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Zurich University of Applied Sciences

ZHAW School of Engineering

Institute of Applied Information Technology,
Service Engineering Research Area

Service Prototyping Lab Report - 2016 (Y1)

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Giovanni Toffetti Carughi

August 31, 2016

Dear Reader,

This lab report summarises the inaugural "startup" year of the Service Prototyping Lab (SPLab) at Zurich University of Applied Sciences which officially opened its doors on Friday, August 28, 2015. Within this first year, the focus on scientific research and development to bring diverse applications into the cloud has already produced the first tangible results. Like a binary star formation, the Service Prototyping Lab works with the InIT Cloud Computing Lab (ICCLab) in one joint Service Engineering research area with the mutual benefit of covering methods and technologies across the whole stack of software, platform and infrastructure as a service (XaaS). The research area employs more than 20 full-time staff members, dedicated lecturers and researchers to advance the state of the art, to prototype new solutions quickly and to transfer new findings into applied research projects and education for the next generation of skilled technology experts.

Enjoy the lab report and find out more about our lab, its scientific publication and its open source software products at the websites `http://blog.zhaw.ch/icclab` and `https://github.com/serviceprototypinglab`.

Doz. Dr. habil. Josef Spillner
Senior Lecturer
Head, Service Prototyping Lab

The Service Prototyping Lab

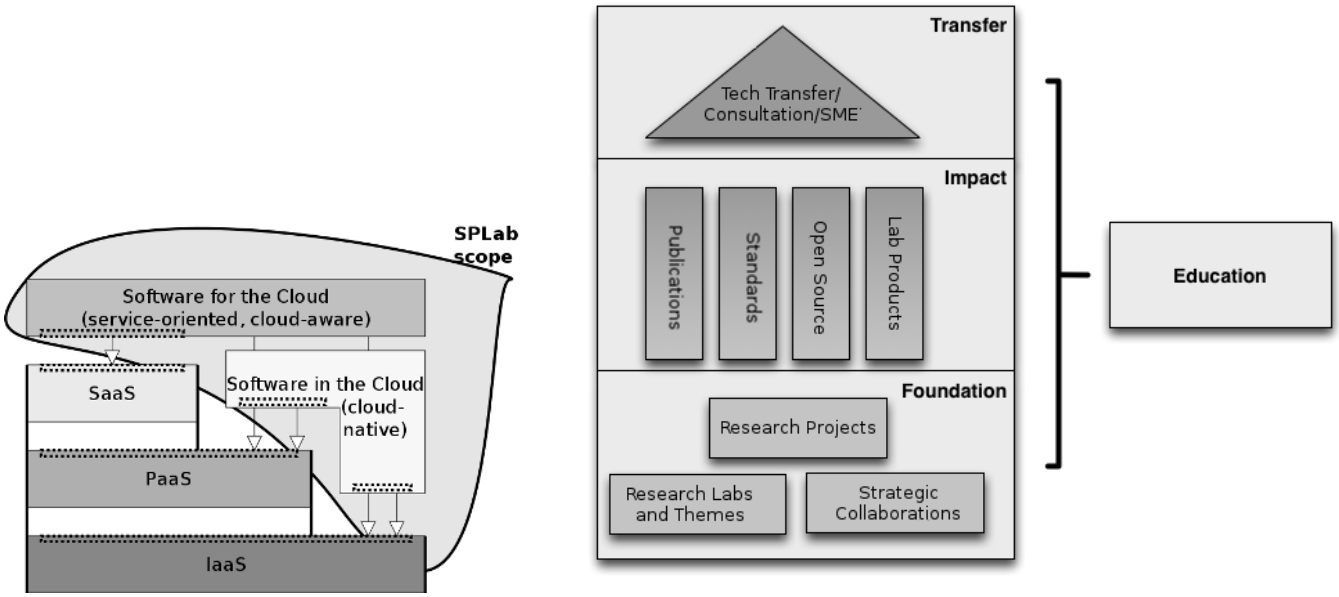
One of the fastest-growing trends in terms of complex software-service systems is the use of cloud computing platforms to build and run distributed applications. Clouds are known to be hard to get into due to evolving APIs, even harder to get out of due to technology and vendor lock-in effects, and not without risks during their use. Still, cloud computing offers many compelling advantages to many application classes, including scalable web applications, industry applications such as smart connected things and robots, and mobile backends. The advantages encompass highly elastic scalability, flexible on-demand provisioning and wiring, fine-grained usage tracking, and the outsourcing of critical tasks such as backups and updates. An additional advantage is the consequent use of service orientation to foster re-use of software services.

