

# ICT-based continuous innovation and research in German university admissions

Guido Bacharach<sup>1</sup>, Winfried Raab<sup>2</sup>, Hans Pongratz<sup>1,3</sup>, Peter Pepper<sup>1,4</sup>

<sup>1</sup> Stiftung für Hochschulzulassung (SfH), Germany

<sup>2</sup> Leibniz Supercomputing Centre, Garching, Germany

<sup>3</sup> Technical University of Munich (TUM), Germany

<sup>4</sup> Technische Universität Berlin, Germany

guido.bacharach@hochschulstart.de, raab@lrz.de, pongratz@tum.de,  
peter.pepper@tu-berlin.de

## Abstract

The German Foundation for University Admission (Stiftung für Hochschulzulassung - SfH) operates the Germany-wide procedure for awarding university places. These allocation activities cause with more than 2 million applications a high load in the supporting technical infrastructure, especially at the end of the allocation period. In order to handle such a load, the SfH cooperates with one of the leading scientific computing centers, the Leibniz Supercomputing Centre (LRZ). The goal of this cooperation is to continuously improve the IT infrastructure via joint research and development. It is a showcase project in the LRZ for coordinated workflows across institutional boundaries. The research results are intended to help not only the SfH procedure, but also other specialized software stacks, to perform optimally through innovative solutions. This article presents the results of the first two years of this research cooperation and the planning for 2021.

## 1 Introduction

Since 2010, the Leibniz Supercomputing Centre of the Bavarian Academy of Sciences and Humanities (LRZ) and the Foundation for University Admission (Stiftung für Hochschulzulassung - SfH) have been successfully cooperating in the operation of the SfH's specialized procedure. The LRZ is a national and European high-performance computing center and was founded in Munich in 1962. With the development of computer and information technology, the LRZ has grown to become one of the largest computing centers in Europe for science, research and education.

The SfH, based in Dortmund, is a foundation under public law. The main task of the SfH is to carry out and coordinate the application and admission process for courses of study with restricted admission.

For this purpose, a web-based system was developed with the dialog-oriented service procedure (DoSV).

The Foundation has been operating the DoSV since the procedure for the 2012/13 winter semester. In this procedure, an online-based data comparison enables the effective distribution of offers for study places. The main aim of the procedure is to enable applicants to be admitted quickly, without the need for lengthy backlogs, and to avoid vacant places and multiple admissions.

Since the procedure for the summer semester 2020, the reformed Central Allocation Procedure (ZV) for degree programs with nationwide admission restrictions has also been an integral part of the DoSV. As a result, admission offers for medicine, dentistry, veterinary medicine, and pharmacy are now also matched with all other admission offers of the study programs participating in the procedure. The adapted Dialog-Oriented Service Procedure consists of an application phase, the coordination phase, and the final coordinated move-up phase.

According to SfH figures, 151 German higher education institutions with 1,818 study programs participated in the integrated DoSV procedure in the winter semester 2020/21. This procedure was attended by 309,416 applicants with 2,189,480 applications.

In spring 2019, LRZ and SfH decided to expand their future cooperation on the basis of a "Cooperation Agreement for the Further Development of the Dialog-Oriented Service Procedure for the Allocation of Study Places."

## 2 Challenges

The DoSV software is a custom development whose scope and complexity in terms of operation, maintenance and development cannot be compared to standard software. For this purpose, the IT systems of the DoSV including their test and training environments as well as further web-based support systems have to be operated in a data center.

The applicant, application and study offer figures described above show that DoSV is a system with a large volume of data. The access profile is very inhomogeneous: phases with low activity alternate with phases of extremely high demand. Extreme usage peaks occur just before the application deadline. This poses high challenges for providing services that are sufficiently performant without causing excessive costs.

Due to the importance of the subject, the allocation of study places and the parallel further development of the DoSV require an absolutely reliable and smooth operation of the DoSV. Problems of a comparable nature also affect the universities in their systems, so that solutions developed here are relevant for all universities nationwide and can be used.

## 3 Goals of the cooperation

The SfH would like to master this challenge together with the LRZ. The DoSV, as a complex and unique software that requires a highly complex, mass-capable, fail-safe, reliable and innovative IT base infrastructure, serves both as a research object and as a prototype for possible comparable IT infrastructures and applications of other users of the LRZ.

Through this collaboration, the cooperation partners intend to gain medium-term impetus in the necessary expansion of capacities (capacity planning) and competencies in information security (including certification) and in research into user behavior. The SfH applications are characterized by very large user numbers and very unusual usage behavior and load profile.

The insights that can be gained from the operational use of the application cannot be obtained using synthetic load or usage tests. Therefore, it is important for the cooperation partners to be able to use

operational operation as a source of knowledge. The knowledge gained from this and from operation can be used for optimization and transferred to other areas.

The LRZ wants to transfer the knowledge gained in this research cooperation to other services and user scenarios. Conversely, the SfH would like to use the knowledge gained to optimize its own systems and processes and make the corresponding information available to the universities and their manufacturers of student-information-systems.

This cooperation should indirectly provide both sides with important insights for their respective fields of activity.

## 4 Results to date

In the course of the two years in which this cooperation agreement has now been in effect, valuable research results have been achieved, especially in the optimization of the load and performance behavior of complex specialized procedures such as the DoSV. With new monitoring, a model was created for further load and performance tests using the DoSV as an example, but also independently of the DoSV as a scientific result. Based on this work, the load and performance behavior of the DoSV could be further analyzed by SfH and optimization measures could be initiated. The results of this research work were described in detail in an analysis report by SfH.

## 5 Research work planned in 2021

For the optimization of the load and performance behavior for the DoSV, runtime data was already extracted and evaluated in 2020. From the evaluations, initial conclusions could be drawn about the causes of the system's performance behavior. The supposedly promising causes were implemented in the software.

The next step will be to test the implementations in 2021 and to further evaluate and analyze the deviations. The goal is to optimize performance to the extent that fast and legally compliant behavior of the DoSV is ensured.

In addition, the LRZ plans to build a Kubernetes cluster to provide CaaS starting in Q3/2021. The demand for container-based compute resource utilization has increased significantly in recent years, as containers make it easier to build, package, and deploy an application or service and all of its dependencies throughout its lifecycle and across different compute environments. However, there are still some challenges with container security. For this, the monitoring tool used may need to be further developed and optimized.