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Christoph Meinel, Christian Willems

**Technische Berichte Nr. 80**

des Hasso-Plattner-Instituts für
Softwaresystemtechnik
an der Universität Potsdam


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Universitätsverlag Potsdam

**Bibliografische Information der Deutschen Nationalbibliothek**
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.dnb.de/ abrufbar.

**Universitätsverlag Potsdam 2013**
http://verlag.ub.uni-potsdam.de/

Am Neuen Palais 10, 14469 Potsdam
Tel.: +49 (0)331 977 2533 / Fax: 2292
E-Mail: verlag@uni-potsdam.de

Die Schriftenreihe **Technische Berichte des Hasso-Plattner-Instituts für Softwaresystemtechnik an der Universität Potsdam** wird herausgegeben von den Professoren des Hasso-Plattner-Instituts für Softwaresystemtechnik an der Universität Potsdam.

ISSN (print) 1613-5652
ISSN (online) 2191-1665



Online veröffentlicht auf dem Publikationsserver der Universität Potsdam
URL http://pub.ub.uni-potsdam.de/volltexte/2013/6717/
URN urn:nbn:de:kobv:517-opus-67176
http://nbn-resolving.de/urn:nbn:de:kobv:517-opus-67176

Zugleich gedruckt erschienen im Universitätsverlag Potsdam:
ISBN 978-3-86956-264-3

# openHPI

## The MOOC Offer at Hasso Plattner Institute

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**Abstract.** The new interactive online educational platform openHPI, (https://openHPI.de) from Hasso Plattner Institute (HPI), offers freely accessible courses at no charge for all who are interested in subjects in the field of information technology and computer science. Since 2011, "Massive Open Online Courses", called MOOCs for short, have been offered, first at Stanford University and then later at other U.S. elite universities. Following suit, openHPI provides instructional videos on the Internet and further reading material, combined with learning-supportive self-tests, homework and a social discussion forum. Education is further stimulated by the support of a virtual learning community. In contrast to "traditional" lecture platforms – such as the tele-TASK portal (http://www.tele-task.de) where multimedia recorded lectures are available on demand – openHPI offers didactic online courses. The courses have a fixed start date and offer a balanced schedule of six consecutive weeks presented in multimedia and, whenever possible, interactive learning material. Each week, one chapter of the course subject is treated. In addition, a series of learning videos, texts, self-tests and homework exercises are provided to course participants at the beginning of the week. The course offering is combined with a social discussion platform where participants have the opportunity to enter into an exchange with course instructors and fellow participants. Here, for example, they can get answers to questions and discuss the topics in depth. The participants naturally decide themselves about the type and range of their learning activities. They can make personal contributions to the course, for example, in blog posts or tweets, which they can refer to in the forum. In turn, other participants have the chance to comment on, discuss or expand on what has been said. In this way, the learners become the teachers and the subject matter offered to a virtual community is linked to a social learning network.

## 1 MOOCs – New Concepts for Online Learning

### 1.1 Online Teaching and Learning

The use of information and communication technology in teaching has been the scene of innovative research and development activities for years. The rapid spread of the Internet and the WWW has created the conditions for overcoming the geographic distance between the acting parties. Furthermore, today learners independent of time

and place have access to university teaching offers with the most varied of provenance and quality. Initially, educational offers were tied to the institutional system for which the term “learning management system” had been established. At that time the discussion about the potential and limits of e-learning was concentrated on the technical systems rather than on the more important – and more interesting – question of the subject matter itself.

At the end of the 1990s, universities began to offer learning material across institutional borders. This meant online availability for more students and those parties from other universities who were also interested. The Massachusetts Institute of Technology (MIT), for example, started a worldwide movement with the OpenCourseWare project (OCW). Here, the online learning contents were available under an open license that allowed further processing of the material in the sense of the OpenSource and Creative Commons initiatives. The OCW project focused on motivated self-learners or teachers who wanted to incorporate the material in their own classroom or in e-learning offers.

Research in the context of online teaching and learning (e-learning, tele-teaching) was by far not limited to the Internet in offering learning material on a broad scale. Rather, it concentrated on how modern educational concepts for online learning could be developed in the first place. Emphasis was placed on the conception and support of learning processes and social relationships. Numerous tools were developed for the areas addressed: “experience-based”, “project-oriented”, “collaborative”, and “social" learning.” This created an experience far beyond the mere imparting of knowledge. These tools support the learner in the practical application and collective further development of knowledge. The steps taken in recent years have been particularly intensive with the development of Web 2.0, technologies such as blogs, wikis and video podcasts as well as the integration of social networks and e-learning.

The concept of MOOCs, short for “Massive Open Online Courses”, proposed in 2008 and then broadly implemented starting in 2012, represents a culminating point in this development. The concept focuses on the learner, for whom access to collections of open information and communication in open communities is taken for granted. The uniqueness of such massive online courses involves the combination of an offer of teaching and learning contents within a social media platform enabling the course participant to learn in a virtual community. This social community, with its great number of participants, has established a social effect and defined an attraction to MOOCs. Over the long term it also serves to connect the user directly into the process of learning itself.

MOOCs are *open* in several respects. They are open because they are neither bound to a certain institutional affiliation nor to entry requirements or tuition fees. They are above all open because the learner is not confronted with a closed stock of knowledge, and thus because the learning process itself is open. Learning evolves in an atmosphere of virulent, open participation and discussion. In this environment not only the teacher provides subject material, but also the learners, who contribute substantially to reflections on the subject as well as to its updates and expansion. This moment manifests itself all the more strongly the larger (more *“massive”*) and, consequently, the more heterogeneous the group of participants proves to be in terms

of knowledge and experience as well as cultural background. The openness and unpredictability supported by these qualities can turn a MOOC into a unique community experience.