The *Service Prototyping Lab* concentrates research on overcoming the challenges to bring applications to the cloud with confidence in their predictable quality. The notion of prototyping incorporates the desirable properties *fast*, *low barrier* as well as *high quality* in additive combinations. The results are thus of benefit to companies in need to try out new technologies without high upfront investments in both training and software development, thus aligning with a truly *applied research* perspective. Through the Service Prototyping Lab, tools, guidelines, and system modifications will be propagated to streamline the process of onboarding applications into cloud environments.

Due to the wide range of topics around cloud applications and services, the lab is structured into two research themes, one taking a look at the global picture of service ecosystems from the outside, and one detailing the handling of single cloud applications from the inside. Consequentially, these themes are called *Pervasive Services* and *Service-Based Applications*, respectively.

Each research theme contains several concrete initiatives which are long-living under the assumption of being led by a researcher in the lab. Initiatives are fueled by funded projects, often running for shorter periods of time, as well as additional research activities. The initiatives will be presented on the subsequent pages. Research results are transferred to companies and into education alike which is a crucial element given the likely employment of students at local companies which are in turn candidates for knowledge and tooling transfers.

The delineation between the two views *inside the cloud stacks* and *on top of the cloud service interfaces* determines the scope of Service Prototyping Lab. The lab carries out research on how to best bring applications into the cloud, considering the interfaces, tools, layers, processes and essential services.



Left: Scope of the SPLab; right: Research approach (shared with ICCLab)

Researcher Spotlight: Manuel Ramirez Lopez

Manuel is from El Burgo, a nice village in Málaga, Spain. He studied a bachelor in Computer Sciences and a MSc in Mathematics, both in the university of Málaga. He started to work in ARPA solutions, a company from Málaga. He worked inside Augmented reality project. In May of 2015, Manuel arrived to Switzerland with a IAESTE internship in the university FHNW and he was working for one year in a Big Data project. In June of 2016 Manuel finished his studies and he joined to the SPLab as a scientific assistant in July of 2016 where he solves problems in cloud-native applications, for instance. Currently, Manuel is working in the ARKIS project to cloud-natify a document management system.

Related software

- `kubeGUI`. A web interface for container management in Kubernetes.
- `CNDBbench`. A benchmark for cloud-native database systems and services.

Related scientific publications

- S. Brunner, M. Blöchlinger, G. Toffetti, J. Spillner, T. M. Bohnert: "Experimental Evaluation of the Cloud-Native Application Design", 4th International Workshop on Clouds and (eScience) Application Management (CloudAM), Limassol, Cyprus, December 2015

Related blog posts

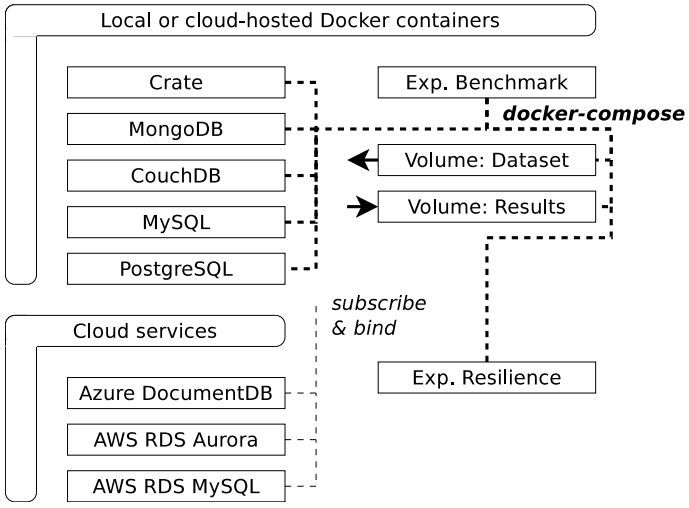
- "A Web-based user interface for Kubernetes", June 2016
- "CNA seed project: CoreOS/Fleet implementation wrap-up", February 2016
- "MySQL Galera cluster with Fleet on CoreOS", November 2015
- "Process Management in Docker Containers", June 2015

