

# Cloud Storage Services in Higher Education – Results of a Preliminary Study in the Context of the Sync&Share-Project in Germany

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**Abstract.** In recent years, a growing number of institutions in higher education is in progress to adopt cloud storage services. This paper describes the Sync&Share NRW-project in North Rhine-Westphalia (Germany) with a target audience of up to 500,000 users and presents the main results of a preliminary large-scale survey at the University of Muenster with more than 3,000 participants. The results of the analysis indicates a very high demand for an on-premise cloud service solution in German higher education with mobile access, a storage volume comparable to commercial offerings, collaborative features such as simultaneous work on text documents and, above all, high data protection standards.

**Keywords:** cloud storage services, higher education, technology adoption, trust.

## 1 Introduction

Cloud storage services like Dropbox allow users to store files remotely and to synchronize them over multiple devices. This approach has gained increasing attention during the last years. Beside the ubiquitous availability of personal files through mobile devices like smartphones and tablets, enhanced collaboration possibilities also contribute to the arguments for the use of such services. However, a still unsolved problem is the legal framework for governing cloud solutions. Until now, there exists no international legislation regarding data protection. Furthermore, national laws are rarely equivalent and can be even conflicting on a global level. The situation is aggravated by the fact that all major public cloud storage providers like Dropbox, Google, Amazon, Microsoft or Apple are located in the US. Latest revelations on the mass surveillance undertaken by the NSA caused a further loss of trust in public cloud services. In the academic community, the utilization of cloud services, free or paid, is not uncommon, even for storing sensible research and teaching data. This creates substantial data privacy and confidentiality issues.

Against this background, the leading IT managers of the majority of the research universities in North Rhine Westphalia (NRW) have launched the “Sync&Share NRW”-project with the aim to set up a cooperatively operated cloud storage platform for researchers and students. A consortium of research and applied science universities, headed by the University of Muenster and covering approx. 60 percent of the academic community in NRW, has been formed to design a system for possibly up to 500,000 users. In this paper, we describe and discuss the results of a large-scale survey conducted at the University of Muenster, which includes more than 3,000 responses.

This article is structured as follows. In the next section we provide a general introduction into cloud computing and cloud storage services in higher education. Afterwards, the design and structure of the survey as well as main facts regarding the group of participants will be described. In the subsequent section we present the main survey results. The paper concludes with a summary and some implications of the results as well as an outlook for further research and next steps of the Sync&Share-project.

## **2 Theoretical Background**

### **2.1 Cloud Computing**

As a new emerging technology and due to its considerable benefits for companies [1], cloud computing has gained a lot of attention in recent years. According to the definition of the National Institute of Standards and Technology (NIST), cloud computing is “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with a minimal effort or service provider interaction as a pool of computing resources” [2]. There are three types of cloud computing service models: Software as a service (SaaS), platform as a service (PaaS), and infrastructure as a service (IaaS) [2-4]. In the case of SaaS, access to software is provided remotely as a web-based service [2]. PaaS provides a computing platform to allow users, mostly developers, to build applications and services over the internet [2]. In the case of IaaS, computing resources such as storage is provided through the internet [4]. Regarding the deployment models, four types can be distinguished: A private cloud is exclusively used by a single institution whereas a public cloud is used by the general public [2]. A community cloud is exclusively used by a community of users from institutions that have the same concerns (e.g. security or compliance requirements) [2]. A hybrid cloud is a composition of two or more cloud infrastructures. The physical location of the cloud infrastructure can be either off premise or on premise (except in the case of public clouds) [2].

### **2.2 Cloud Computing in Higher Education**

Cloud computing is not only used in the business community. Educational establishments have also recognized the various benefits of using cloud computing services

[5]. As is the case with organizations, cloud computing can help to reduce universities' IT complexity and costs by replacing software installation on campus computers with applications delivered via the Internet [6]. Furthermore, due to web-based access, university teachers, students and staff can access educational tools or files saved in the cloud from almost any internet-capable device [7]. Especially in case of hardware failures, cloud computing can serve as an effective backup and recovery solution [8] for study related materials such as theses or research papers. In addition, cloud computing can be used to facilitate collaboration among working groups as well as between universities and their partner organizations [9, 10]. For example, a researcher team working on a paper can collectively create a temporary shared workspace and thus ease the joint work on this paper [10]. Since more and more researchers are working with team members from different universities and countries, this kind of virtual teamwork could gain in importance.

