“sciebo — theCampuscloud” for NRW

Raimund Vogl[1], Holger Angenent[1], Dominik Rudolph[1], Anne Thoring[1], Christian Schild[1], Stefan Stieglitz[2], Christian Meske[2]

[1]Westfälische Wilhelms-Universität Münster, ZIV, Röntgenstraße 7-13, 48149 Münster/Germany, {rvogl|h.angenent|d.rudolph|a.thoring|schild}@uni-muenster.de
[2]University of Duisburg-Essen, Department of Computer Science and Applied Cognitive Science, Bismarckstrasse 81, 47057 Duisburg/Germany, {stefan.stieglitz|christian.meske}@uni-due.de

Keywords
cloud services, cloud storage, information infrastructure, collaboration, cooperative project

1. ABSTRACT

More than two years after its conception and after intensive preparatory work, a large scale cloud service for the academic community in the German state of North Rhine-Westfalia (NRW) has become operational at the beginning of February 2015. Under the brand name “sciebo — theCampuscloud” (derived from “science box”), the sync & share NRW project (Vogl et al. 2013, Walter et al. 2014) is now ready for the registration of potentially 350,000 users from 22 (out of 33) research and applied science universities in NRW. A powerful system platform with five Petabyte of net storage space and 77 servers, hosted at three university data centers providing sync & share cloud storage in compliance with German data protection legislation, has been set up, elaborate contractual frameworks have been developed, scientific studies for preparation and evaluation have been and will subsequently be conducted and a mainly student driven state-wide marketing campaign has been staged. Just ten days after its launch, sciebo has already found 5,000 users and functionality, performance and availability have been well received. Starting with the much anticipated data privacy compliant sync & share functionality, sciebo offers the potential to become a more general cloud platform for collaboration and research data management which will be actively pursued in upcoming scientific and infrastructural projects.

2. THE SYNC & SHARE NRW PROJECT AND CONSORTIUM

2.1. Project History

In early 2012, long before the disclosures on NSA activities by Edward Snowden in May 2013, concerns about the protection of private and sensible data in public cloud services were already manifest. Services like Google Mail and Dropbox were widely used, the academic and research community making no exemption. These convenient, easy und mostly free to use services had already secured their place within collaboration settings in research and learning, and catered well for the growing community of users with multiple mobile devices, allowing to keep data in sync across multiple system platforms. Terms and conditions that force users to virtually surrender all data transmitted to these services to the companies operating them were duely ignored, even if that meant that using those services was in violation of university regulations for the use of cloud services, national data protection laws or terms of articles of employment. But compliant solutions were hard to find.

Against this background, in April 2012, a student motion in the IT commission of Münster University asked the university computer center (ZIV) to come up with a sync & share storage solution provided by the university for its students. A representative user survey held at Münster University (Vogl et al., 2013) in May 2012 reassured the demand for such a service amongst both students and employees.

With this and similar input, ARNW, the board of IT directors of the 14 research universities in the German state of North Rhine-Westfalia (NRW), decided to launch a project to create an on-premise private sync & share cloud storage service as a joint effort of all universities in NRW (with potential-

ly 500,000 employees and students as its users) in June 2012, with the ZIV of Münster University as the project lead. First considerations for systems architecture, possible software solutions and capable system integrators were done in summer and fall of 2012, resulting in two vendor proposals in late 2012 and in early 2013.

Talks with the Ministry of Innovation, Science and Research NRW (MIWF) in late 2012 showed the willingness of MIWF to support this effort under the grant program for university IT infrastructure. A kick off meeting to start the formation of the sync & share NRW consortium was held on January 15 2013, which led to Letters of Interest from 16 research and applied science universities by April 2013. Accompanying scientific studies were launched at the beginning of 2013 to provide an empirical foundation for the sizing and features of this future service (Meske et al., 2014). A project proposal was prepared by the project lead and filed with MIWF in May 2013 for submission to peer review by the German Research Council (DFG).

While waiting for the results from peer review throughout 2013, preparatory work went on with continuous monitoring and evaluation of software solutions for on-premise sync & share (showing very good progress for the open source ownCloud project), suitable hardware platforms (with a very promising proof of concept by IBM with its GPFS storage server (GSS) platform and ownCloud — demonstrating scaling for a 100,000 user per site setup) and a revised multi-university survey on user expectations in cloud services and on demand for storage space and features, answered by over 10,000 employees and students at three major universities (Stieglitz et al., 2014).

Additionally, a framework for contract agreements to constitute the sync & share NRW consortium had to be developed. This was initiated in July 2013 by grant funding from MIWF for a joint research proposal from ZIV and Münster University's Institute for Telecommunication and Media Law (IMT), resulting in a set of template contract agreements for multi-university cooperative IT projects, consisting of a consortium agreement, an agreement for data processing outsourcing, and end user terms and conditions of use. The resulting templates were presented in March 2014 and distributed amongst the committed consortium members for feedback in April 2014.