Related talks

- J. Spillner: "The Next Service Wave: Prototyping Cloud-Native and Stealthy Applications", IBM Research Zurich, September 2015

Research Initiative: Cloud-Native Applications

In a nutshell, a cloud-native application (CNA) is a distributed application that runs on a cloud infrastructure and is in its core scalable and resilient. These requirements are derived from the essential characteristics that every cloud infrastructure must by definition possess. It is of course possible to run an application in the cloud that does not meet all those criteria. In that case it would be described as a cloud-aware or cloud-ready application. Through a carefully cloud-native application design based on composed microservices, the hosting characteristics can be exploited so that scalability and elasticity do not translate into significantly higher cost.
The CNA initiative provides architecture and design guidelines for cloud-native applications, based on lessons-learned of existing applications and by taking advantage of best-practices (cloud application architecture patterns).



Container composition to test database service characteristics

Project Spotlight: ARKIS

Funded by the Swiss Commission for Technology and Innovation (CTI) and executed with Kendox AG, ARKIS aims at going beyond the current trend of "just" moving data and document management into the cloud by defining a cloud-native architecture for managing documents reliably and with scale in an ecosystem of third-party services around a document management system. Business-critical aspects such as fully compliant and auditable document access procedures are made service-oriented by rating and billing them on a per-use basis. Cloud features such as differentiated storage and surge pricing are analysed for their suitability in this particular domain.

Researcher Spotlight: Giovanni Toffetti Carughi

Giovanni Toffetti Carughi is a senior researcher in the InIT Cloud Computing Lab at the Zurich University of Applied Sciences. Apart from country hopping, in the last 15 years Giovanni has had is fair share of startup, academic, and large industry research experience. He graduated in 2001 from Politecnico di Milano (PoliMi) after a 5 years engineering degree, and right away joined WebRatio in the early days of WebML. He received his PhD in information technology from PoliMi in 2007 with a thesis on modelling and code generation of data-intensive rich internet applications. He then went on to be a postdoc and a research fellow respectively at the University of Lugano (USI), and University College London (UCL). In January 2013 he joined the IBM Haifa research labs where he was part of the cloud operating systems team until early December 2014. During his professional career Giovanni has been involved with different roles in several EU funded projects, namely PLASTIC, RESERVOIR, UNIVERSELF, and FIWARE. His main research interest are currently cloud-native applications with a focus on elasticity/scalability/availability, web engineering, IaaS/PaaS cloud computing, and cluster schedulers. At InIT, Giovanni will be setting up the Service Prototyping lab and collaborating on the Cloud-Native Applications initiative.

Related software

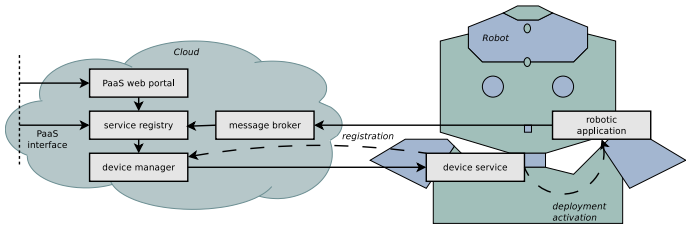
`roboreg`. A service registry and device manager for fleets of robots.
`uprocman`. A user-friendly and user-level process manager.

Related blog posts

"Multi-Tenant Process Management as Single User", August 2016
"Robotic Service Management with Roboreg", June 2016
"Challenges with running ROS on Kubernetes", April 2016
"From unboxing RPLIDAR to running in ROS in 10 minutes flat", January 2016
"ICCLab & SPLab @ ROSCon 2015", October 2015

Research Initiative: Cloud Robotics

THE connection between the physical world and the virtual world has never been as exciting, accessible, and economically viable as today. Sensors, actors and robots are able to deliver many physical services in several scenarios, including industrial production and home automation, elderly care, assisted living, logistics and cooperative maintenance.
In isolation, computing capabilities of robots are however limited by embedded CPUs and small on-board storage units. By connecting robots among each other and to cloud computing, cloud storage, and other Internet technologies centered around the benefits of converged infrastructure and shared services, two main advantages can be exploited. First, computation can be outsourced to cloud services leveraging an on-demand pay-per-use elastic model. Second, robots can access a plethora of services complementing their capabilities (e.g., speech analysis, object recognition, knowledge sharing), enabling new complex functionalities and supporting learning.
Cloud robotics is a natural extension to the Internet of Things (IoT). Where IoT devices will gather information about an environment to help make smarter decisions, cloud robotics will be able to use this information and act on it.
Although there is clear recognition that Cloud access is required to complement robotics computation and enable functionalities needed for robotic tasks (e.g., self-driving cars), it is still unclear how to best support these scenarios.