Statistics show that the use of cloud computing in educational institutions is on the rise. The CDW 2011 Cloud Computing Tracking Poll<sup>1</sup> for example reported that 34% of higher education institutions use some form of cloud computing [5]. A number of universities, such as the University of Westminster or the New York University, for example, use Google Apps for education which provides email and collaboration tools [11]. In the next years, higher education institutions even plan to spend more on cloud resources.

However, the use of public cloud at universities also entails certain risks such as privacy invasion or data security breaches [10]. For example, researchers storing research data in a public cloud could lose the copyright of their research work. Furthermore, universities could face regulatory compliance problems [12]. Employees of the university administration are working with very sensitive personal data of their students. When they store personal data of the students on the servers of a cloud provider, they lose a degree of control over these sensitive data [12]. The cloud provider then has to protect that data from hackers and internal data breaches rather than the university [12]. Nevertheless, the university has to comply with relevant regulatory laws as well as information security standards (e.g. ISO27001) and thus is still ultimately responsible for that data [12]. Due to certain characteristics of cloud computing, to fulfill this responsibility becomes a very challenging matter. In most cases for example, the storage location of the data is obscure and it is also unclear, who has accessed the data [13]. In addition, the university often does not exactly know which security measures the provider has implemented to secure the data [12]. These mentioned concerns indicate that a cloud computing system specifically for university purposes is needed. There are very few practical examples showing that this concept can succeed. The Oxford University together with VMware e.g. created a database-as-a-service (DBaaS) in a hybrid cloud for use by its researchers [15]. With this service,

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<sup>1</sup> The CDW 2011 Cloud Computing Tracking Poll surveyed 1,200 IT professionals in U.S. organizations: small, medium, and large businesses, local government agencies, health care organizations as well as K-12 and higher education institutions.

researchers are able to securely store their research materials for easy access. In the following sections, we want to contribute to the discussion of cloud services in higher education on a large-scale basis.

### 3 Survey Structure and Participants

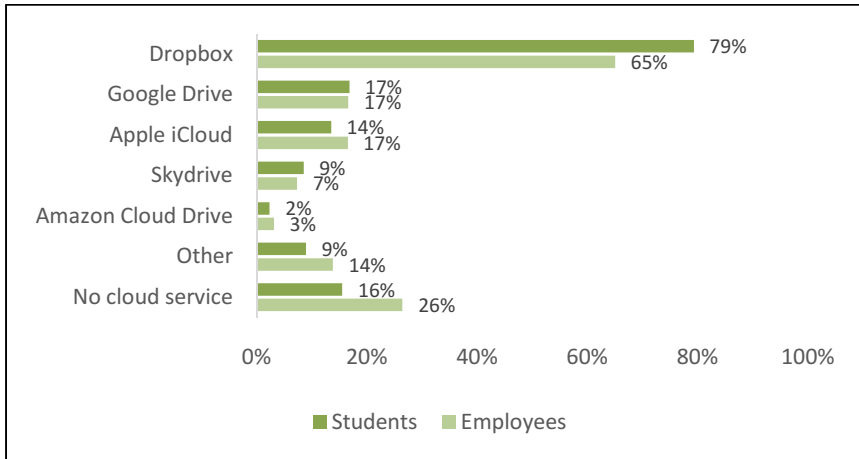
To study user expectations as well as acceptance on a broad basis, the Research Group for Communication and Collaboration Management (CCM) at the University of Muenster, which represents the headquarter of the European Research Center for Information Systems (ERCIS), conducted an online survey in cooperation with the Centre for Applied Information Technology (ZIV) at the University of Muenster. Established in 1780 and with 40,800 students as well as 6,650 employees (2013), the University of Muenster is one of the oldest and biggest universities in Germany, located in the federal state of North Rhine-Westphalia. All students and employees of the University of Muenster were invited to participate in the survey; 4,830 of them started and overall 3,774 (2,704 students and 1,070 employees) completed the questionnaire. Each of these participant groups, students and employees, were asked up to 27 questions, dependent on their replies to specific filter questions. Four topics were assessed in total. In the first section the respondent was assigned to a participant group (student or employee) and also to a specific area of studies (e.g. economic sciences). The second section served the goal of raising the status quo, by enquiring i.e. the actual memory storage requirements and gathered experience with other cloud storage services (e.g. Dropbox). In the third section the Sync&Share project was described in detail. Following, the relevance of certain properties, features and functionalities as well as the participant's willingness to use the service were surveyed. The last section included the sampling of demographic and additional personal data (age, gender, used devices and operating systems, etc.), that could be voluntarily provided by the respondents. The posed questions predominantly consisted of multiple choice questions that allowed both single and multiple selections of predefined answers. At some points, the participants were also able to leave comments, additions and specify their responses with regard to certain aspects, by using the provided text fields.

