. The header contains two DWORD values that indicate the file signature and version. The body consists of registry values in the following format.

[key;value;type;size;data]

E. File Synchronization

Tonido offers a bi-directional file synchronization between the client and the server systems. The synchronization is efficient and the user is instantly notified a message online. All the files to be synchronized should be placed in a TonidoSync folder created automatically on the server or created on the client when the Tonidosync application is installed. When sync is enabled, Synced Files option is displayed in a Tonido menu system as shown in Figure 19.

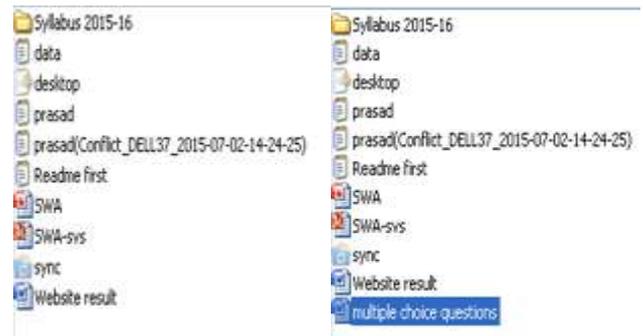


Figure 19. Contents of Tonido Sync Folder.



Figure 20. Enabling Sync in Tonido

We have employed FolderSpy utility for notifying the user when the new document gets uploaded on the server. Configuration of the FolderSpy tool for reacting to the specified folder change and configuring E-mail server in FolderSpy are shown in Figure 20 and 21, respectively. The application triggering this action will lookup a 'DocumentCreation' table for the flag based on the user logged into the system and displays a notification message as shown in Figure 22. The flag is automatically reset four days after the document is created.

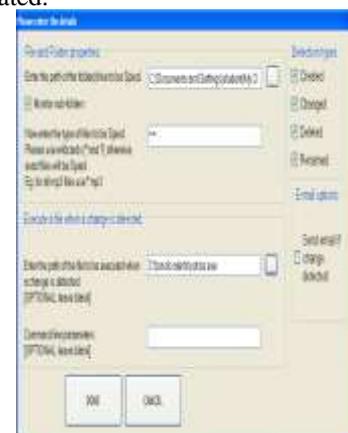


Figure 21. Configuration of FolderSpy Tool

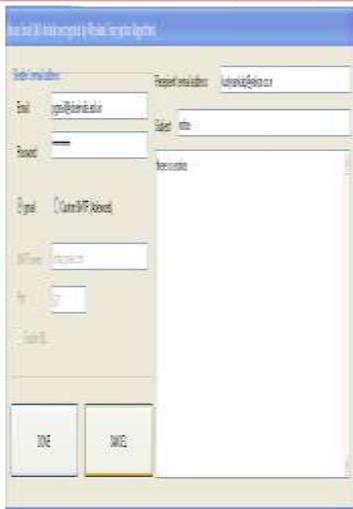


Figure 22. Configuring E-mail Server in FolderSpy

F. Downloading a Folder in Tonido.

In order to download a folder from tonido cloud server, select the folder and select ‘Download Folder’ option from the menu. The zip file is created in the same folder. Download the zip file and extract it at the desired location. Figure. 23 shows creation and downloading of zip file.

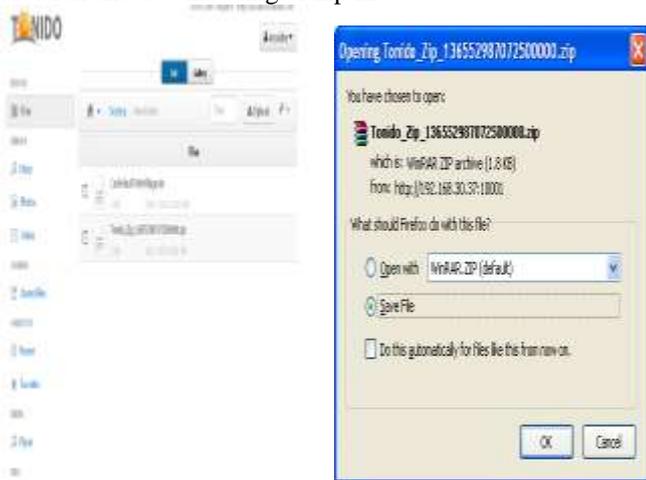


Figure 23. Creation and Downloading Zip File

G. Uploading a Folder in Tonido

For uploading a folder on Tonido cloud server, first create a Folder Folder_Upload on desktop of Cloud Server. Navigate to the Folder_Upload and click on ‘Upload’ option, browse to the required folder, hold down Ctrl key, and drag and drop the folder on Folder_upload. All the files from the source folder and copied to a target folder, Folder_Upload on the cloud server. This feature is supported only by Google Chrome. Figure. 24 a) and 24 b) show user interfaces for



Figure 24 a) – 24 b). Uploading a Folder on Tonido Cloud Server

H. Integration of Tonido Cloud Server with Moodle Server

In CSIBER, Moodle server is installed on Ubuntu platform on a machine with a private IP 192.168.30.42 in an intranet environment. Hence the important notices can be accessed by staff and students only from institute premises which greatly limits its scope. This geographical barrier is overcome by integrating Moodle server with Tonido cloud server so that notices can be accessed anywhere, any time and by any device. As a first-hand exercise only different notices to the staff and students are synchronized with the cloud server. An interface application is written in Java for accessing MySQL database hosted on Linux server from a Windows-based cloud server using Java Database Connectivity (JDBC). The following steps enumerate the synchronization procedure and MySQL server configuration for enabling it for accessing remotely.

