



Project Report **TUMcloud**

Team	Natalie Kira Eisenhut Stefan Froschmeir Fabian Gura Michael Haubenschild Jennifer Herrmann Nikolai Morin Ingmar Polte Leonard Przybilla Sebastian Zäpfel
Tutor	Bernhard Bohn Hendrik Heenen Paul Stursberg
Mentor	Prof. Dr.-Ing. Klaus Diepold

To the cloud and beyond

“I’ve always been a connected person. Ever since I got my first computer I’ve used technology not just for work, but also to stay connected to those who matter most to me. In my opinion, the Internet is all about collaboration, about sharing, about being close to people even if in reality they are on the other side of the planet. It is fascinating to see how the pace of innovation seems to be ever increasing. Life is so much more convenient nowadays.”¹

The Internet has always been a place for great innovation. Over the years it has fueled the rocket-like rise of young startups, some even steeper crashes and the phoenix-like resurrection of a whole industry. Today, major parts of our everyday life heavily depend on the Internet. One of the latest trends stimulated by the world wide web is so-called “Cloud Computing”. Since giving a precise technical definition about what “the cloud” really is seems to be impossible, let us stick to what it means for most people: The cloud is a simple way to store and share data of all kind and to have it available no matter where you are and no matter what device you have with you.

A centralized system for data storage that is universally accessible through the Internet creates new opportunities for simple and convenient collaboration. On the other hand, there are reasonable concerns when it comes to uploading private data to “the cloud.” Apart from general fears about government mass surveillance there have been dramatic cases where unauthorized access to private or business-critical data has led to tremendously negative consequences for the owner. It is obvious that cloud technologies come with great potential, but also with risks that need to be dealt with adequately.

“To be honest, when I first came to the university and started working with its IT systems, I felt a little bit disappointed. It’s not that I missed anything specific, but my overall impression wasn’t exactly what I had imagined IT at a leading technical university would be like. I have had experiences with the easy to use systems from some of the commercial market leaders. At TUM, to me it felt like they got most things right, but very little was perfect.

Many different solutions seemed to be available, but often they were hard to find and a great degree of fragmentation led to inconsistencies that made work feel inefficient. Furthermore, most systems just were not flexible enough to support true collaboration. In consequence, a lot of my colleagues decided to use commercial alternatives, including all disadvantages this implies in an academic context.”

Universities are all about collaboration. Modern IT systems can drastically reduce the overhead that comes with working in a team - no matter how small or large it is. In consequence, they can help to better connect teams, increase their productivity and make collaborative work a much more pleasant experience for all involved parties. At TUM, a lot of effort is being spent on continuously introducing such innovative systems, on improving the overall user experience, unifying existing systems and promoting them amongst the members of the university. Nevertheless, there still is room for improvement towards a consistent IT infrastructure that really fosters collaboration.

Furthermore, IT is a rapidly changing field with new trends arising at an enormous rate. Trying to be at the forefront of innovation is a

great challenge. Impetus provided by somebody with an unbiased view can be beneficial to identify aspects that might need additional work.

“It is important that decision makers really focus on innovation. To me, part of that is listening to the ideas and concerns of students. There are some great efforts especially among student initiatives. I discovered that they can really set up a lot of impressive things. It seems like in the end it is a lack of communication that prevents those efforts from being turned into something really great!”

We started project TUMcloud because we are convinced that even a small group of students can have a great positive impact on the whole university by making contributions towards further improving university IT. The original idea was to create a simple, consistent and collaborative platform for data management at TUM. In more concrete terms this means that we wanted to create a system combining functionalities of Dropbox, Eduroam and Google Docs. Realizing that there already are several initiatives aiming into the same direction, we decided early on to expand the scope of our project. Over the course of the following months we started collecting suggestions and feedback from fellow students and university personnel, generated our own ideas and established connections to relevant institutions within the university.