With regards to the group of participants in the collected data set, the majority of the students is between 20 and 30 years old (84%). 36% of the employees is between 20 and 30 and 32% between 31 and 40 years old. Furthermore, 57% of the students and 64% of the employees are male. 65% of the students (employees: 67%) rank their computer knowledge as "good" and 22% (employee: 26%) see themselves as experts. The majority of the surveyed students is enrolled in economic sciences (13%) respectively mathematics and informatics (11%), while the largest share of the participating employees works in the areas of medicine (17%) respectively chemistry and pharmacy (9%). With regard to the deployed operating systems on their PC/laptop, both user groups mainly use Windows (students: 76%; employees: 73%), followed by Mac OS (16% respectively 17%) and Linux (7% respectively 8%). Students use Android smartphones more frequently than employees (62% versus 52%), while the latter is more frequently in the possession of an iPhone (32% versus 40%).

## 4 Survey Results

### 4.1 Current Use of Cloud Services and Reasons for Rejection

85% of the students currently use at least one cloud service (employees: 73%). Most of them use Dropbox (79%; employees: 65%) and Google Drive (each 17%), as can be seen in fig. 1. The majority of the participants started to take notice of cloud services due to recommendations from their closer social environment like friends, relatives or colleagues (students: 81%; employees: 76%).



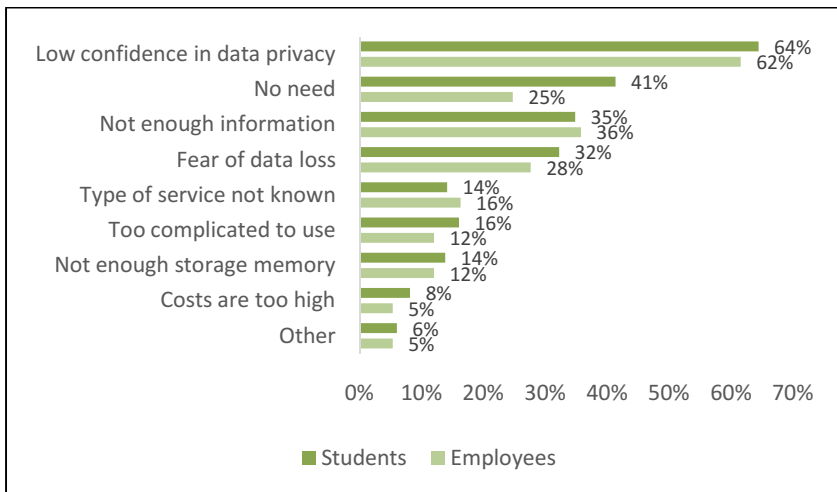
**Fig. 1.** Current use of cloud services

Students currently use cloud services for project work (83%) and teaching material (78%). Furthermore, cloud services are used for private pictures (54%) and other personal data (58%). Employees use cloud services mainly for work-related material (78%), private pictures (52%) and other private data (62%). The majority of the students states to use a study related data volume between 1,1 to 4,9 GB (30%). Others (21%) indicate a volume ranging from 5 to 10 GB. Only 3,3% utilize a volume from 21 to 30 GB and 5% more than 30 GB. By comparison, employees specify a considerably higher data volume. Here, the most frequently stated storage volume is more than 30 GB (20%). Another 19% claim a volume ranging from 5 to 9,9 GB and 17% a volume of 1,1 to 4,9 GB.