The innovative form of teaching of the MOOCs can be used for every discipline and is not restricted to a certain subject area. Course material is prepared in a multimedia form (e.g., as excerpts from lecture recordings) and the learning effect is monitored interactively (e.g., by means of multiple-choice questions). MOOCs open new possibilities for the development and testing of entirely new functionalities. These can then subsequently acquire disciple-specific significance. For example, as seen in computer science projects which provide virtual labs (e.g., *Tele-Lab Internet Security*, see paragraph 2.4) where learners can carry out experiments and gain practical experience over the Internet. Here, users receive access to virtual machines with preconfigured systems. They are then given concrete tasks to solve, such as breaking password. Not only do users see previously conceived simulations, but they also experience the actual live events themselves.

### 1.2 Scientific Discourse about MOOCs

In a theoretical consideration of MOOCs, their classification is discussed in view of the role assigned to the learner. The primary objective of MOOCs is to support the learner in taking on an active role, thus the term cMOOC - short for "connectivist MOOC" [1] - has been established. A distinction is made between cMOOCs and the so-called xMOOCS, which are closer to the traditional learning method of the university lecture.

Typically, with xMOOCs, new learning material is made available on a weekly basis and different tools and formats are offered for presenting and learning the new materials. These could be lecture recordings, self-tests, homework or extra reading material. The "x" refers to an important representative: the edX platform. This platform was founded by MIT and Harvard with the aim of making university lectures available to an audience world-wide.

xMOOC and cMOOC describe ideal-typical formats, each representing a particular style of learning. Experience-based learning (cf. [2]) may be summarized as a cycle made up of four phases:

- concrete experience (CE, feeling),
- reflective observation (RO, looking),
- abstract conceptualization (AC, thinking),
- and active experimentation (AE, doing).

If we take into account that learners prefer to combine two phases each, such as looking (RO) or doing (AE) with feeling (CE) or thinking (AC), then xMOOCs fit the form of an assimilated style combining RO and AC. cMOOCs, on the other hand, describe an accommodative style combining AE and CE[1]. If the wish behind MOOCs

[1] Additionally, Kolb describes the converging style as the combination of AB and AE and the diverging style as the combination of KE and RB.

is to reach more than just a segment of learners, then an integration of the concepts from xMOOC and cMOOC is necessary. This is what is already being done, for example, by the Stanford University Venture-Lab[2] or by openHPI. Here, the emphasis is on experience-based and social learning stimulated by practical tasks, discussion incentives and learning through play. In [3] design guidelines for MOOCs (in particular for openHPI) are described that address these objectives. They are based on the concept of "Cultures of Participation" by Gerhard Fischer.

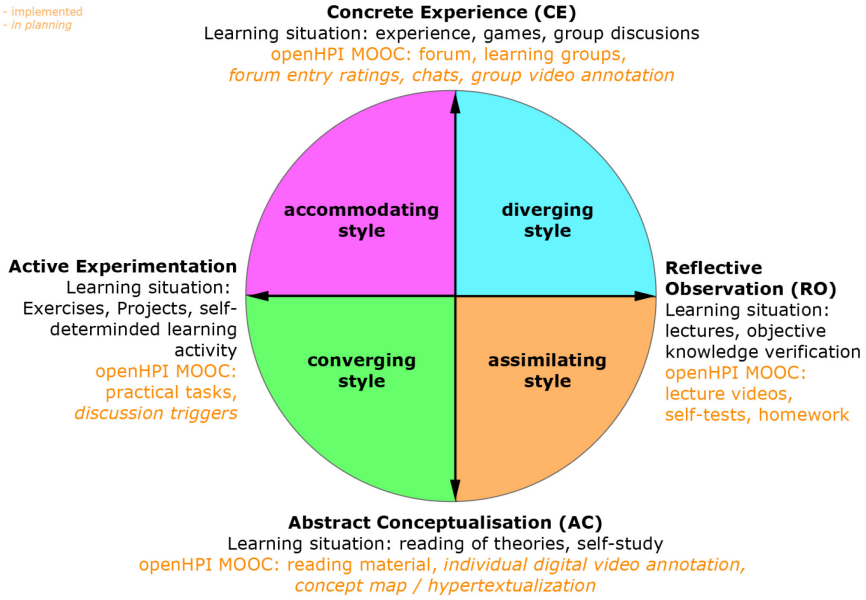


**Fig. 1.** Learning Styles

## 2 MOOC offers at Hasso Plattner Instxitute

The Potsdam University-affiliated *Hasso Plattner Institute (HPI)* is Germany's university excellence center for IT Systems Engineering. HPI teaching and research focus on the foundation and application of large-scale, highly complex and interconnected IT systems. HPI has consecutively earned the highest positions in the CHE university ranking of German-speaking computer science faculties.

HPI offers bachelor and master programs in "IT Systems Engineering" – a practical and engineering-oriented study program in computer science in which currently 450 students are enrolled. There are altogether ten HPI professors and over more than150 guest professors, contracted teachers and lecturers at the Institute. HPI

[2] see https://venture-lab.org

carries out research noted for its high standard of excellence in its nine topic areas, as well as at the "HPI Research School", an interdisciplinary PhD program with external branches at the University of Cape Town, the Technion in Haifa, Nanjing University and the HPI-Stanford Design Thinking Research program. There are addition training programs in the development and research of user-oriented innovations for all areas of life. Modeled after the HPI d.school at Stanford University, the "HPI School of Design Thinking" offers 160 places annually for a supplementary course of studies in Design Thinking.

One of the driving ideas behind HPI's openHPI initiative has been to open a part of its study program to a wider audience. HPI professors and lecturers prepare appropriate excerpts from their lectures for the openHPI course format, thus enabling an open audience to benefit from the otherwise exclusive curriculum.