In the beginning our focus was placed on comparatively minor, rather concrete pain points and on ways to overcome them, but over time we started to think in a much more visionary way about what we call the “digital academic workplace of the future”. We tried to work out the trends that will have the greatest impact in

the next years and subsequently started deriving actions and decisions that we think need to be discussed today in order to be well prepared for future developments.

Assuming that a group of nine students can radically change and innovate IT of a whole university would be presumptuous. We see ourselves in a very different position: First, we focused on listening to the people who are behind the core parts of university IT. We wanted to learn more about their specific tasks, services and ideas. Furthermore, we tried to better understand the different interests and concerns those people have. Afterwards, we worked on bringing our ideas to the agenda, to promote them and to explain what benefits they will generate for all members of the university.

By directly implementing some of these ideas in the form of software prototypes we demonstrated for example how system interfaces can be used to access information in a more convenient way, how two distinct systems can be connected for additional user benefit and how existing systems can be augmented to enable collaboration. Details about the results of our work can be found in the report on the following pages.

“It’s been quite some years since I’ve last set foot on the university campus, but now that I am back all those memories came up again. Considering for example the remarkable innovations in IT, everything seems to be so much easier nowadays. Systems got so smart, it feels weird if they are not there anymore. I wish I could have used this new “digital workplace” back in my days. Being a student would have been so much easier.”

¹ The statements in the paragraphs marked by quotation marks were compiled from interviews with students and alumni. In consequence in its entirety they do not reflect the opinion of a single person, but rather illustrate a common pattern among the individual statements.

Abstract

IT services have become an omnipresent factor in everyday student-life. The TUMcloud team set out to discover how new trends in IT can help to simplify common tasks, foster collaboration, and boost productivity.

1. Background

In the light of strong competition between universities, partly triggered by intensified international mobility of students and the regular release and consultation of global university rankings, students are increasingly viewed as customers of services offered by the university. Therefore, the institution and especially the IT solutions it chooses to offer to students are evaluated with regard to the quality of service they manage to provide (Alt et al., 2010, pp. 186). ‚Student lifecycle‘ is one of the keywords mentioned in this context (Bick & Börgmann, 2009, pp. 109), indicating not only that the student is explicitly viewed and treated as a customer of the university he or she attends, but also signifying the necessity to divide a student’s interaction with the university into several phases, beginning with the orientation and decision for a certain field of study and university, followed by the core studies, graduation, and different stages as alumna or alumnus (Alt et al., 2010, pp. 186). All of these phases impose different requirements on the university’s IT systems.

Students are increasingly viewed as customers of services offered by the university

While the university’s IT infrastructure with the campus management system at its core should support all of the phases mentioned above, our role as current students enabled us to focus specifically on the demands this target group might have. Students often expect institutions of higher education to adopt some of the major technological trends from the consumer or entertainment sector. During early discussions within the project team innovative approaches towards collaboration within the student community and between students and lecturers as well as the convenience of gathering, editing, and storing university-related documents such as lecture notes, lecture videos, personal notes etc. in a consistent

way were tentatively identified as potential areas of improvement. According to Johnson et al. (2014) within the upcoming two years increasing pervasiveness of social media and integration of online, blended, and collaborative learning (pp. 9) will be major trends. This view is backed by Sharples et al. (2014), who identify massive open social learning (pp. 9) and the flipped classroom approach (pp. 15) as two major innovations in the area of education. Another field of development, that over the past few years has already found its way into private and corporate use (Gandhi et al., 2012) and possibly yields a lot of potential for applications in the academic context, are cloud storage services. They might help to solve the challenge of providing convenient access to cheap, centralized and secure data storage and could serve as the fundamental technological basis for the effective implementation of innovative educational concepts.