By the end of January 2014, a positive review from DFG was in, recommending a total project volume of 3,1 Mio Euro with a possible increase when further demand becomes manifest. The corresponding funding was made available by MIWF by March 2014, and the procurement process was initiated.

A final evaluation of available software solutions led to the decision that ownCloud was covering all features required for the project and was uniquely positioned as an open source solution, enabling the universities to incorporate inhouse developed enhancements and having the prospect of long time sustainability and prosperity due to the active community supporting the project. Thus, the contract for the software solution and services for five years was awarded to ownCloud in May 2014. An EU tender for the hardware platform was launched in April 2014 and the contract was awared for an IBM GSS storage platform in July 2014, with hardware delivery in September.

Coordination efforts to enable all participating universities to join the Shibboleth-based Athentication and Authorization Infrastructure operated by German Research Network (DFN-AAI), which was required for the envisioned self enrollment portal, were also started at Münster University in April 2014. Onsite system integration at the three data center sites took place in October and November 2014, and software setup and tests were done in December 2014 and January 2015.

In fall 2014, a student marketing team was recruited by the Marketing Center of Münster University to set up an online viral marketing campaign preparing for the planned public launch on February 2 2015, reaching a wide audience mainly through approx. 400 Facebook groups at the participating universities. For better brand recognition, the synthetic, easy to memorize name "sciebo" (short for "science box") was coined by the ZIV public relations team, along with trademark and domain registration and the conception of the sciebo elephant logo (Figure 2).

Despite an abundance of unexpected last minute challenges, the preannounced date for public launch on February 2 2015 could be met.

2.2. Legal Framework of the Sync & Share NRW Consortium

The considerations on the legal framework resulted in the decision that the formation of a dedicated legal entity for sync & share NRW was futile, and that Münster university as consortium lead should conduct all legal businesses.