### 2.1 openHPI – The MOOC Platform of HPI

With its *openHPI platform*, HPI is the first European university institute to offer interactive online courses (MOOCs) in German and English in the field of computer science and IT technology. The significance of the MOOC phenomenon is not new at HPI thanks to the years of work by the web university team, headed by Prof. Dr. Christoph Meinel, on the subject of on-line learning. This work has included the development of the mobile tele-TASK technology – licensed by Dell for the recording of lectures and presentations[3], operation of a large lecture portal in the Internet[4], the development of different virtual labs[5], and regular lecture transmissions to the Technical University of Peking[6]. The key elements of the MOOC innovation for online learning were quickly identified: the synchronization of learners, the possibility of providing the learning materials a little at a time, supplying various feedback tools for self and external evaluations of learning success and linking with a social platform to enable learners the experience of being part of a social (albeit virtual) learning community. To actually test this approach the interactive online learning platform openHPI (https://openHPI.de) was born. Under the direction of Prof. Dr. Christoph Meinel, openHPI offers courses for anyone who wants to learn about topics from the field of information technology and computer science. Already in September 2012 the much acclaimed first openHPI course was launched with Hasso Plattner (SAP co-founder and the founder of HPI) as course instructor. In November 2012, Prof. Dr. Christoph Meinel held the first MOOC in German language.

[3] see http://www.tele-task.de/teletask/about

[4] see http://www.tele-task.de

[5] Tele-Lab Internet Security (http://www.tele-lab.org) und SOA Security Lab (http://www.soa-security-lab.de)

[6] Information at www.hpi.uni-potsdam.de/meinel/knowledge_tech/internet_bridge.html

## 2.2 openHPI – Conception of the Online Courses

The online courses offered at openHPI are didactically prepared in accordance with specific guidelines. Courses have a *fixed start date* and offer a balanced *schedule* of six consecutive course weeks. Every course week is prepared in a multimedia form and, whenever possible, interactive learning material is supplied, dealing with a specific topic of the course. At the beginning of the week, the course participants are offered a series of videos that have been recorded with the tele-TASK system. The videos are supplemented with further reading material, interactive self-tests and homework for participants to complete during that particular week. The self-tests, which alternate with the videos, help participants to check their learning progress. Learners are thus able to check whether they have mastered the most important information from the previous video. The homework exercises at the end of each course week are the building blocks for the performance evaluation of the participants. Here, points can be accumulated relevant to the successful completion of the course.

These offers are combined with a social discussion platform where participants have the opportunity for exchange with course instructors and other participants. Here they can get answers to questions and discuss topics in depth. But naturally the type of learning activities and their extent is up to the participants themselves. The learners can make personal contributions to the course, for example in blog posts, wiki pages, mindmaps or other visualizations of the subject matter. Fellow learners can comment on, discuss or expand on what has been said. Through the discussion of the subject matter, the participants become part of a virtual community with each other and with the instructors, thus creating the links of a social learning network.

Upon successful completion of the course, participants qualify for an openHPI certificate. To do this they must have earned at least 50 percent of the possible points from the six homework exercises as well as on the final exam. Besides the number of points received, it is also noted on the certificate whether the participant is among the best 5, 10 or 20 percent in the course. Additionally, all participants who have completed at least 50 percent of the course material receive an ungraded certificate of participation.

The determination of a 6-week framework for the length of an openHPI online course, with a concluding exam week, was based on a consideration of the necessary time for making the course participants form a virtual “community”. Additionally, the focus was on limiting the burden placed on course participants. The offer applies not only to students but to anyone interested whether it be a professional person, high school student or retiree. Evidence shows that the percentage rate of those completing openHPI online courses is 15-25 percent higher than the number of those who completed comparable MOOCs running for a whole semester.

The subjects addressed originate in the courses of the HPI IT Systems Engineering curriculum. The HPI professors and senior researchers address topics on the latest developments and research results from the area of computer science, for example the in-memory database technology developed at the chair of Hasso Plattner. At the same time, broad basic knowledge is also conveyed, such as how the Internet works. The

subject matter taught in an online course cannot encompass an entire lecture program, based on time restrictions alone. Furthermore, the courses are not intended to be lecture substitutes but rather aim to teach essential knowledge to a wide, general audience.

### 2.3 openHPI – Courses and Terms

The first openHPI online course was taught by Prof. Hasso Plattner on the subject of the "*In-Memory Data Management"* technology. The course examined the management of corporate data in column-oriented main memory databases. The latest trends in the hardware and software industry have lead to the development of this revolutionary technology that allows the flexible and lightning-fast analysis of huge amounts of data. The basic concepts and design principles of this technology were presented in detail. Furthermore, the discussion focused on implications for the future development of enterprise applications. The course was directed at an advanced audience with solid background knowledge in the field of "databases".

There were more than 13,000 course participants who came from over 100 countries. Over 4,000 took part regularly in the exercises and discussions, while 2,132 participants earned a certificate upon successful completion of the final exam. Most of the participants in the first open online course invested three to six hours per week for serious study of the materials. The time was used for watching the learning videos, working through the reading material, checking personal progress based on the supplied self-tests and actively participating in the discussion forums. The participants in this course took 106,231 self-tests and turned in 17,738 homework assignments. In the discussion forums there were 2,270 posts. During the course, participants viewed 140,201 videos and 74,746 wiki pages.

The second openHPI online course was taught by Prof. Christoph Meinel. The course, entitled "*Internetworking mit TCP/IP"*, explained how the Internet worked. The course was taught in German and is therefore the first German-language MOOC with a significant number of participants. Ten thousand had registered for the course, of which 2,700 took part actively. At the end of the course, following the successful performance on homework and a passing grade on the final exam, 1,662 participants received a certificate for their successful completion of the course. The teaching team was very impressed by the high degree of active participation by course members. The learning videos were accessed 118,779 times; the participants checked their learning progress via the numerous self-tests 84,751 times. More than 3,900 different posts were made on the 700 individual topics in the discussion forum. Additionally, there was also a group of especially active participants who enriched the educational content by providing and refining their own contributions to the online learning aids in helping complete the homework.