As already mentioned, the consideration of major technological innovations and trends that universities such as the Technische Universität München face has to be accompanied by an analysis of established IT systems that are already in place and actively used by students on a regular basis. Our approach towards identifying potential areas of innovation with regard to IT services therefore incorporates not only the assessment and evaluation of current and future trends in education and technology, but also the potential of ad-hoc improvements to the IT systems currently in use. Furthermore, the question remains whether all major technological trends can be transferred successfully for use within institutions of higher education and whether they would actually contribute to the fulfillment of the university’s core mission. In the following we would like to provide an overview of the goals of the project, the methods harnessed, our key findings and the implications one can derive from these findings regarding the IT systems at TUM.

2. Goals and Methods

Goal

The project started with a simple idea: Help students at TUM spend less time on gathering lecture material from numerous places to have more time to focus on their actual studies by simplifying both

access to data and digital collaboration. Often, extracurricular projects like these start extremely ambitiously, with the idea of changing everything by challenging all existing solutions and starting again from first principles. However, this approach usually does not work in practice and most of the time people are brought down to earth rather soon. We knew that we could not change the entire IT landscape at TUM being only a handful of students. Instead, right from the beginning, we tried to aim for more realistic goals and embraced our key ability: providing a customer’s perspective to the people who are responsible for today’s IT systems to help plan those of tomorrow. This strategy enabled us to put some of the greatest concerns of students as well as many innovative ideas to the top of the agenda of the individual decision makers.

Methods

In order to really understand all restrictions that might limit the applicability of the changes that were discussed initially and developed over time, we first analyzed the status quo including an investigation into how the established IT systems at TUM have developed and what the underlying rationale has been. Several brainstorming sessions supported by a Design Thinking workshop helped us to define the topics we wanted to cover. In subsequent expert interviews and through in-depth literature research we were able to compile an extensive report on a) the number of different IT services currently in use, b) the responsible management structures in charge of these systems, and c) the financial and legislative framework they are tied to. These investigations were supported by an assessment of the IT systems established at other universities in Europe, North America, and Asia. Furthermore, we worked on developing a visionary concept of how a student’s daily life in the future could look like, given the fact that technology will without doubt play an even greater role.

All acquired and developed points for improvement were bundled together into a portfolio of ideas and were presented to a group of students in a survey. Altogether we wanted to understand which systems are most important at the moment, which improvements promise the greatest benefit from the students’ perspective and thus which of them should be prioritized. The survey was distributed both on paper in selected lectures and online for promotion

in social network student groups. The analysis of this survey enabled us to make evidence-based recommendations to responsible stakeholders about the degree of urgency required to fix existing issues and about which new features should be considered for implementation first. A number of short-term issues have already been fixed as a result of our efforts and members of our team developed prototype implementations as a proof of concept for other ideas. In cases where there have already been independent efforts to solve a given problem, we reached out to the respective parties to reassure them that those efforts were perfectly aligned with the user needs we identified.

3. Outcome and Discussion

In the following paragraphs we will discuss some key results of the survey we conducted regarding the use of IT systems at TUM among students. Alongside these findings we present key learnings and results of our project work relevant to the discussed issue. For the survey we decided to focus primarily on two non-computer science faculties so that, out of the 111 respondents to our survey, 35.5% were enrolled in the Faculty of Chemistry and 32.7% in the School of Management. 64.5% were seeking a Bachelor’s degree while 32.7% were pursuing their Master’s.

TUMonline

On the topic of TUMonline, the student lifecycle management system at TUM, a number of ideas presented in our survey received overwhelming support by respondents. 95.9% would welcome a login field directly on the homepage, foregoing the need to click a link to reach the login page. When it comes to actual use of the system, or more specifically its search function, a majority of respondents (66.3%) searched for courses at least once a month and a smaller yet still significant share (36.6%) looked up the location of rooms on a regular basis. All of the other search categories were hardly ever used. While these numbers suggest search in its status quo is useful, a large majority of 79.6% rated the introduction of a unified search function, i.e. the ability to search across all categories at the same time, as ‘helpful’ or ‘very helpful.’ Even more pronounced was the wish for additional features and enhancements in the area of general usability. 83.1% rated a dynamic version of

their personal TUMonline homepage, which would for example display mandatory courses or reminders for exam registrations for courses the student is registered in, as ‘helpful’ or ‘very helpful.’ A great majority furthermore expressed strong or very strong support for efforts to optimize the user interface for use with mobile devices via browsers (87.5%) and more than 77% would appreciate or highly appreciate the possibility to access the system through a smartphone app.