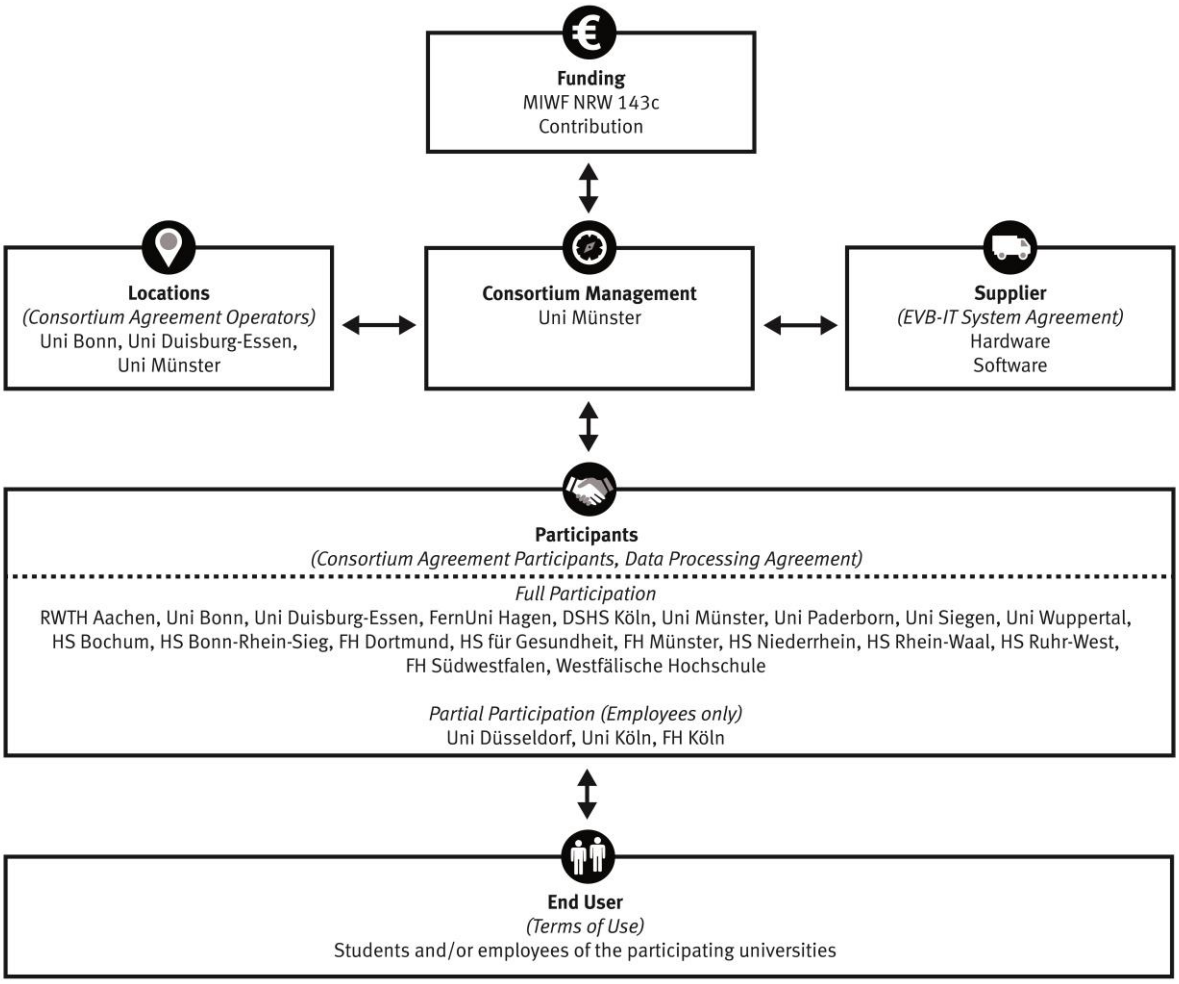

Figure 1: The framework of the sync & share NRW consortium.

The consortium was established by consortium agreements between Münster University and all consortium partners. Additionally, agreements for data processing outsourcing for the operation of the sync & share cloud service were made between Münster and its partners. Common end user terms and conditions of use are provided for the participating universities, which are legally the institutions providing the sync & share cloud service to the end users.

3. SOLUTION ARCHITECTURE

3.1. Service Specifications and Features

The sync & share NRW consortium agreed on the following specifications for the sciebo cloud service:

- Focus on cloud storage:
    - Up- and download of files to sciebo
    - Synchronization of directories on personal computers
    - Sharing of files and directories with other sciebo users or through anonymous links

    - Additional features of ownCloud like calender, collaborative document editing etc. (new features can easily be added through ownCloud apps) will initially not be supported due to better system stability and performance.
- Access to storage:
    - Desktop sync clients for Windows, Mac and Linux.
    - Mobile clients for Android and iOS; available free as “sciebo branded clients” in App and Play Store.
    - Web interface.
    - WebDAV to mount sciebo box as drive share.
- Accounts for sciebo:
    - Participating universities can offer the sciebo service to employees and/or students in their deliberation.
    - Self service registration through the sciebo enrollment portal. User authentication and authorization for use of sciebo is done via Shibboleth/SAML through the DFN-AAI service: sciebo accounts are created only for persons correctly authorized by their home university.
    - Compulsory re-authorization after six months to clear users no longer eligible for the service. When no timely re-authorization takes place, a six month grace period starts, after which access to sciebo will be blocked. All user data will be deprovisioned after further three months.
    - Sciebo personal boxes have 30 GB quota. Employees will be provided with self service tools to increase quota to 500 GB if needed.
    - Sciebo project boxes will be provided for working groups with quota ranges from 500 GB to 5 TB. Sciebo is currently not considered an adequate platform for projects requiring more than 5 TB.
    - Guest accounts with 0 Byte quota for users outside the sciebo community with whom data can be shared will be made available.
- End user support:
    - Best effort approach with no central phone support — only through online support form including integration with FAQs at www.sciebo.de (Figure 2).
    - Trouble tickets are assigned in the first level to the respective helpdesks of the participating universities, with escalation to the second level support provided by the central sciebo support team (two persons financed by the consortium for the five year project period). Third level support is provided by ownCloud for the Enterprise version license procured for the sciebo project together with five years of support.
    - File versioning and features for undeletion of ownCloud should prevent unnecessary support cases.
    - A web portal for sciebo users for self service is provided:
        - Self enrollment
        - Re-authentication (6 month intervals; email notification)
        - Password reset for the sciebo account (with authorization via DFN-AAI)
        - Account deletion (when deliberately and prematurely quitting sciebo)
        - Monitoring information on sciebo service availability
- Availability:
    - No explicit SLAs between hosting institutions and the participating universities.
    - Based on data center availability records of Münster university, a target availability for the sciebo service of 99,5% p.a. has been agreed, with monthly availability above 98% and a maximum of four hours of continuous service outage.

- Server and storage hardware are highly redundant with no single point of failure.
- The GSS storage system operates with triple-parity RAID 8+3 and is thus extremely unlikely to loose data.
- As precaution against operational errors that could lead to data loss, snapshots are taken daily and stored for 14 days.
- Backup to offline media (tape) is thus considered unnecessary and could not be realized due to the sheer amount of data.

Figure 2: the sciebo homepage, prominently featuring the sciebo logo.

3.2. System architecture and integration

From the beginning of the sync & share project it was clear that the hardware platform was to be distributed over several university data centers in NRW, due to the following reasons:

- rack space and power supply need.
- internet bandwidth that could be dedicated to the operation of sciebo.
- symbol for the multi-university cooperative effort.