Cloud Robotics PaaS architecture

Project Spotlight: ECRP

A design for an Enterprise Cloud Robotics Platform is the main objective of this project funded by the Swiss Commission for Technology and Innovation (CTI) and executed with Rapyuta Robotics AG, an ETH Zurich spinoff with meanwhile offices in Zurich, Bengaluru and Tokyo. The results will be released as open source software. First findings are available on how to do device management and how to design hybrid cloud-robotic applications with multi-tenancy provisioning and billing.

Researcher Spotlight: Christof Marti

Christof Marti is Associate Professor (Docent) at Zurich University of Applied Sciences lecturing in the areas of Software Engineering, Programming, Web-Technologies, ICT-Infrastructure, Operating System Technologies and is responsible for the PaaS research theme at the ICCLab. Christof is also the deputy head of the ICCLab. His intrests are on enabling ICT-Services and Enterprise Applications to run on modern cloud computing technologies and infrastructure. He has FH-diploma degrees in Electrical Engineering (Electronics and Communications Engineering) and Software Engineering. Prior to joining ZHAW he was IT director (CIO) at the Winterthur School of Polytechnic (TWI), which is a predecessor organization of ZHAW. He is also a co-founder of the Software Engineering Startup SENAG, which provides Information Management Systems with a special focus on semantic and genetic data analysis.

Related software

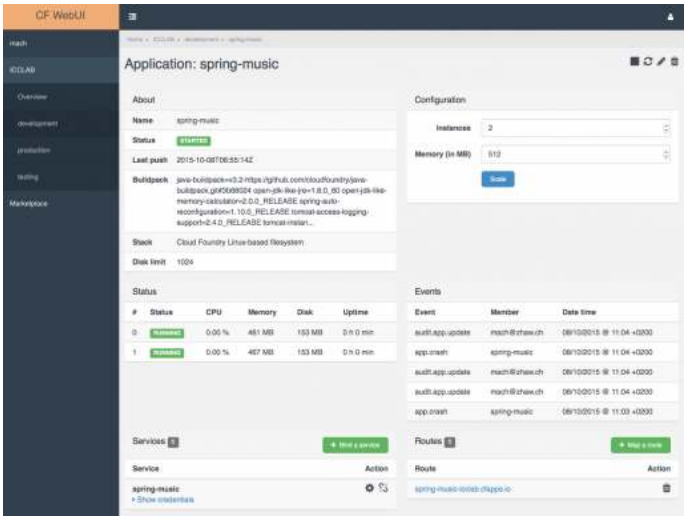
`push2cloud`. Advanced and highly configurable solution to manage complex microservice applications in production.
`CF-WebUI`. Single page Cloud Foundry Web User Interface based on AngularJS and Bootstrap.

Related blog posts

"push2cloud – Deploy complex microservice applications in style", May 2016
"Announcing CF WebUI – an open source web interface to Cloud Foundry", November 2015

Research Initiative: Cloud Application Development Tooling

CUSTOMERS in the cloud age expect fast innovation and a downtime-free application provisioning. Modern cloud development tools, cloud automation and continuous delivery of software as a service makes this possible. This delivery model depends on a continuous service deployment functionality in the hosting environment, i.e. in the PaaS or IaaS stack, in combination with powerful version control systems and automated continuous testing and integration. To bring software to scale and avoid failures, decentralised stacks and systems are used to deploy the services. Once they are deployed, scalability and resilience are taken care of by run-time methods such as CNA.
Cloud Application Developer tooling and Continuous deployment on PaaS platforms is a particularly popular research topic with industrial relevance. Tools are being created to support CloudFoundry, OpenShift, Heroku, and Azure. The goal is to get the services running with a single button click and no more worries about dependencies, random breakage or interface incompatibilities.
Innovation in the entire application development lifecycle: design, modelling, testing, packaging, deployment, debugging, publishing, running, monitoring. This initiative will therefore contribute open source tools to build application development ecosystems.