In July 2015 a delegation of the team had the opportunity to travel to Graz for a meeting with the lead architects of CAMPUSonline, the system TUMonline is based on. Apart from deep insight into the technical details of the current system, the rationale behind it and possible limitations, the developers shared their ideas and plans for the next major release of the product scheduled for launch in 2016. We presented our own findings from research, benchmarking, surveying, and expert interviews we had conducted throughout the project. The software architects expressed great interest in our results. While discussing some of the major pain points students regularly encounter when using the system, it turned out that they are often merely due to configuration or data administration issues that are fixable in the short term by the respective university or faculty.

Overall the meeting has been highly productive and of great benefit for both parties. At this point we can disclose that the next major version of CAMPUSonline to be released in 2016 and to be introduced at TUM in 2017 will be based on modern web technologies. The main trends it will incorporate are universally accessible application programming interfaces (APIs), usability on mobile devices, and the removal of rarely used features from the core product. All of the aforementioned aspects can contribute to increasing the system’s flexibility, usability, and overall performance. The developers are optimistic about addressing all of the issues we discussed during the meeting either directly within the core product or by giving individual universities the ability to add specific functionality to the platform in a sustainable and easily manageable way. By placing emphasis on subjects such as modularity, testability, and extensibility, the software engineers are furthermore trying to be quicker in adapting to user needs through shorter release cycles.

Cloud Storage and Collaborative Systems

Inextricably linked to the growing use of cloud storage is the topic of privacy and data protection. The survey results on this subject are, however, somewhat contradictory. While 68% indicated that privacy is ‘important’ or ‘very important’ to them, only 41.8% of the respondents stated that they take active measures to protect it. General adoption of cloud storage services in our sample is high with 60.4% using them for university and 60.4% for private purposes. Almost three out of four respondents would use a cloud storage system offered by the university. When given the choice between placing the focus on privacy or ease of use for such a system no clear consensus is reached with 54.6% voting for a focus on privacy and 45.4% favoring ease-of-use.

Shortly after we started the TUMcloud project we learned that there had already been ongoing efforts in the direction of introducing a cloud storage system inspired by commercial providers such as Dropbox at TUM. The initiative is coordinated by the Leibniz Rechenzentrum. We reached out to the project coordinator and met him not only to learn more about their priorities, plans, timeline, technical choices, and current challenges, but also to discuss ideas on how to integrate the cloud storage system into existing platforms through universal programming interfaces, how to foster collaboration, and how to promote the system to obtain appropriate adoption rates within the university.

The result of this joint effort by LRZ, both Munich universities, and others, is a system based on the commercial PowerFolder software called LRZ Sync+Share which started trial operation in April 2015. We have been actively working with the system ever since and have contributed by providing feedback on synchronization and usability issues as well as by encouraging all involved parties to not just think about creating a stable system, but also about how the platform can enable innovative ideas just by providing open and reliable programming interfaces. As of August 2015 the system is scheduled to start regular operation by the end of the year. It is, however, unclear when support for programming interfaces can be enabled. This currently blocks other parties such as the Medienzentrum from moving forward with interesting ideas such as solutions for simplified collaborative project work.

One of the ideas we presented in the survey is automatic synchronization of course material between an e-learning platform and a cloud storage system. Starting the very moment a user signs up for a course in the campus management system, relevant course material will be available and up-to-date on all of his or her devices. Since 73% of the respondents considered the idea ‘helpful’ or ‘very helpful,’ we decided to develop a small prototype implementation of a system that can synchronize data between Moodle as a central e-learning platform and an arbitrary cloud storage provider. User feedback has been very positive and TUM’s Medienzentrum as the center of competence for e-learning at the university and the owner of the Moodle platform at TUM has expressed great interest in the idea and the code behind our prototype.