The chosen software solution had to be able to realize this scenario in one cloud service with sharing of data being possible between all users, regardless of the actual storage location of their data. The universities Bonn, Duisburg-Essen and Münster were selected as loactions for the sciebo sites, each hosting individual ownCloud instances for every single participating university (Figure 3).

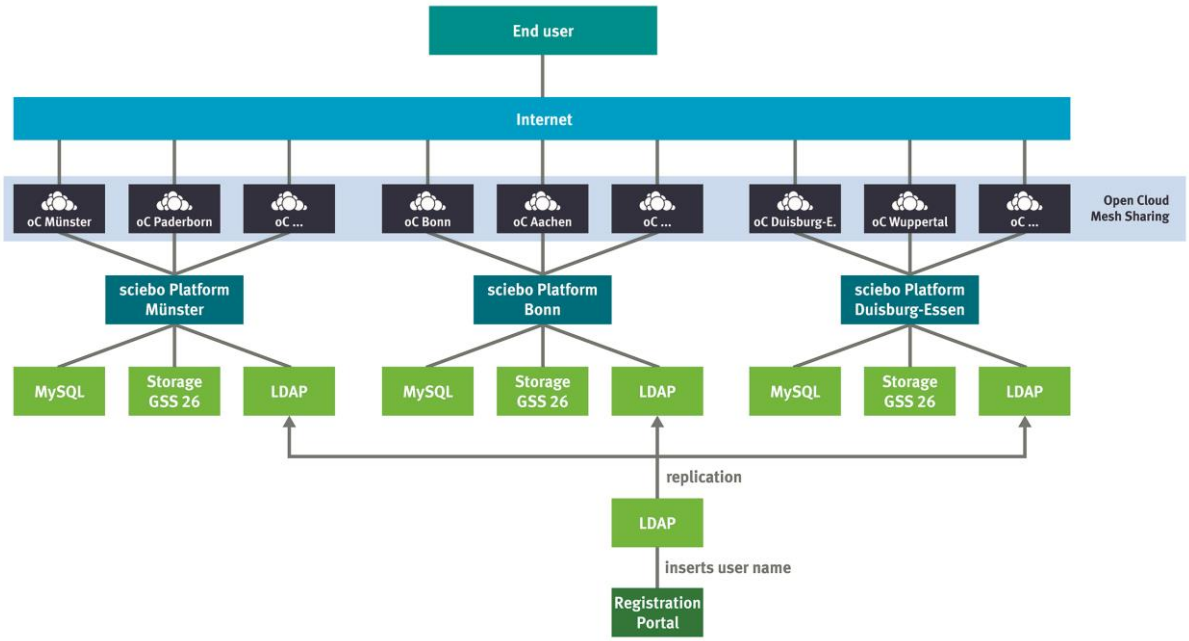

Figure 3: Schematic view of the multi site sciebo architecture.