After conclusion of the course, a detailed survey was taken of the participants. Approximately 1,000 users took part. According to the survey, 84 percent of those questioned said that their motivation for joining the course had been general interest in information technology. The motivation for 55 percent was listed as professional reasons, while 34 percent stated that were taking the course in hope of earning a HPI

certificate. The largest age group - at 28 percent - were those between 20 and 30 years old. This age group was followed by the group between 30 and 40 at 25 percent. Ten percent gave their age as over 60. 82 percent of the participants were men. 38 percent have a bachelor or master's degree and approximately 4 percent a PhD. 27 percent carry out a leadership function professionally. 26 percent of those surveyed indicated that they have less than five years of working experience, while 14 percent have been working up to ten years. The largest amount of participants - at 35 percent - were those who have worked in their jobs for more than ten years.

In response to questions regarding the quality of the learning videos the ratings were high. In particular the technical contents (92 percent), the understandability (89 percent) and the entertainment value (75 percent) were rated positively. The technique of the openHPI platform, the course structure and the support also received high scores.

The third course, which was conducted in February and March 2013 in English by Dr. Harald Sack was devoted to "*Semantic Web Technologies"*. The "Semantic Web" is an extension of the traditional WWW in terms of supplementing texts that are present in the web in natural language with explicit semantics based on formal knowledge representation. Therefore, the information expressed in natural language is extended in the so-called Semantic Web to enable a machine readable interpretation of its meaning. The course covered the fundamentals of the Semantic Web technologies and conveyed to participants how knowledge is represented and how it can be accessed and used in the web. The course addressed an advanced audience with prior knowledge in web technology and formal logic. Of the 5,692 registered participants, 2,440 took part actively in the course, with 784 of them receiving a certificate.

In April and May 2013, the course "Datenmanagement mit SQL" was held by HPI professor Felix Naumann. Databases form the basis of almost all major software applications. Whether in business, in research, or on the web huge amounts of data are generated everywhere. The data must be stored safely and be made available for efficient querying. The course taught the basics of modern database systems, their structure, the planning of the design of databases and the querying language SQL. Using SQL one can send simply formulated but extremely powerful queries to a database. These requests can search for data, filter data and finally analyze data in multi-faceted ways. The course was directed to a broad but technically adept audience. Of the nearly 7,000 registered participants (of them 3,100 active), there were 1,641 who received a certificate.

A total of more than 41,000 people registered for these four openHPI courses with nearly 6,200 certificates issued.

### 2.4 openHPI – Technological and Scientific Foundations

The openHPI project builds on technology and research results gleaned from a range of projects carried out at department of Internet Technologies and Systems, under the direction of Prof. Dr. Christoph Meinel. In addition to the development of its own learning platform, valuable experience was used from e-lecturing (tele-TASK), the

provision of a virtual, Internet-based learning platform for practical training (Tele-Lab and SOA Security Lab) as well as practical work on the semantic analysis of multimedia data (SEMEX).

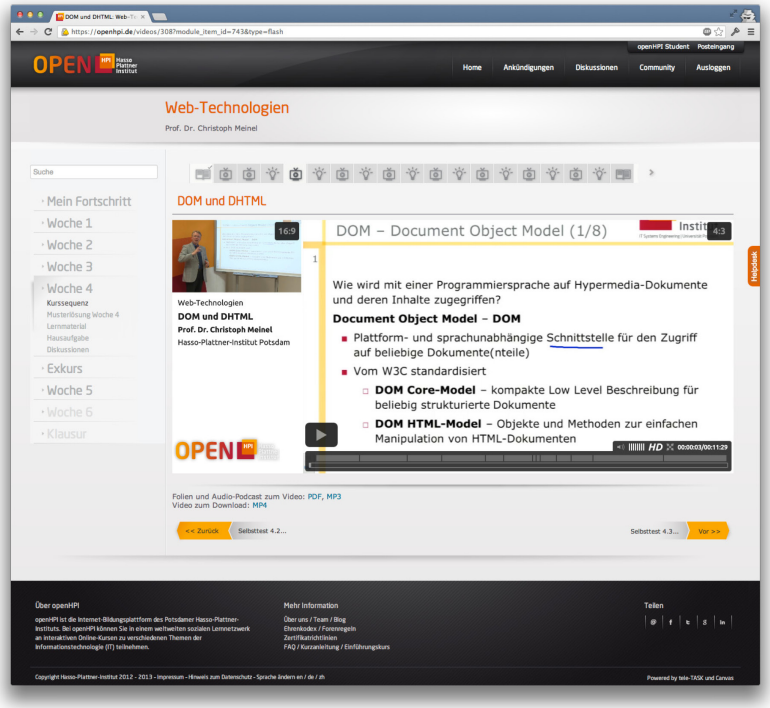


**Fig. 2.** Screenshot – openHPI Web Platform

### openHPI Web Platform

The openHPI online courses are offered via the proprietary *openHPI Internet platform*. The platform was developed by an HPI team led by Christian Willems at the chair of Prof. Dr. Christoph Meinel (see Fig. 2).

With the goal of offering its own individualized MOOCs on the Internet in a timely manner, the open source learning management software *Canvas LMS* was chosen as the basis for the development of the platform. After evaluating comparable systems, this decision was made due to the modern user interface and sophisticated quiz functionality provided. In its use as a MOOC platform and to ensure scalability of the high number of participants, the software was subject to extensive modifications by the openHPI development team. In particular, the following (to some extent major) changes were made:

- Complete reworking of the user interface (design) and the main navigation,
- Addition of new, content-type lecture videos,
- Integration of the tele-TASK video player,

- Adaption of the content navigation to the 6-week course concept,
- Implementation of a "Course Sequence Browser" for navigation within a course week,
- Addition of a helpdesk widget for technical support,
- Massive change in the original discussion forums for better scaling and the addition of a search feature,
- Utilization of existing learning group functionalities in the context of a MOOCs,
- Development and implementation of a functionality to display the learning progress and to generate the certificate.