Screenshot of CloudFoundry web interface

Researcher Spotlight: Josef Spillner

Josef Spillner is affiliated with Zurich University of Applied Sciences as senior lecturer and head of the Service Prototyping Lab in conjunction with the InIT Cloud Computing Lab. Before founding the lab, he conducted research and led activities as post-doc at TUD, SAP, NTUU, UFCG and UniBZ. He wrote a doctoral dissertation about metaquality of services (2010) and a habilitation treatise about stealth computing in multi-cloud environments (2015) and published more than 50 papers on related matters. Josef Spillner is active in several cloud communities and initiated the Open Source Service Platform Research Initiative to promote re-usable software for scientific work.

Related software

`aws-cli-experiments`. Scripts and raw data for observing the (need for the) retry functionality in aws-cli-retry, the AWS-CLI tools with retry patches.

Related scientific publications

J. Spillner, M. Beck, A. Schill, T. M. Bohnert: "Stealth Databases: Ensuring User-Controlled Queries in Untrusted Cloud Environments", 8th IEEE/ACM International Conference on Utility and Cloud Computing (UCC), Limassol, Cyprus, December 2015

Related blog posts

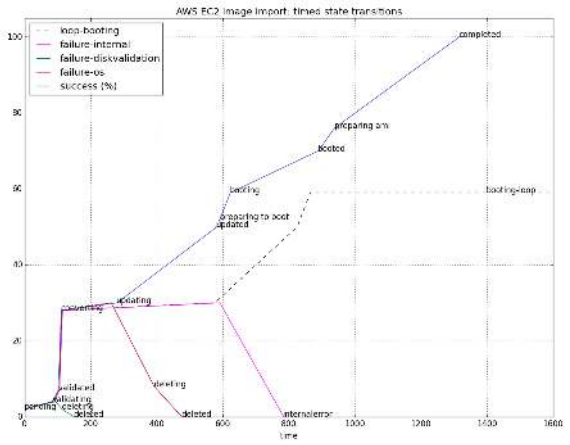
"Walk-through: Importing virtual machine images into EC2", June 2016
"Making Tools Robust and Breaking Robust Tools", May 2016

Academic tooling blog posts

"Creating PDF/A Documents for Long-Term Archiving", August 2016

Research Initiative: Service Tooling

WORKING with remote services requires appropriate and decent tooling. A service idea may take just five seconds ("I want to offer a robust note-taking service"), but its realisation may take much longer ("Which programming language?", "How to describe the service?", "Where do I find a fitting file service to store the notes on unless I want to take care of backups by myself?", "Where do I publish my service so that it runs and generates income?"). Therefore, modelling, engineering and integration tools are primarily needed. These tools work in combination with a certain service environment, called ecosystem, consisting of more tools, dependency services, and service platforms which bring services to life.
Open source service platforms such as SPACE and FIWARE went from being architectural visions to actually usable platforms. However, in comparison to cloud stacks and virtualisation platforms, their popularity is limited and they are far from being used pervasively. Therefore, the Service Tooling research initiative of the Service Prototyping Lab intends to identify tools and platform services which are straightforward to deploy, easy to use and generic enough to be re-usable in many service scenarios. Candidates are marketplaces, dashboards, brokers, migration wizards and service advisors.



Empirically determined state transition times for AWS EC2

Researcher Spotlight: Tobias Lötscher

Tobias is an assistant researcher at ZHAW Service Prototyping Lab. He has completed his bachelor in computer science at ZHAW in 2016. Now he is working on the cloud robotics initiative, which aims to connect the world of robotics with cloud computing. He likes to challenge himself and try out all sorts of new technologies like the Google Tango platform which he used in his bachelor thesis. In his Bachelor Study he learned the bases of cloud computing and is now eager to dive into the details. Beside the work he is a passionate skier and loves to be in the mountains.

Related software

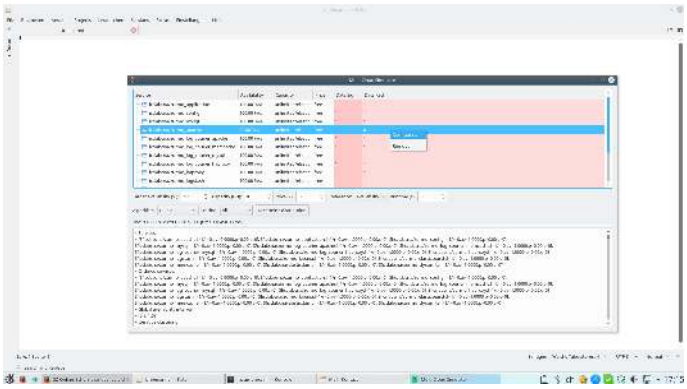
`MC-SIM/MC-EMU`. Multi-Cloud Simulation + Emulation framework for targeted failures of compute, storage and networking resouces.
`Dynamite`. Dynamite's ultimate goal is to manage the deployment and the automatic scaling of a dockerised application on CoreOS.