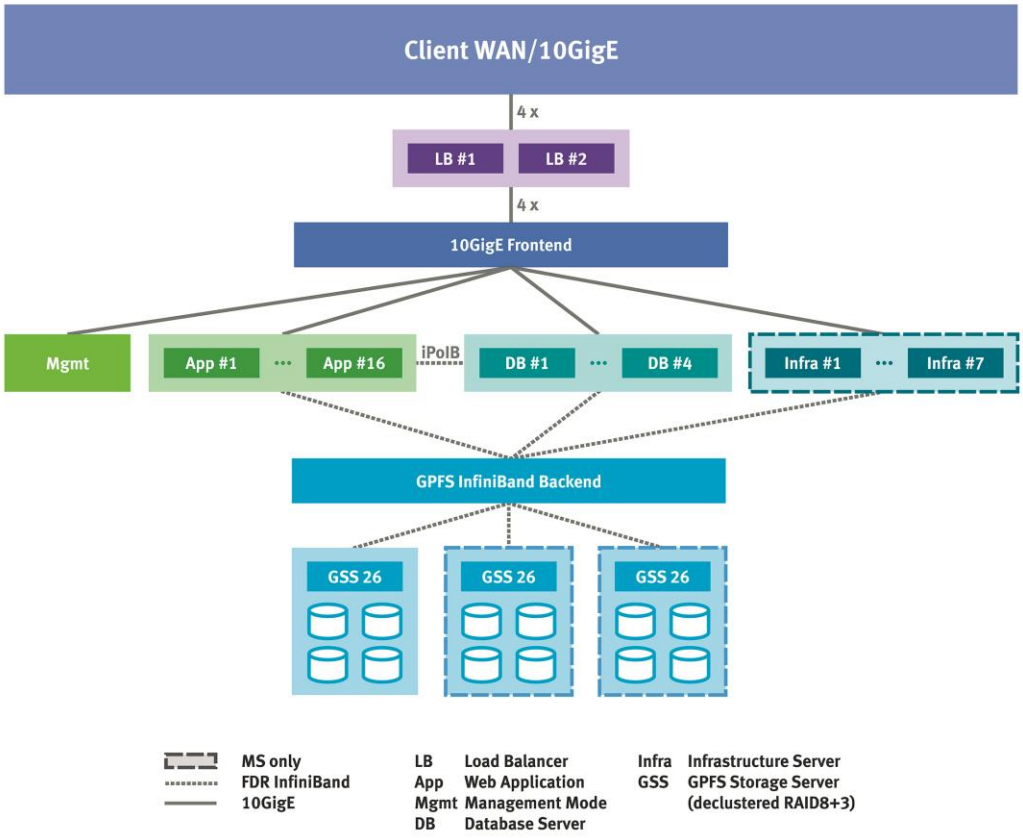

Figure 4: System architecture for a sciebo site installation.

The hardware platform at the 3 sites is virtually identical. At each site there are (Figure 4):

- 4 database servers (256GB RAM, SSDs) for a Galera MariaDB Cluster with MaxScale as database load-balancer (Figure 4).
- 16 apache web frontend server for ownCloud.
- 2 network load-balancers.
- 1 GPFS Storage Server (GSS26) system with 1 Petabyte of net storage (1,392 TB raw storage befor RAID 8+3).
- 1 management server.
- 10 Gbps Ethernet for IP traffic to all hosts.
- 56 GBps FDR Infiniband for storage access.
- 2 additional GSS26 storage systems as capacity reserve and 7 servers for backend services (DFN-AAI SP, LDAP server, Web-Portal, …) at the Münster site.

The software stack is comprised of a wide range of production quality open source tools (figure 5).

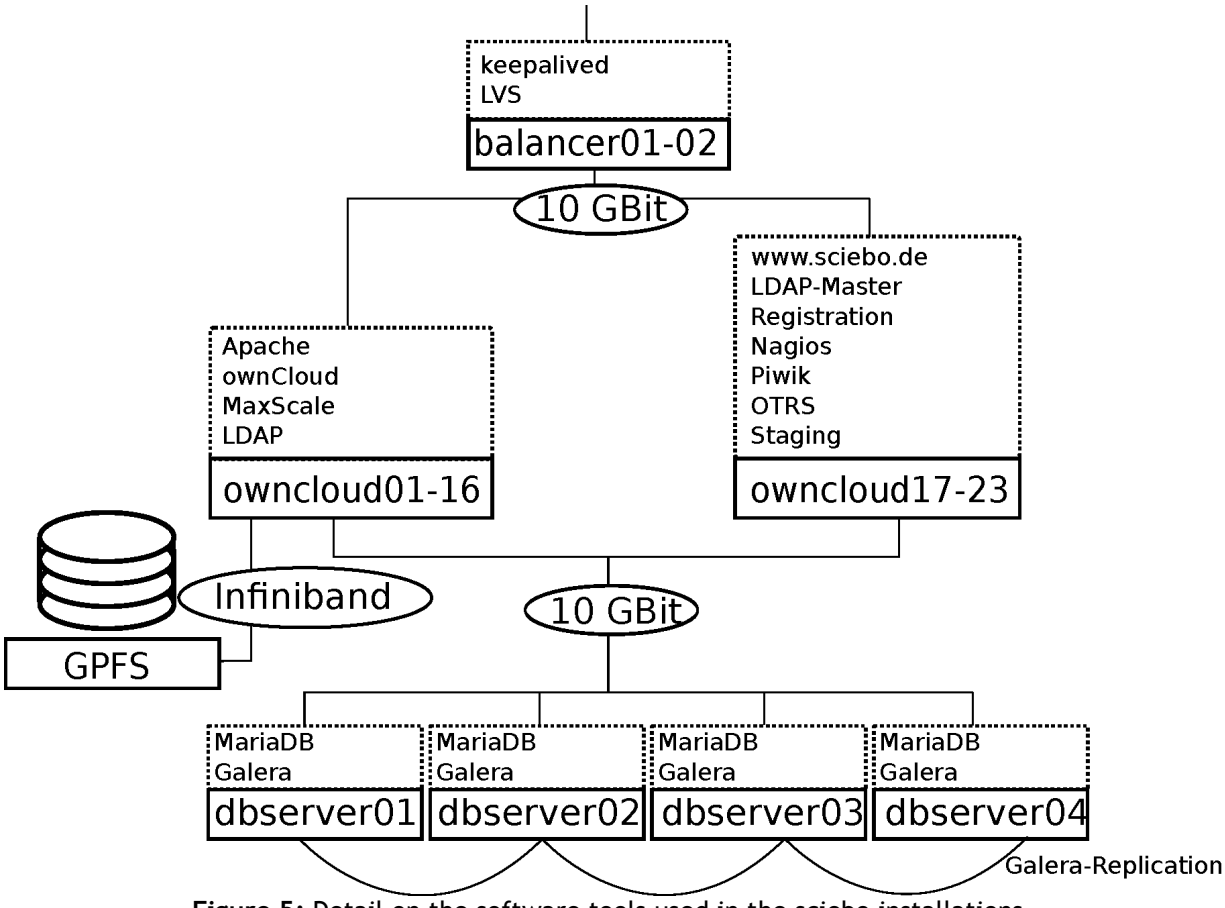

Figure 5: Detail on the software tools used in the sciebo installations.