The operation of the openHPI platform is in HPI's hands. A private cloud was implemented on the basis of the cloud framework *OpenNebula* (see Fig. 3), to easily meet the scaling requirements of the platform. It allows for the possibility of activating additional physical hosts as needed (or to turn off or save power) on which to run many virtual machines in carrying out web applications parallel. Currently, two hosts are used, each with 64 processor cores and 64 GB RAM as well as rapid RAID 5 storage systems. Central services, such as database monitoring and log analysis, run on additional physical servers. A dedicated load balancer is responsible for SSL encryption and the distribution of requests at the virtual machines. The video streaming was outsourced to the service provider Vimeo, which offers a cost effective and easily scalable operation.

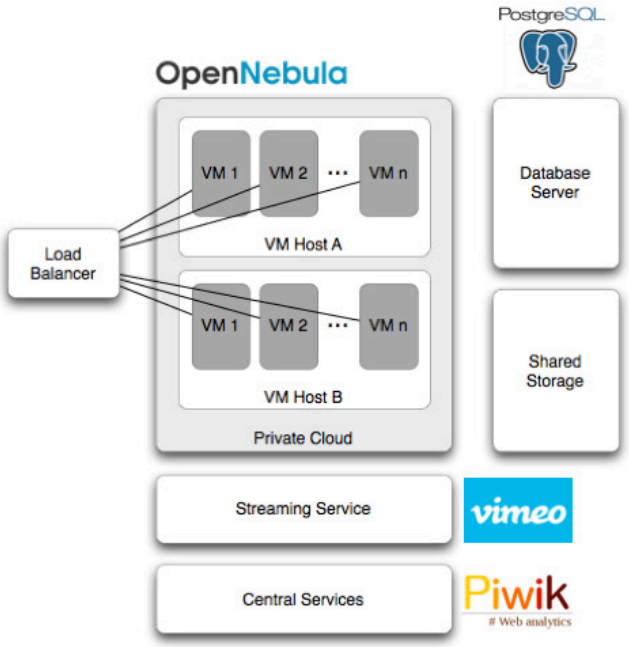


**Fig. 3.** openHPI Infrastructure

**New development – openHPI as a Service-Based Architecture**

After a thorough analysis of the operational experience of the first openHPI courses, the openHPI team began work on developing a new platform for openHPI that is planned to be operational this year.

Among the key findings from the first openHPI courses it was determined that, in principle, Learning Management Systems (LMS) is not suited for use as a MOOC platform. This is partly due to the lack of scaling in respect to the number of course participants. Classically, LMS is used in schools or universities. In this environment there are generally many different courses, which however have just a small number of participants (most of the time not more than a few dozen or a few hundred). The situation is reversed in respect to MOOCs. MOOC platforms each offer (relatively) few courses with the number of participants easily reaching a figure that is 5 or 6 digits long. For this reason, not only the scalability regarding the platform is a limiting factor but also the many user interfaces. Some that work for a few participants can be unusable for thousands of others (this applies especially to the area of the course supervisor: participant lists with 15,000 entries are not very helpful and need an excessively long time to load). On the other hand, it is obvious that the focus of many LMS implementations is on the *management* of courses in view of the participants, instructors, course material etc. But for a MOOC platform the focus is on creating a motivating social learning experience – a requirement that LMS cannot adequately fulfill.

Important impetus for this new development has come from the research work on the subject of online learning and web university conducted at the chair of Internet Technologies and Systems at HPI. Through the utilization of these research results it should be possible, for example, to

- provide new learning tools that enrich the existing learning content with practical exercises, such as programming tasks or database queries, but also more generic exercises such as the configuration of systems or enriching of networks, which should also be automatically rateable,
- establish personal learning environments (e-portfolio systems) and to enable in-depth interaction with other social networks and
- create and integrate content production workflows, as they are already set up for the tele-TASK portal.

The new platform will have a service-oriented architecture (SOA) and thus it will be possible to flexibly integrate new functionalities and services and to test them. The services can also be acquired from existing systems – just as the newly developed openHPI services can be integrated as components in external applications. The architecture also allows for load distribution at the application level and therefore offers better scaling. Services that are particularly “resource hungry” simply get more power in the cloud (i.e., more processors, more main memory) and can, if necessary, use a dedicated database. These opportunities are not readily available in a monolithic architecture.

Additionally, from the beginning attention was paid that the implementation of the new platform offered comprehensive support for mobile end devices. Already now one can complete an openHPI course using a tablet PC as well as an iPad or modern android tablet. Because the web application was primarily developed for workstation computers, there are certain limitations to usability. These shortcomings will be remedied with the new development. Smartphones will also be supported. This is achieved primarily through the use of modern web technologies such as HTML5 and CSS 3 or responsive web design. The service-oriented architecture of the platform also allows easy access for mobile operating systems such as iOS or Android.

In developing the next generation of the openHPI platform, extensions will continue to be implemented. These makes it possible to investigate a wide range of research topics such as:

- ***Gamification:*** How can the learner's motivation be increased through the functionality and design principles used in computer games?
- ***Analytics:*** How can teaching be improved through the analysis of the learner's behavior in the online environment? How can unstructured learning feedback (e.g., in discussions) be developed in a partially automated form for the quality management of the course materials?
- ***Innovative learning services:*** How can learning be supported in hetergenous contexts in which the learners live and work?
- ***Virtual learning labs:*** How can environments in which learners interact with virtual IT systems be made scalable for massive participation?