The most important reason for rejecting cloud storage services (multiple selections) is a low confidence in the data protection of commercial providers (students: 64%; employees: 62%). Based on a first analysis of answers on an open-ended question, answered by 1,636 (43%) of the survey participants, we were able to identify factors that are important for the trustworthiness of a provider. In this regard, data privacy and data protection are of top priority. Approximately 45% of all participants state that the provider has to consider certain technical aspects in order to be evaluated as trustworthy: the provider needs to implement measures for data privacy and protection, to comply

with high security standards, to be certified by independent institutions, to ensure a high availability of the system, to use data encryption techniques also during data transmission and to realize access restrictions. In addition, 18% state that high transparency is an important criterion for establishing trust. The participants want to know, for example, who has access to their personal data, where the data is being stored, and which security measures are being implemented in order to ensure data protection and security. Furthermore, the comprehensiveness of the terms of conditions (AGB) and the privacy policy are mentioned. 42% of the respondents express that the provider should not only act in his own interest but also in the interest of the users. In addition, the data should not only be protected against the access of third parties, but also against the provider itself. Another aspect is legal compliance. The respondents, who mention this aspect, emphasize the importance that the provider’s servers and jurisdiction are located in Germany. Furthermore, a closed-ended question indicates that universities per se enjoy a high level of trust. 81% of the students and 74% of the employees would trust a cloud provider more if it was a university rather than a private sector company.. The personal contact to the provider is named by 10% of the participants as another criterion for trust establishment.

The second most important reason for students’ reluctance to use cloud services is “no current need” (41%), while this is only the case for 25% of the employees (see fig. 2). For the latter group of participants the insufficient presence of information (36%) is the second most important reason (students: 35%). For the majority of the participants, it is very or rather important that the provider gives them information regarding implemented security and privacy measures (students: 77%, employees: 82%), skills and responsibilities of their staff (students: 56%, employees: 69%), general information about their organization (students: 77%, employees: 75%) and descriptions of users’ rights (students: 71%, employees 67%). The fear of data loss is for both students (32%) and employees (28%) of comparatively low relevance.



**Fig. 2.** Reasons for the disuse of cloud services

In an open text field, 24 participants give further indications for the disuse. In doing so, 29% again express their concern for data privacy concerns. 25% prefer other methods to share or backup data (e.g. “USB sticks are safer”; “I own a network drive (NAS)”). 17% state that there is a lack of motivation and time to deal with the topic.

### 4.2 Expectations Towards a Cloud Storage Service at the University

The expectations towards the features and functions of a university cloud storage service are quite homogenous among students and employees (see fig. 3).