All user accounts are created through the self enrollment portal (with authentication and authorization via DFN-AAI), maintained in an LDAP database replicated between the three sites. Each participating university has a separate ownCloud instance. These ownCloud instances are distributed over the three sites to achieve balanced hardware utilization.

Sharing data between sciebo users from different universities is done by means of the server-to-server sharing mechanism (also known as Open Cloud Mesh) which allows to create this “cloud of clouds” and was developed by ownCloud in view of the sync & share NRW project.

4. SCIENTIFIC STUDIES ON USER ACCEPTANCE AND SERVICE ADOPTION

The design and management of such an infrastructure is a challenging and complex task — and empirical information with scientific scrutiny is crucial for an optimized design and appropriate sizing. Furthermore, users need to be persuaded to change their working routines and to adopt a new solution. Therefore, not only do the technical aspects have to be considered, but also the actual individual demand for a new solution, as well as the willingness and ability to use it. Accompanying the preparatory work for the sync & share NRW project, scientific research to provide a solid foundation for the choices to be made on core functionalities and sizing was initiated.

Researchers have already developed various models to address these questions, for example, models for technology acceptance like TAM, UTAUT (Davis 1989, Venkatesh 2003) and for adoption processes such as Diffusion of Innovation Theory (Rogers 2003), which we will not discuss in detail. A crucial first step is to gather data on the potential users' requirements. Based on the understanding of cloud services as an infrastructure according to Pipek and Wulf 2009, as well as on Masud and Huang's (2012) service-centered approach, we conducted an online survey at three large German universities (RWTH Aachen, University of Münster, University of Bonn) in 2013 with a total of 10,367 completed questionnaires (7,623 students and 2,744 employees). In our study (Meske et al. 2014, Stieglitz et al. 2014), we concentrated on the system components (features/functionalities, data storage volume) and attributes (such as interoperability and privacy policy) that are recognized and of immediate interest to the (potential) users. The design of these components and attributes has a direct impact on employees' and students' decisions to use the system, keep using it, or avoid using it. This aspect is especially meaningful because potential users can easily compare the characteristics of each component or attribute to those of profit-oriented services.

Data shows that sciebo will face a major challenge: 81% of the students and 72% of the employees already use commercial cloud services like Dropbox. Despite the high market share of these potential competitors for sciebo, 81% of respondents state their willingness to use the sciebo campuscloud additionaly or even exclusively.

The survey results clearly show that security and privacy concerns play an important role and will most probably be one of the major drivers for the adoption of sciebo. For example, 60-70% of the students at all the universities and approximately 80% of the employees mentioned that the physical data storage should be located in Germany. We also found that a lack of trust is the major reason for not using cloud computing. Universities in their role as cloud service providers substantially benefit from being perceived as trustful organizations. More than 80% of the students and more than 75% of the employees confirmed that they would trust the cloud computing that a university provides more than one provided by enterprise-operated services.

Our survey data shows that the university students and employees expect to need more data storage volume than they currently use on commercial cloud computing. The reasons for this could be:

(1) users' higher trust in university provided cloud services and their plan to store additional data,

(2) users anticipating they would require a higher data storage volume in the future,

(3) users already facing profit-oriented providers that limit the data storage.

Our data shows that about three-fourths of the students and approximately two-thirds of the employees at all the universities stated that they would require data storage volume of between 1 and 20 GB. Based on a maximum user base of 350,000, this would give a wide spectrum between 0.35 and 7 petabytes. Given the users' growing demands, data storage should be sized with the upper boundary in mind to offer each employee and each student as much volume as possible. This could also positively affect the service's perceived attractiveness. However, investment decisions are very complex in this area, since it is difficult to estimate the actual demand. Additionally, the design of such an infrastructure needs to be seen as an ongoing dynamic process (for example, the required data storage volume might significantly increase over time, and other commercial services could extend their offering).

Our survey also shows that there is a high demand to integrate collaboration features into sciebo. For example, employees want to share documents (91%), collaborate with each other in real time (76%), and comment on other employees' documents (59%). Surprisingly, these features are not only demanded by employees, but by students on an even larger scale. Taking this finding into account in

the design process could result in higher user satisfaction and workforce and student productivity. Furthermore, it could increase the attractiveness of the service compared to that of profit-oriented competitors.