**tele-TASK – tele-Teaching Anywere Solution Kit**

The production of the openHPI learning videos is done with the tele-TASK system [5], which was developed by HPI scientists under the direction of Prof. Dr. Christoph Meinel. *tele-TASK (**t**ele-**T**eaching **A**nywhere **S**olution **K**it)* is an innovative system solution with which lectures and talks can be recorded and disseminated worldwide via the Internet. Thanks to tele-TASK, anyone who is interested worldwide has the possibility to access live broadcasts as well as archived recordings at trainings, presentation and events. The special property of tele-TASK is that the lecturer is shown simultaneously with his/her demonstration material. This proven mobile technology, which has been regularly implemented for years as study support at HPI, is characterized by its simple operation and brilliant picture and sound quality. It is always being expanded in terms of new functionalities and offers a solid experimental foundation for the ongoing research work in online learning.

The tele-TASK system solution encompasses the tele-TASK recording system, the tele-TASK player and the tele-TASK portal. The video clips for openHPI are recorded with the tele-TASK system and can be viewed with the tele-TASK player.

The **tele-TASK recording system** consists of a compact, portable box that contains a pre-configured computer on which the recording software is installed ready for use. Also included are a video camera, microphone and the necessary connection cables for the equipment. In tele-TASK, parallel to the video image and sound of the speaker, the screen of the presentation computer is also recorded and transmitted

synchronously. Presentation contents, such as animation or films, can also be fluidly recorded thanks to the high frame rate possible in recording.

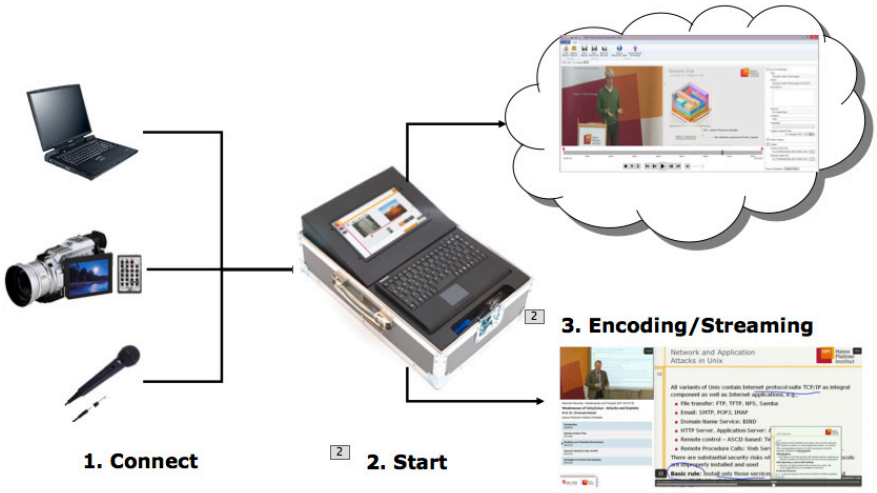


**Fig. 4.** tele-TASK Recording System

The **tele-TASK recording software** is constantly being developed and expanded. Currently it is based on Windows 7 as an operating system, C#, .NET 4.5 and WPF. In particular it is optimized for touch operation, live streaming in the MP4 format, an integrated podcast function, higher resolution and frame rates. Great importance is placed on simple and self-explanatory operation. The recording software uses the codecs H.264/MPEG-4 AVC and AAC for recording and has been optimized for multiple-core processors (in particular Intel Core i5).

The **tele-TASK player** is an innovative video player with a split screen that synchronously shows the presentation (e.g. lecture slides or animations) and the video of the speaker as well as information about the structure of the lecture. Because of the variable data management of the recordings in two separate files – lecturer and presentation – the division of the screen in the player is also variable. The user can adjust the size ratio between the lecturer and the presentation, depending on interest or situation, up to a full picture mode in which the entire screen can be utilized. The lecture slides, which are automatically extracted from the videos, can be browsed on a timeline and provide fast navigation support and entry to a relevant place in the recording [6].

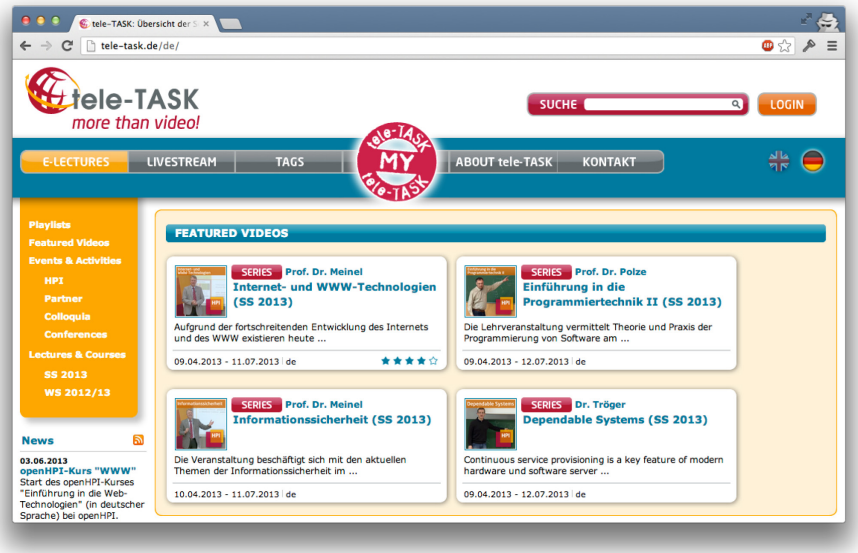


**Fig. 5.** Screenshot – tele-TASK Web Portal

The **tele-TASK web portal** (http://www.tele-task.de) offers a rich video archive with recordings from lectures (e-lectures), complete lecture series, conferences, workshops and symposia. Depending on the configuration, these recordings can be viewed live as well as on-demand via the Internet. Upcoming live stream events are noted on a live stream calendar. The tele-TASK web portal is optimized for use on both large monitor and in a minimized viewing mode for small cell phone displays. At this time, the library offers over 4,000 e-lectures, which are also available in shorter learning units on the 1,4500 video podcasts.