1. Locate /etc/mysql/my.cnf file on Ubuntu file system and change the value of bind-address in [mysqld] section from the loop-back address, 127.0.0.1 to IP address of the machine as shown below:

```
[mysqld]
Bind-address 192.168.30.42
```

2. Grant permission to access moodle database to all users using the following command.

```
Grant All on Moodle.* to root@'%' identified by
<password>
Substitute actual Mysql password in the place of
<password>.
```

3. Restart MySQL server using the command:
server mysql restart

The architecture for integrating moodle server with Tonido Cloud Server is shown in Figure, 25

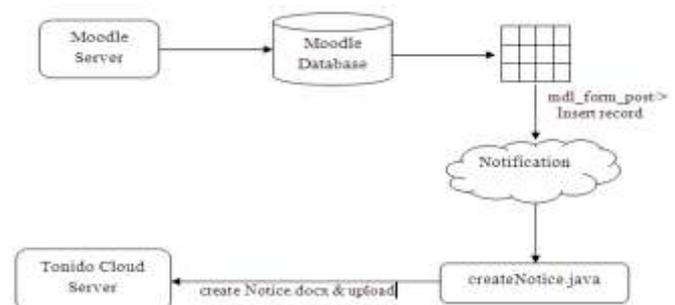


Figure 25. Architecture for integrating moodle server with Tonido Cloud Server

Appendix A lists a partial code for connecting to MySQL database service running on Ubuntu OS from Windows Platform and dynamic creation of Word Document

VI. CONCLUSION AND SCOPE FOR FUTURE WORK

Big data analytics and cloud computing have become one of those buzz phrases in IT industry today. Both academic and non-academic institutions and companies of all sizes are beginning to reap the benefits offered by cloud computing. To stay ahead in market it has become mandatory for every organization to go for implementation of these cutting edge technologies and automate the common routines. Further, the data needs to cross its geographical barriers and reach its stake holders anywhere, at anytime and on any device. Cloud computing exactly addresses this issue. There is a plethora of open source cloud softwares, of which Tonido was found to be suitable for most of the needs of academic institutions. As such Tonido offers cost-effective solution for setting up cloud server in an academic institution. In this paper, authors have set up a private cloud server using Tonido cloud server software. Security has been implemented using role-based authentication. File synchronization, drive mapping are enabled using Tonido tools and several add-ons for Tonido available freely on web. Another challenge faced is the integration of cloud server with Fedena, an institute's ERP system and Moodle server installed on Ubuntu. The authors have designed an interface application for integration of Moodle server with cloud server where as a first-hand exercise only notice generation is synchronized. In future, the authors intend to integrate cloud server with Fedena and synchronize larger Moodle dataset with cloud server based on organizational needs.

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- [9] Cozy <http://cozy.io/en/>
- [10] AeroFS <https://www.aerofs.com>
- [11] SparkleShare <http://sparkleshare.org/>
- [12] git-annex <http://git-annex.branchable.com/>

Appendix A

Connecting to MySql database stored on Ubuntu OS from Windows Platform
import java.sql.*;

```
class Test
{
    public static void main(String args[]) throws Exception
    {
        Class.forName("com.mysql.jdbc.Driver");
        Connection
con=DriverManager.getConnection("jdbc:mysql://192.168.30.42:3306/moodle
","root","mca123");
        //Connection
con=DriverManager.getConnection("jdbc:mysql://192.168.30.42:3306/moodle
?user=root&password=mca123&useUnicode=true&characterEncoding=UTF-
8");
        Statement st=con.createStatement();
        ResultSet rs=st.executeQuery("SELECT message FROM
mdl_forum_posts");
        while (rs.next())
        {
            System.out.println(rs.getString(9));
        }
    }
}
```

Dynamic Creation of a Word Document

```
import org.apache.poi.hwpf.HWPFDocument;
import org.apache.poi.hwpf.extractor.WordExtractor;
import org.apache.poi.hwpf.usermodel.*;
import org.apache.poi.hwpf.HWPFDocument;
import org.apache.poi.hwpf.extractor.WordExtractor;
import org.apache.poi.xwpf.usermodel.*;
import java.io.*;

public class CreateNotice
{
    public static void main(String args[])
    {
        String filename;
        File file;
        XWPFDocument document=null;
        try
        {
            document=new XWPFDocument();
            OutputStream out1=new FileOutputStream("d:\\notice.docx");

            XWPFPParagraph title = document.createParagraph();
            title.setAlignment(ParagraphAlignment.CENTER);
            XWPFRun run1 = title.createRun();

            run1.setFontSize(24);
            run1.setBold(true);
            run1.setText(rs.getString("title"));
            run1.addCarriageReturn();
            XWPFPParagraph body = document.createParagraph();
            XWPFRun run2 = body.createRun();
            run2.setFontSize(12);
            run2.setText(rs.getString("message"));
            document.write(out1);
            out1.flush();
            out1.close();
            System.out.println("Notice Created...");
        }
        catch (Exception e)
        {
            System.out.println(e);
        }
    }
}
```