All user groups mentioned PCs as the most important device from which to access cloud storage. However, our survey results confirm the success of smartphone usage at universities. Two-thirds of the students stated that they plan to access sciebo via smartphone if possible. More than half of the employees shared this intention.

The integration of sciebo with other services has also been mentioned as an important design issue. For example, 64% of the employees and 43% of the students wish to integrate their calendars and task lists into sciebo. More than half of the students and half of the employees want sciebo to be integrated into the existing e-learning system or work environment.

By our study, we gained insights into what students and employees expect from sciebo. Even though we draw on a solid database, it is important to state that the design of such an infrastructure is a continuous process. Further, different changes in the environment (such as technical, political, and legal) affect the cloud infrastructure service. Therefore, all of the relevant stakeholders, such as representatives of different user groups, should be involved in the ongoing process of development and adaption. As mentioned before, it is essential to continuously adapt the system to the changing environment (for example, storage requirements, new working routines, new tasks, improved technologies). In order to do so, we need to regularly gather information on the system's statistics and user behavior.

5. FIRST RESULTS

Despite an abundance of unforeseen challenges in setting up the multi-site hardware platform and software solution, with extensive tests needed for integrating the identity management systems of the participating universities with the sciebo self enrollment portal through DFN-AAI, the preannounced launch date of February 2, 2015 could be met. User registrations in the first three days amounted to 3,000, with 5,000 users registered after 10 days — in good agreement with the 2,5% ration of "innovators" according to the Theory on Diffusion of Innovation (Rogers, 2003) and proving the effectiveness of the online marketing campaign. Only partial and rarely noticed service interruptions occurred on the first two days due to a small software issue with the LDAP user account data interface in ownCloud (duely fixed), performance issues occurring because of an erratic storage device defect and the need for advanced database tuning for heavy user load. User-support interaction through the feedback forms provided on www.sciebo.de and through Facebook and Twitter proved to be effective and provided valuable information for service improvements and on user satisfaction. Awareness for sciebo in the technology-savvy online community showed to be high, with hacking-activist students volunteering to provide input for improved security, which was openly accepted.

Of the 22 universities committed to the project, 15 managed to overcome all technical (DFN-AAI integration) and organizational (signing of contracts in university presidia, consent of personell representatives, etc.) challenges on time for the launch, with the rest working to join in the next weeks. Further universities not yet committed are now considering to join the consortium.

6. FURTHER ACTIVITIES

In continuation of the well established scientific evaluation of the project work, a survey on user satisfaction and input for service improvement will be conducted three month after the launch. Non-personal data on the usage of sciebo will be closely monitored to confront predictions from theory (e.g. Diffusion of Innovation, Rogers 2003) and to established updated projections for resource utilization in order to timely initiate funding proposals and tendering for necessary expansions of the system platform.

Since we comprehend sciebo not just as a sync & share cloud storage service (a "one trick poney", so to say) but as the seed for a versatile information infrastructure (Pipek et al, 2009), further research will especially focus on user demand for and adoption of novel usage scenarios, based on a powerful, elastic, well established and widely used cloud platform. Amongst these additional usage scenarios, research data management and e-learning are the most concrete. For research data management, we see huge potential for addressing the collaboration domain in the curation domain

model (Treloar et al. 2007, Klump 2011) and creating further benefits for researchers by providing easy to use interfaces to the publication domain. In the field of e-learning, close integration with the most common e-learning systems at NRW universities (Moodle, Ilias) are planned, making it possible to easily distribute digital materials to student mobile devices for paperless learning.

The sync & share NRW project was seminal for ownCloud to develop their Open Cloud Mesh approach towards interconnected private clouds. Based on this upcoming standard, we expect to create interoperability with other cloud storage services similar to sciebo in academia and research.

7. REFERENCES

Davis, F.D. (1989): Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. In: MIS quarterly, 13 (3), 319-340.

Klump, J. (2011): Langzeiterhaltung digitaler Forschungsdaten. In: Büttner, S, Hobohm, H.-C. & Müller, L. (eds.): Handbuch Forschungsdatenmanagement. Bock + Herrchen: Bad Honnef, 115–122.

Masud, A., Huang, X. (2012): A novel approach for adopting cloud-based e-learning system. In: Proceeding of the 11th International Conference on Computer and Information Science, IEEE, 37-42.

Meske C., Stieglitz S., Vogl R., Rudolph D. & Öksüz A. (2014): Cloud Storage Services in Higher Education – Results of a Preliminary Study in the Context of the Sync&Share-Project in Germany. In: Zaphiris, P. Ioannou, A. (ed.): Learning and Collaboration Technologies. Designing and Developing Novel Learning Experiences. Lecture Notes in Computer Science. (Proceedings of the 16th International Conference on Human Computer Interaction (HCI International) 2014., Crete, Greece. Cham: Springer International Publishing, 161-171.