The tele-TASK portal is constantly being expanded in the way of online learning support functions, and thus provides extensive search capabilities. Moreover, users are offered numerous innovative functionalities for efficient navigation in the individual e-lectures based on findings from current research in the area of the Semantic Web. For fast orientation, learners can quickly access the (automatically generated) table of contents of the e-lecture and a slide preview. In the e-lectures themselves (and not just in the lecture titles) they are able to search for key words as well as to use many other new tools for convenient self-study.

Especially noteworthy is the possibility offered in the portal of creating personal digital lecture notes. The e-lecture can be enriched with personal notes and transcripts at the desired place with the help of an editor developed especially for this purpose. If desired, these notes can also be made visible to other users. Many more community and social web functions are implemented in the tele-TASK portal, for example tagging videos, setting timestamps, compiling playlists or evaluating the lectures.

**Tele-Lab Internet Security – Virtual Laboratories for Practical Online Training**

Particularly in IT security education or cyber security training, traditional teaching methods prove to be of limited use. This is only because students are not able to use the concepts from the academic curriculum directly in a realistic systems environment. However, for IT security training it is crucial to gain experience based on practical application. The absolute precision essential in IT security must be practiced: just one faulty firewall rule can destroy an entire network security concept.

The greatest difficulty in integrating practical tasks in a curriculum is providing a suitably realistic learning environment. The reason for this is that the students need privileged rights to gain access to the training system (root or administrator accounts) and to act out many of the possible training scenarios. In training attack scenarios the appropriate hacker tools should be available on the computers. But with these rights and tools the training system could easily be made inoperable or even misused for attacks on computers in the campus network or on the Internet.

The **Tele-Lab system [7] as a virtual lab** was introduced as an innovative e-learning system which for the first time allowed practical security training on the Internet with a simultaneous guarantee for the required need of a dedicated, isolated computer lab. Characteristic of virtual labs is that learners can carry out practical exercise on preconfigured virtual machines (VMs). These run at a server in a private cloud and are accessed by means of remote desktop access. Virtual machines are software systems that implement a runtime environment for operating systems. The operating system behaves in a virtual machine exactly as it would on physical hardware. Such software-simulated computer systems not only allow the operation of multiple operating systems simultaneously on a single hardware platform, but also the fast dynamic provisioning of systems or an easy restoration in the case of failure or incorrect operation. Tele-lab uses this latter feature to automatically return the virtual machine in the training environment back to its original state following its use by students. The current technological foundation for the Tele-lab is based on the cloud framework OpenNebula – just as the openHPI infrastructure.

Tele-Lab essentially consists of a tutoring tool and training environments made up of virtual machines for the practical exercises. The learners are offered key curriculum topics on IT security (e.g., cryptography, authentication, secure e-mail, etc.) in different chapters and are thus enabled to acquire knowledge related to IT security. The study material in the individual chapters provides background information, introductions to security software and hacker tools and interactive practice scenarios, which build the core of each teaching unit.

An **exemplary learning unit in Tele-Lab** on *malware* (described in detail in [8]) starts off by providing background to the topic with basic information, for example on the definition and classification of malware (viruses, worms and Trojan horses). Following this, several software kits used by the attacker are presented (e.g., virus construction kits, Trojan horses) and various ways to infect a victim explained. Already this knowledge serves as direct preparation for the practical exercise to come.