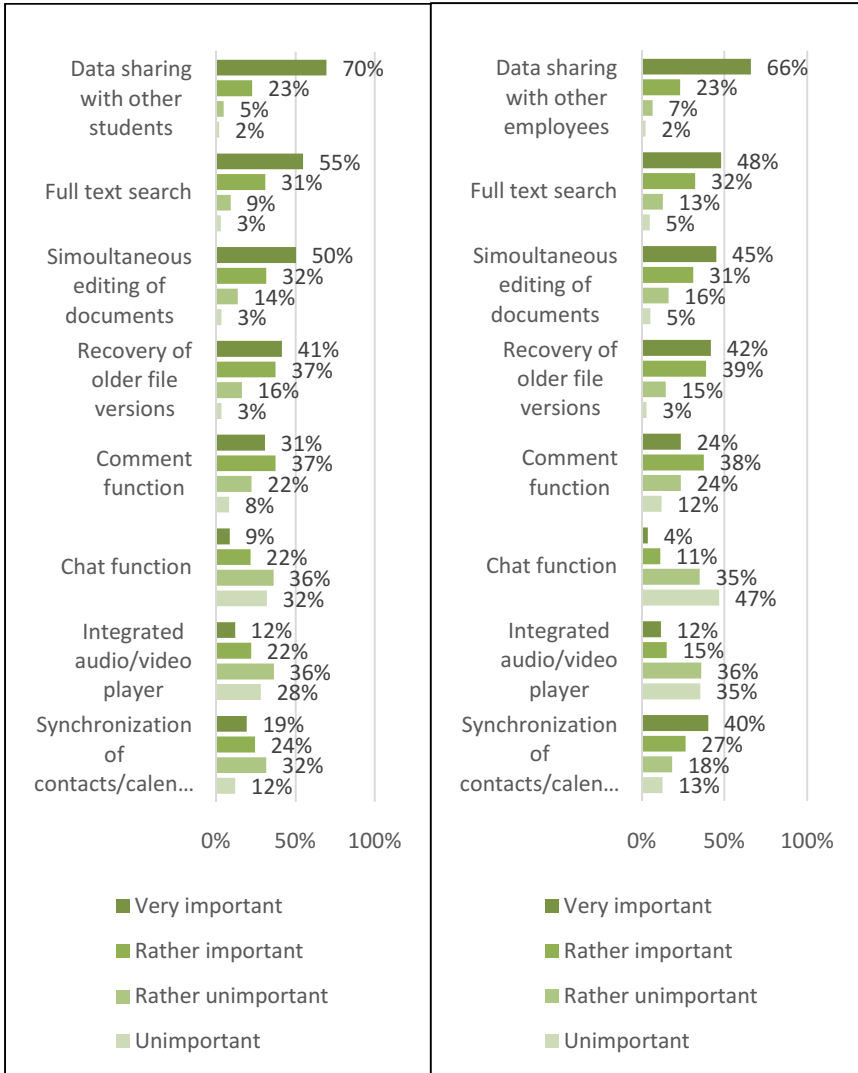


Fig. 3. Expected features by students (left) and employees (right)

The majority of both participant groups considers the possibility of flexible data sharing with other students/employees (students: 70%; employees: 66%), a full text search function (55% respectively 48%) and the simultaneous and collaborative editing of electronic documents as most important features.

With regard to the required properties and attributes, 74% of the students consider a constant availability on different devices very important (employees: 80%). Furthermore, 65% of the students agree on the high importance of the encryption of data (employees: 64%). The storage of the data on German server sites is regarded as very important by 41% of the students and 53% of the employees. With regard to the integration of existing learning systems, this is the case for 29% of the students and 44% of the employees. Concerning the preferred devices deployed for the use of the services, students would mainly use PCs/laptops (98%), followed by computers provided by the university (63%), and smartphones (59%). The employees specified to use their professional (95%) respectively private (79%) PC/laptop, followed by the private smartphone (48%). Moreover, 33% of the students and 37% of the employees consider their personal relationship to the provider of the service important. To have a local contact person is important for 67% of the students and for 76% of the employees.

### 4.3 Demanded Storage Volume and Intention to Use

With regard to the required memory storage offered by the cloud service, the participant groups show deviating volume needs (see fig. 4). While the surveyed students are predominantly satisfied with 1,1 to 4,9 GB (29%) respectively 5 to 9,9 GB (25%), the majority of the employees specifies a required data volume of 10 to 20 GB (25%) respectively 5 to 9,9 GB (20%). 12% of the employees state a required data volume of more than 40 GB what is only for 4% of the students the case.

