EMBEDDING OF CONTAINERIZATION TECHNOLOGY IN THE CORE OF THE VIRTUAL COMPUTING LAB

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The purpose of the paper is to share of practice of implementation in university the new cloud technologies supported by Virtual Cloud Computing Laboratory (VCL), as IT learning platform that integrates research, training and collaboration with business partners. The approach is considered by an example of introduction containers technology in research and courses connected with cloud computing. We show that complex approach is an effective and fast way to accustom students to new technique of deployment of IT infrastructure.

Keywords: virtual computer lab, containerization, virtualization, Docker, education, training IT specialists, cloud computing.

1. Introduction

Dubna University located in one of the most innovative place of Russia — Special Economic Zone. Among the University's partner enterprises - International Joint Institute for Nuclear Research (JINR), Aviation Company Group "Progresstech", Dubna Machinery Plant, Dubna Farma, Municipal project "Smart Dubna" and multiple software engineering organizations. One of the fist university cloud in Russia was launched in 2009 in Dubna as IBM Shared University project based on IBM Blade, IBM Tivoli and VMware technologies. The initial purposes of this cloud were research and elaboration the better cloud architecture. Later on, after series of immersed researches it was transformed into the full-functional Virtual Computing Laboratory (VCL) as a platform for full-time and distant learning and — Dubna Open University and new direction on virtual organization design as a part of Faculty of System Analysis and Management. The virtual computer lab provides a set of software and hardware-based virtualization tools that enable the flexible and on-demand provision and use of computing resources in the form of "cloud" Internet services for carrying out research projects, resource-intensive computational calculations and tasks related to the development of complex corporate and other distributed information systems. The service also provides dedicated virtual servers for innovative projects that are carried out by students and staff at the Institute of System Analysis and Control. Training highly skilled IT professionals, it is an important challenge for the university to teach professional competencies to graduates that they will be able to use to successfully solve a broad range of substantive problems that arise at all stages of the lifecycle of distributed corporate information systems. Such information systems in practice, as a rule, are used for enterprise management, workflow management in technological processes, IT infrastructure management, creating web-solutions for high availability, data collection, and data analysis and storage. It is obvious that in order for students to learn these professional competencies, they need to master a large amount of theoretical material and to carry out practical exercises and research on the development of modern information systems, their deployment and support, the effective implementation of solutions for problem-oriented tasks, etc.

2. Brief concept of approach

The organization of an effective process for the goal-directed training of IT experts has demanded a speedy solution to the following problems: an often insufficient number of classroom hours for students to cover a necessary and sufficient set of practical exercises that help students learn complex information systems; on a typical personal computer with average capabilities it is impossible to get real practical experience working with multi-component information systems because the hardware requirements for such systems often go beyond what is offered on typical home, office and laptop computers; sometimes there are difficulties installing and supporting some information systems, and these problems cannot be solved without gaining experience about how to use such systems. Since students of 3 – 4 years start working in one of the mentioned partner's enterprise their IT education has shifted from general purpose IT knowledge to project orientation embracing requirements management, load optimization, web-services integration in cloud and many others. In this development the implementation of containers technology in educational process means — from one side - a new stage of virtualization in design process of large partner's corporative IT systems, and correspondently - a new challenge for renovation and update courses curricula.

In their learning projects students focused on new technologies. In that number:

- Failover and NLB solutions;
- Hadoop infrastructure for processing and storage of extremely large data;
- Modern ERP systems and Workflow solutions including IBM WebSphere software;
- Business process management and optimization with Software AG ARIS suite;
- Business integration technologies based on Microsoft BizTalk server;
- Oracle RDBMS and OLAP analysis with Oracle Business Intelligences;
- IBM Cognos Analytic and Microsoft Analysis Services;
- Machine learning and modern cognitive technologies;
- Requirements management with IBM Rational Doors;

- Web service programming and deployment with use of modern languages C#, Java, Node.js, Python, PHP, Scala;
- Core network services and Linux based open source technologies;
- Network audit and monitoring technologies;
- Distributed load testing;
- Version control systems, release management and continuous integration;
- ITSM software including OpenStack, Boilerplates, mobile software development for Android, iOS, SailFishOS, Tizen and etc. [1, 2].

The new practice with containers is different compared to VMware or OpenStack cases. For the underlying operating system kernel can be used for all containers. On the one hand, it introduces restrictions on the use of other operating systems while, on the other hand, it improves payload on the north of a similar configuration. This can be achieved due to the specifics of the containerization architecture, which we will examine on the example of Docker.

Docker uses a client-server architecture in which the Docker-client interacts with the Docker daemon, enabling the operations of creating and launching containers on the server and providing them to students. In general, a containerization system can be represented in the form of three key components: images, registries, and containers. Images represent read-only templates that contain an operating system based on the same kernel version as the host system with necessary pre-configured and adapted software. These images are created, modified if necessary, and then used for deployment of individual solitary containers. The images are stored in the registry, which is a tool for their storage and distribution. The registry content corresponds the curriculum and laboratory plans prepared by the teaching staff. Public Hubs containing a large collection of images created by independent enthusiasts can be used to download the required images.

The containers per se are, in fact, similar to catalogues (directories) of an operating system, where all the changes made by the user and the system software in the course of work are stored. Each container installed from an image provides the capacity for fast creation, start, stop, move, and delete. It also works as a safe sandbox for running applications, allowing the student to carry out any experiments without compromising the base operating system, while maintaining the highest level of performance. Current evolution of VCL lead to development of design templates for both corporate IT deployment and students learning project.

3. Conclusion

The Virtual Computing Lab provides an optimal and sustainable technological, educational-organizational, scientific methodological and regulatory-administrative environment for supporting innovative approaches to computer education. It promotes the integration of the scientific and educational potential of Dubna State University and the formation of industry and academic research partnerships with leading international companies that are potential employers of graduates of the Faculty of System Analysis and Control [3-5]. The results that the Institute of System Analysis and Control has achieved in improving the educational process represent strategic foundations for overcoming perhaps one of the most acute problems in modern education: the fact that it tends to respond to changes in the external environment weakly and slowly.

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