Pipek, V., Wulf, V. (2009): Infrastructuring: Toward an Integrated Perspective on the Design and Use of Information Technology. In: Journal of the Association for Information Systems, 10 (5), Article 1.

Rogers, E.M. (2003): Diffusion of Innovations (5th ed.). New York: Free Press.

Stieglitz S., Meske C., Vogl R. & Rudolph D. (2014): Do Universities Need To Host a Cloud Computing? Proceedings of the International Conference on Information Systems (ICIS) 2014, Auckland, New Zealand.

Treloar, A., D. Groenewegen & C. Harboe-Ree (2007): The Data Curation Continuum: Managing Data Objects in Institutional Repositories. In: D-Lib Magazine, 13 (9/10), 13.

Venkatesh V., Morris, M., Davis, G. & Davis F. (2003): User acceptance of information technology: Toward a unified view. In: MIS Quarterly, 27 (3), 425-478.

Vogl R., Angenent H., Bockholt R., Rudolph D., Stieglitz S. & Meske, C. (2013): Designing a Large Scale Cooperative Sync&Share Cloud Storage Platform for the Academic Community in North Rhine-Westfalia. In: Sukovski U. (ed.): ICT Role for Next Generation Universities - 19th European University Information Systems - EUNIS 2013 Congress Proceedings, Riga: Riga Technical University, 205-208.

Walter N., Öksüz A, Compeau D., Vogl R., Rudolph D., Distel B. & Becker, J. (2014): Sync&Share North Rhine-Westphalia. In: Proceedings of the 22nd European Conference on Information Systems (ECIS 2014), Tel Aviv, Israel.

8. AUTHORS' BIOGRAPHIES

R. Vogl holds a Ph.D. in elementary particle physics from the University of Innsbruck (Austria). After completing his Ph.D. studies in 1995, he joined Innsbruck University Hospital as IT manager for medical image data solutions and moved on to be deputy head of IT. He served as a lecturer in medical informatics at UMIT (Hall, Austria) and as managing director for a medical image data management software company (icoserve, Innsbruck) and for a center of excellence in medical informatics (HITT, Innsbruck). Since 2007 he has been director of the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster (Germany). His research interests focus on management of complex information systems and information infrastructures.

H. Angenent has studied physics at the Technical University of Ilmenau and the University of Münster (Germany). He worked four years as a research assistant at the institute of Theoretical Physics in Münster. Since 2010 he is a research assistant at the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster and responsible for high performance computing systems and cloud services.

D. Rudolph is a research assistant and member of the management at the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). He received his Ph.D. from the University of Münster, where he also studied communication sciences, economics and modern history. His research focusses on the diffusion of media innovations from the user perspective. In the context of the sciebo project, he is research coordinator and responsible for the marketing.

A. Thoring is a research assistant for public relations and marketing at the Zentrum für Informationsverarbeitung (the computing center) of the University of Münster (Germany). She graduated from University College London (UK) and the University of Münster with degrees in communication sciences, publishing and strategic communication. Her research focuses on strategies and tools of corporate communications.

C. Schild is a research assistant at the Zentrum für Informationsverarbeitung (the university computing center) of the University of Münster (Germany) and responsible for authentication systems. He studied physics at University of Münster. He was a leading member of the JOIN project at the university of Münster which participated in several european cooperative projects (some ipv6 task forces, 6WIN, 6NET) to develop and propagate the IPv6 protocol.

S. Stieglitz is full professor for 'Professional Communication in Electronic Media/Social Media' at the Department of Computer Science and Applied Cognitive Science (INKO) at the University of Duisburg-Essen (Germany). Previously he was an assistant professor at the Department of Information Systems at the University of Münster (Germany). He is founder and academic director of the 'Competence Center Connected Organization' at the European Research Center for Information Systems (ERCIS). His research focuses on economic, social, and technological aspects of collaboration software and has been published in reputable international journals such as Journal of Management Information Systems, Social Network Analysis and Mining, MIS Quarterly Executive, and International Journal of Social Research Methodology.

C. Meske is a research assistant and Ph.D. candidate at the Institute for Professional Communication in Electronic Media / Social Media, at the Department of Computer Science and Applied Cognitive Science (INKO) at the University of Duisburg-Essen (Germany). He was a Visiting Scholar in the Discipline of Business Information Systems at the University of Sydney Business School and is member of the Competence Center Connected Organization at the European Research Center for Information Systems (ERCIS). He studied Business Administration at the University of Potsdam (Germany). His research focuses on the governance, management, and adoption of innovative technologies within organizations.