One of the weaknesses we could identify in the current environment is the lack of systems that directly support collaboration. In the future Sync+Share could be the central place to store data that several users work on at the same time, although right now the necessary functionality to support such applications is not yet available. At the moment the university does not offer a real alternative to commercial systems such as Google Docs or Microsoft Office Online for collaborative document creation.

There is furthermore no universally accessible version control system for programming projects. Video conferencing is in general not available to all members of the university and the system offered can not compete with other commercial services such as Microsoft’s Skype or Google’s Hangouts in both usability and functionality. As part of our project we set up a test instance of a system for collaborative creation of scientific documents in LaTeX. Feedback from students and researchers has been overwhelmingly positive and our system has been taken over by TUM’s Medienzentrum for further evaluation.

e-learning / Moodle

95% of all students have used Moodle

Almost 80% of all students download lecture material from two or more platforms

Adoption rates of the university’s primary platform for e-learning are, as expected, very high: 95.3% indicated that they had used Moodle before. This being said, a large majority of 79.8% reported that their lecture materials are located on two or more platforms and a majority of 69.3% considers the current distribution of lecture materials to be ‘uncomfortable’ or ‘extremely uncomfortable.’ As an improvement to the way material is currently distributed through Moodle, an overwhelming majority of 89.3% would like to be notified about changes to existing documents.

Another topic investigated by the survey was demand for and use of collaborative features. 63.3% rated a proposed functionality to add comments and feedback to uploaded documents as ‘helpful’ or ‘very helpful.’ Around half of the respondents use Moodle’s built-in forums on a regular basis. For those reporting their use of the forum to be less than once a month, ‘No need for forum’ was the most frequent answer with 48.8% of responses, followed by ‘use of alternate means for asking questions’ with 46.5%. Facebook groups as an alternate means of discussing study-related topics were not particularly popular, either. 52.8% reported using it at least once a week. The third option included in the survey was by far the most popular one: personal communication with fellow students. 90.6% reported discussing study-related topics with fellow students at least once a week.

Over 90% of students still prefer to discuss study-related topics in person

One of the concerns that was raised repeatedly is the fact that Moodle at the moment is mostly used as a platform for the unidirectional distribution of PDF documents. Our research indicates that increased consulting efforts directed towards lecturers are a promising way to promote the use of advanced features of the platform such as polls, glossaries, quizzes, and forums. As a result, user engagement with the platform increases drastically and so does the rating of the overall user experience.

The idea of developing a plugin that would allow direct communication between students and teaching personnel right next to the uploaded material has been praised by both parties as a great

way both to lower the threshold towards asking questions and reporting errors or ambiguities in the material and to decrease the amount of work for the latter group since questions only have to be answered in one central location.

Among the many other ideas we presented in our survey there are two additional ones that many students would like to see in a top spot of the agenda for the near future: an optimized version of the Roomfinder application and the possibility to access eligible TUM buildings on weekends by using the student card for identification. The former request has been worked on for quite some time now in collaboration with a startup founded by TUM alumni as well as the Internet company Google.

Promising results of preliminary work have been shown, but at the moment no clear timeline for a final product can be given. Forwarding the wish of enabling authorized building access through student IDs, on the other hand, has sparked an initiative by TUM's real estate management department to investigate currently existing solutions for individual buildings and to evaluate campus-wide introduction of a centralized system by launching a pilot project later this year.

4. Summary and Future Goals

In the course of our research we have obtained deep insight into how IT systems are managed within a university; we have met interesting personalities and influential decision-makers; we have learnt a lot personally; and we have been able to make valuable contributions in many areas which we think all members of TUM will benefit from—admittedly to a varying degree.