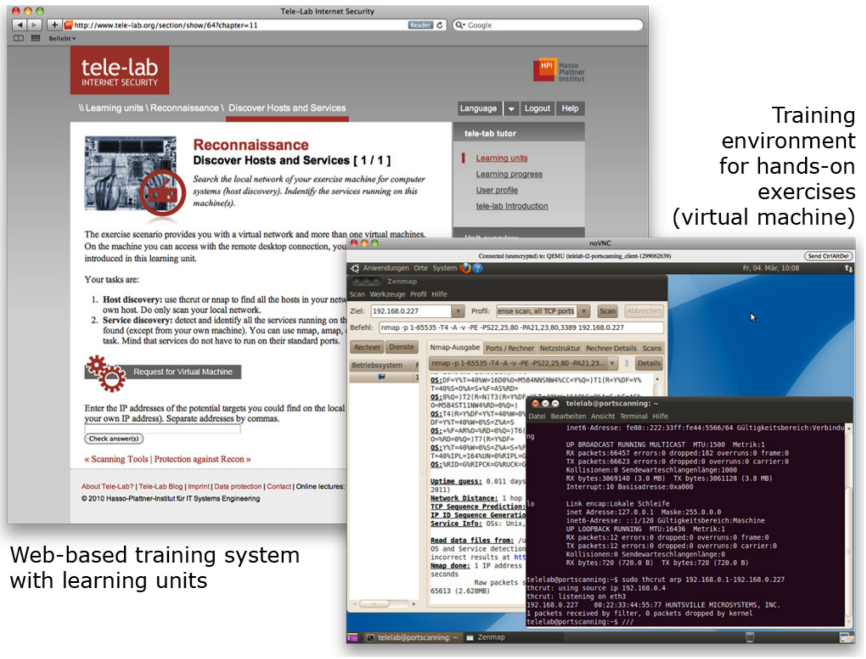


**Fig. 6.** Tele-Lab Tutoring System and Training Environment

Just as in many other Tele-Lab learning units, an offensive approach is taken after the lesson on malware. The student is asked to assume the role of the attacker and in this way to see with his or her own eyes the actual dangers that threaten personal security objectives. The corresponding exercise calls for the user to engage in an attack on a virtual victim (called *Alice* in the following) using a Trojan horse, or more specifically the older Trojan known as *Back Orifice*. *Back Orifice* (BO) is a so-called backdoor Trojan that allows the attacker to remotely control the infected system and to retrieve any data desired. In order to do this, the student prepares a disk file (often a little game or a useful tool) for the BO server and sends it to Alice by e-mail. A script at the virtual machine of the victim responds to the mail with thanks for the game or tool. In this way the attacker is able to conclude that the BO server was installed (i.e., that the e-mail attachment was opened by the victim). The attacker can retrieve the IP address of the victim from the mail and thus connect to the victim with the BO client and spy out confidential data. The student thus proves to the tutoring system that the exercise was successfully accomplished with his or her knowledge of the secret data at Alice's VM. The learning unit closes with information about how malware attacks can be warded off, or infections avoided (virus scanners, system updates, dealing with e-mail attachments).

This type of a task in the interactive exercise clearly illustrates the need for a training environment with networked virtual machines. In the example presented, a VM is needed for the attacker (with all the necessary tools for the task), a mail server for the exchange of the e-mails as well as a vulnerable victim system (here an

unpatched Windows 95/98). Remote desktop access is only allowed in each case to the VM of the attacker.

Moreover, Tele-Lab offers a range of new functionalities for automatic self-assessment – personal performance review in a practical exercise [9]. This research result (in addition to the implementation of the Tele-Lab private cloud architecture) is an important building block in the development of a *Massive Open Online Lab.* This is a lab where practical exercises may be carried out in the context of a MOOCs. First, it must be possible to guarantee that the infrastructure provided for the training environment is scaled for a large number of participants. Second, automatic performance checks must be possible so that the practical exercises can be used as a yardstick for measuring performance.

**SEMEX – Semantic Multimedia Browser**

The content-based search in a video archive constitutes a major challenge in the age of digital media and requires the development of new technologies. The *Semantic Media Explorer (SEMEX)* [10], developed under the direction of Dr. Harald Sack at the chair for Internet Technologies and Systems, combines the latest media analysis techniques, e.g., audio analysis, intelligent character recognition and visual concept recognition for developing video content. The content-descriptive data is semantically linked with each other through the help of knowledge bases, enabling the discovery of new connections between the videos. The focus is on the search experience itself. The user is offered the possibility to discover and examine a large video archive in an exploratory manner. While classic search engines deliver exact matches to specific search queries, the Semantic Media Explorer provides an exploratory semantic search when even formulating a precise search query proves difficult. The user is led to new ideas and alternative search results via semantic links, which help to refine the search and open up new associations.

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## Appendix 1 – openHPI course offer

The 2012/2013 openHPI online course offer in brief:

- September/October 2012:
  Prof. Hasso Plattner: “In-Memory Data Management” (English)
- November/December 2012:
  Prof. Dr. Christoph Meinel: “Internetworking mit TCP/IP” (German)
- February/March 2013:
  Senior Researcher Dr. Harald Sack: “Semantic Web” (English).
- March/ April 2013:
  Prof Dr. Felix Naumann: “Datenmanagement mit SQL” (German)
- June/July 2013:
  Prof. Dr. Christoph Meinel: “WWW-Technologien” (German)
- September/October 2013:
  Prof. Hasso Plattner: “In-Memory Data Management” (English)
- November/December 2013:
  Prof. Dr. Mathias Weske: “Business Process Technology” (English)

All online courses are available in the archive mode after they have ended. The learning videos, slides, reading material, self-tests and discussion forums are also provided in the archive for self-study.

## Appendix 2 – Overview of the tele-TASK Portal Functions

General

- Playback of recorded lectures and presentations (e-lectures)
- Menu-based classification of recordings
- Password-protected community section where users can login and use diverse Web-2.0 functionalities in the portal and manage their own profile
- Extensive search function that allows a keyword search for recorded content
- Calendar for organization and an overview of live webcasts
- News section with the latest information for the portal user
- Static pages with information about the contents of the portal, the presenters and their companies/organizations/institutions

Navigation Support

- Creation of personal playlists
- Table of contents for e-lectures: the structure of the presentation is automatically extracted from the video and provided with a timestamp for a quick browsing of the lecture
- Slide preview for e-lectures: on a timeline, the slides are automatically extracted from the video and presented as a preview to get a quick overview of the lecture as well as direct entry to the point of relevance
- Keyword function: the most important keywords are filtered from the audio recording of the spoken word and from the slides in the slide preview and displayed in a graphical overview. The keywords can be searched. The frequency of a specific keyword's occurrence is highlighted in color on the timeline

Digital Lecture Notes

- Creation of digital lecture notes by enriching the e-lecture with personal notes: not only a simple text field is available for labeling the desired point in the e-lecture, but also an editor especially designed for this purpose.
- PDF export of digital lecture notes: in the portal, the notes on the e-lectures can be exported as a PDF with a timestamp and thus be used as a printed learning resource. Likewise, all of the notes for a playlist can be exported in block form as a PDF.
- Annotation in learning groups: Learners can share their notes in learning groups to promote interaction and collaboration. During a live lecture all of the notes written in the group are displayed in a common interface for all members.
- Screenshot function as video annotation: the screenshot function can be used for transferring the slide to the annotation to better locate a certain slide later.
- Time marker – bookmark for e-lectures: time markers are a fast form of video annotation. Learners can quickly mark certain time points in a lecture in order to

find them easily later. The labeling of the bookmark can be carried out personally or by choosing a default variation.

Administration and Backend

- Comfortable backend area for the creation of new recording series, for setting up new lecture recordings and for the management of metadata on the lectures
- Extended administrative functions: quick overview of the ongoing lectures with their respective conversion status, simple creation of featured videos, inclusion of venues and much morex

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ISBN 978-3-86956-264-3
ISSN 1613-5652