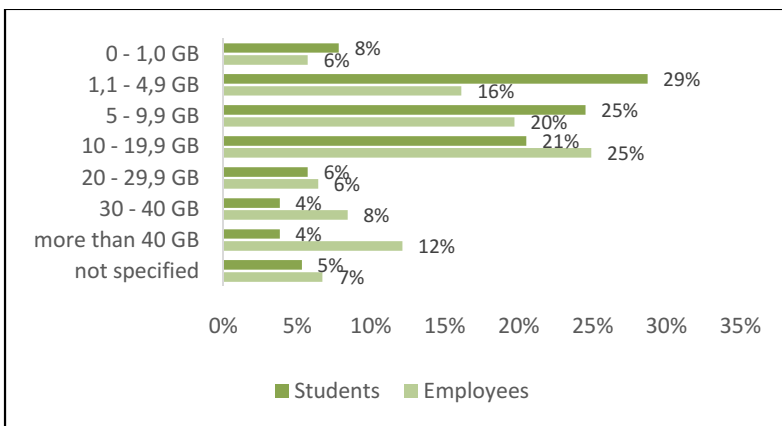


Fig. 4. Demanded storage volume



93% (employees: 90%) of all respondents have the intention to use the university cloud storage service. For the students who have already used cloud services in the past or present, the willingness to use the Sync&Share service (97%) is 22% higher than for students without any cloud experience (75%). Regarding the employees, the results are similar. 97% of the employees with cloud experience but only 76% of those without experiences with such kind of technology signalize an intention to use. 54% of the students and 45% of the employees that state to have the intention to use the cloud service would like to continue to use it even after their studies respectively employment ended. If the university does not facilitate continuous usage, 41% of the students would appreciate a transition period of three to six months (employees: 37%) and 38% of more than six months (employees: 36%).

Besides the descriptive statistics, we also searched in the data for factors influencing the willingness to use the university cloud service. Some results indicate that there might be few influencing factors especially with regard to students' willingness to use the cloud service.. For example, students who already use Dropbox, have a 13% lower willingness to change the provider and exclusively use the cloud service of the university. The more important the information regarding the data security, the higher is the willingness to solely use the service. Furthermore, 22% of the respondents who consider provided information regarding data security as "rather important" state that they would exclusively use the university cloud service while 28% of the participants who consider these information as "very important" give this response. The consideration of a German server site seems to have equal impact on the intention to use. The more a storage location in Germany is considered as important,, the higher is the willingness to exclusively use the university cloud service. 22% are among the participants who consider this as "rather important", while 33% select "very important" as their response.

## 5 Conclusion and Outlook

For the success of the described Sync&Share NRW-project, it is important to gain indications on how the cloud service should be designed to be attractive for the target audience. In this regard, identifying factors which positively impact the intension to use such a university cloud computing service is of high relevance. Furthermore, these results can contribute to knowledge regarding the use of cloud services in higher education in general. The survey shows that most of the survey participants already use or used cloud services for private or professional purposes. This is important, as the Sync&Share cloud storage service will not be a new technology to these persons, what in turn increases the chance of their cloud adoption compared to people without any cloud experience. The possibility of sharing data with other cloud users, a full text search function and the simultaneous editing of text documents are seen as the most relevant cloud service functions. Moreover, the students and employees emphasize the need for data access through different mobile devices such as laptops, tablets and smartphones.

Another crucial aspect has a high impact both on the design of the planned cloud service as well as on the willingness of the users to adopt it: data security. The survey reflects the awareness for data security issues, e.g. caused by the NSA scandal. At the moment, the majority of the participants uses cloud services such as Dropbox or Google Drive that store their data primarily on servers in the US. The survey indicates a significant distrust towards these commercial providers, while public academic institutions are seen as far more trustworthy. The high percentage of current cloud users and simultaneous distrust towards their provider shows that students and employees lack of alternatives to existing commercial cloud solutions. An on-premise solution, hosted by educational institutions with the academic community as the target group, would represent such an alternative. If such a cloud service provides storage volume comparable to current commercial offerings and comprises functions and features that meet the demand for data protection as well as the progression of work in mobile, interdisciplinary and distributed dimensions, it will be an important tool for future collaboration in higher education.

The next step of the research agenda will be the analysis of further survey data that were recently collected from other universities in North Rhine-Westphalia (altogether over 10,000 participants). Regarding the project management, the objective is not only to compare the results on a cross-university basis but also to derive conclusions regarding the cloud service adoption rate and required average storage volume of the target user groups. In aspects of science, the goal is to contribute by additional publications regarding the diffusion of large-scale cloud storage services in higher education, identification of valuable use-cases and impact factors on the technology acceptance. In addition, an in-depth analysis of the open-ended question (factors influencing users' trust in cloud computing providers) would help to develop a general concept of users' trust in cloud computing providers. It is also needed to investigate what kind of additional services (e.g. social media applications, mobile access) could be offered to the users [17, 18]. Furthermore, the Sync&Share NRW project may also serve as a teaching case in order to educate students about cloud computing in the context of higher education, as well as entailed aspects such as trust building.

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