Being part of the TUM: Junge Akademie community has opened a lot of doors for us and thus definitely contributed to the overall success of the project. Our research has attracted great interest from many institutions and individuals within the scope of the university and beyond. User feedback with regard to our ideas, prototypes, and test instances has been overwhelmingly positive and very encouraging.

For a number of projects we have attracted strong partners who have agreed to pursue our work in evaluating individual systems and aiming towards the goal of making innovative functionalities available to all members of TUM. These partnerships enable us to move forward with our ideas on a scale that is far beyond what a small team of students could achieve on its own. Overall the IT landscape at TUM seems to be in good shape, especially compared to other leading institutions. We have, however, identified two strong trends that we think require additional effort: On the one hand the university's current portfolio seems to be weak with respect to systems that support collaborative work.

On the other hand initiatives in the direction of universally accessible interfaces for data exchange between systems can help to spark innovative solutions and enable faster adoption of changing user needs. Users are, however, not looking for the addition of a plethora of bells and whistles, but wish for solid core functionality that perfectly fits their needs and enables them to focus on the task at hand. In general we remain strongly committed to working with our partners to keep student interests at the top of the agenda and to move forward with the ideas and initiatives created as part of this project.

References:

- Alt, R. & G. Auth. Campus-Management-System. *Wirtschaftsinformatik* 52 (3): 185-188.
- Bick, M. & K. Börgmann. Referenzmodell zur Evaluation von Informationssystemen für ein integriertes Campus-Management. *Hochschulmanagement* 4 (4): 108-114.
- Gandhi, P., G. Moe & K. Sprague. 2012. Where the cloud is likely to grow. Special Report. McKinsey.
- Johnson, L., Adams Becker, S., Estrada, V., und Freeman, A. (2014). *NMC Horizon Report: 2014 Higher Education Edition*. Deutsche Ausgabe (Übersetzung: Helga Bechmann, Multimedia Kontor Hamburg). Austin, Texas: The New Media Consortium.
- Sharples, M., Adams, A., Ferguson, R., Gaved, M., McAndrew, P., Rienties, B., Weller, M., & Whitelock, D. (2014). *Innovating Pedagogy 2014: Open University Innovation Report 3*. Milton Keynes: The Open University.

Acknowledgement

Foremost, we would like to express our sincere gratitude to the head of TUM: Junge Akademie, Prof. Gerhard Müller and his predecessor Prof. Regine Keller, for the opportunity to realize our project within the framework of the institution and for their great support and excellent guidance throughout the project. Furthermore we owe a great debt of gratitude to Peter Finger, Managing Director of TUM: Junge Akademie for his invaluable support and encouragement during our research and for liberally sharing his time and expertise.

We are furthermore very grateful to our mentor Prof. Klaus Diepold for inspiring us to think big and beyond established concepts resulting in unconventional discussions which turned out to be valuable contributions to the visionary parts of this project. We wish to gratefully acknowledge our tutors Bernhard Bohn, Hendrik Heenen and Paul Stursberg for their wide knowledge and structured way of thinking which gave us guidance throughout our project.

We would also like to thank Daniel Straimer, a fellow member of Junge Akademie, who organized and moderated a Design Thinking workshop for us. Finally, our deep gratitude goes to all those people working at TUM and associated institutes who provided us with lots of information, contacts, support and fruitful discussions about the status quo and the future of TUM's IT infrastructure.

We would like to especially mention Hans Pongratz (CIO TUM), Michael Folgmann (Coordinator for e-learning), Dimitri Vorona (Moodle Development), Ina Schmitz (Lecture Recording), Ralf Kossul (ITW), Werner Baur and his team (Storage Group LRZ), Dr. Friedrich Käck, Tina Pellegrino-Fesl and their team (ZA4 building and property management), as well as Lucas Reeh and Michael Lorenzoni from TU Graz.

Last but by no means least we would like to thank all lecturers that allowed us to promote our survey during their valuable lecture time and all participants for sharing their opinions with us.