Related talks

J. Spillner: "Cloud Applications: Less Guessing, more Planning and Knowing", University of Coimbra, May 2016

Research Initiative: Active Service Management

SERVICE hosting platforms such as IaaS and PaaS offer a lot of convenience for the service engineer. They take care of proper provisioning, scaling, healing and profiling. Yet, this platform support is limited when it comes to decisions which require insight into the application state and logic, especially considering applications or services ranging across multiple platforms with composition and orchestration.
The Active Service Management research initiative of the Service Prototyping Lab aims at improving the state of the art by letting applications signal their states, conditions and requirements, and by letting platforms understand these signals. Emerging from the work on Cloud Native Applications (CNA), this initiative subsumes work on pro-active/predictive auto-scaling with application metric such as numbers of users and self-* properties such as self-healing by replacing crashed or unresponsive application parts with new instances.



Optimal replication determination over a set of microservices with varying availability

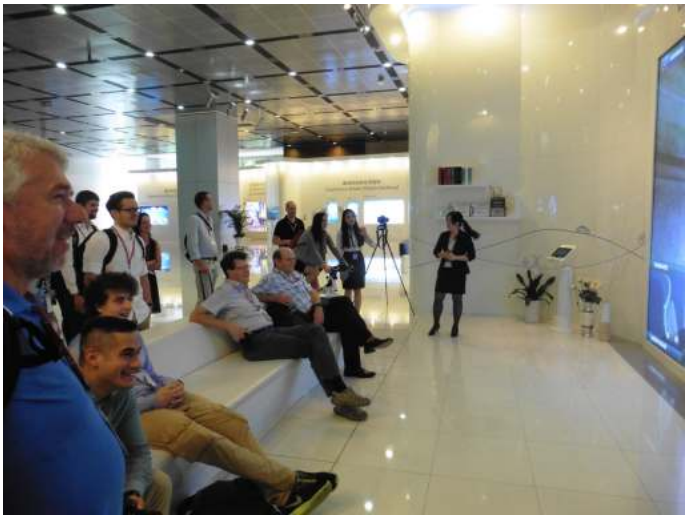
One important aspect of active service management is to know about faults before they occur. By provoking system and network faults (e.g. rejected, dropped and slow connections) in a controlled environment, and modelling the potential complex fault situations in re-usable catalogues, software service developers can automate the hardening of their portfolio.

Education

TEACHING the basic elements of cloud computing found in several textbooks is not enough. We continuously update our lecture and lab materials based on findings in our research. Students benefit from this approach by getting some of the strongest education in the field of service and cloud computing.

Global Information and Communication Technology

Through the Seeds for the Future programme by Huawei, students (and, without selfishness, some accompanying lecturers) get the opportunity to travel to China to explore research and development as well as production of cloud and telecommunication equipment. SPLab was present in 2016 to cover the adjacent topics Internet of Things and Cybersecurity in networked environments.



Group visit at the Shenzhen exhibition hall

Blog post: "Global ICT Module: Swiss Students in China", August 2016

Internet Service Prototyping (bachelor, elective module)

The new elective module Internet Service Prototyping, offered in English in the 5th semester for both Computer Science and Business Engineering students, has been chosen by students immediately for the first iteration. The lecture conveys techniques on how to build cloud applications quickly without compromising quality. It introduces new tools like Vamp, the RAML workbench, Cyclops and distributed key-value stores to support the prototyping.

Cloud Computing 1+2 (bachelor, elective module)

While the Cloud Computing lecture was already offered before, it has now been extended to span two semesters (5th and 6th) for Computer Science students. This makes it the most profound cloud education offer in Switzerland. With hands-on labs on all details of cloud stacks, the students become qualified to solve problems at scale and get familiar with the notion of computing as a utility.

Foundational lectures

SPLab members are also involved in teaching advanced Python programming to Business Engineering students, in advanced Java programming to Computer Science students, and in several other modules.

Misc

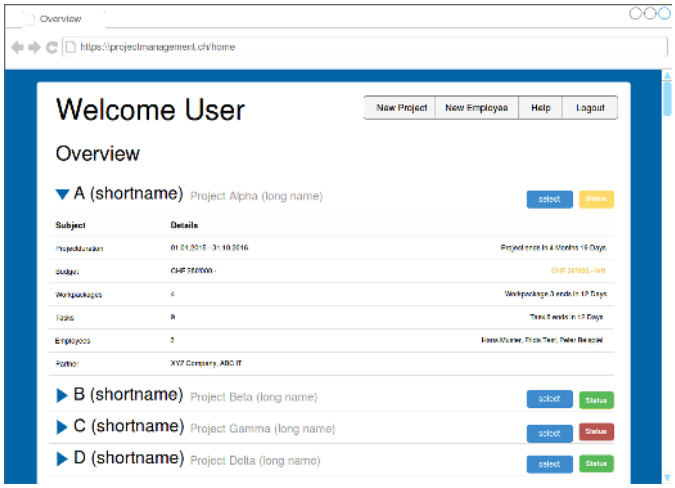
BEYOND the entral research projects and endeavours clustered around our initiatives, the Service Prototyping Lab engages in several activities in the academic and technological communities.

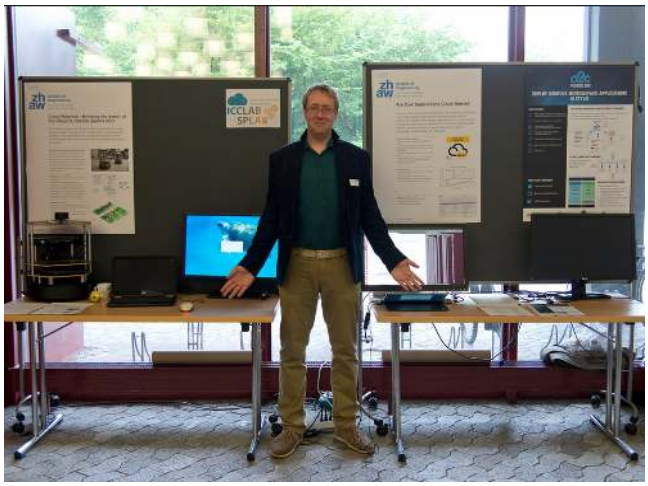
Doctoral theses

SPLab co-supervises two doctorate propositions in its areas of expertise. Stanley Ramalho Lima, from Brazil, spent half a year at Technische Universität Dresden, Germany, followed by joining the doctoral programme of University of Coimbra, Portugal, to investigate matters of resilience and complex faults in cloud computing environment. The research is supported by the Brazilian Ciências sem Fronteiras programme. Ambrósio Vumo, from Mozambique, is currently spending half a year in Cologne, Germany, to learn German intensively. Subsequently, he will join Technische Universität Dresden as a sandwich doctoral student with Universidade Eduardo Mondlane, Mozambique, to revisit the state of cloud computing and networking in his home country.

Apprenticeship

Janine Walther works in the SPLab as part of her apprenticeship on Fachinformatikerin Anwendungsentwicklung. To cover a daily need of the lab, she designs, prototypes and implements a project management SaaS.





Left: Project Management SaaS; right: Open Cloud Day 2016

Events

SPLab members participated in the 4th ROSCon in October 2015 in Hamburg, Germany, and in the 8th IEEE/ACM UCC in December 2015 in Limassol, Cyprus. Furthermore, the lab contributed to two Service Engineering events hosted in Winterthur: The annual Cloud Computing Summer School which primarily targets international students with conceptual lectures and labs, and the Open Cloud Day 2016 which has a mix of speakers from companies and academia to address technological trends. Furthermore, several talks were given at local Docker and CloudFoundry meetups, and several top positions were achieved in the annual group-internal Hackathon.

- Blog post: "Cloud Computing Summer School 2016 - Highlights", July 2016
- Blog post: "Impressions from the UCC 2015 Conference, and Call for 2016", February 2016

SPLab Alumni

- Pietro Brossi. He covered the operations perspective in data centres.
- Özgür Özsu. With us as IMS intern, we expect him back as student next year.