Ad hoc course announcement

Title: **Virtualization technologies and their applications**

Lecturer: **Prof. Luigi De Simone**

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CV: Luigi De Simone (Ph.D.) received his MSc degree with honors in Computer Engineering in 2013, and the PhD degree in 2017 from the Federico II University of Naples, Italy, where he is currently an Assistant Professor. His research interests include fault injection testing, dependability benchmarking, virtualization reliability and its application to critical systems and cloud systems.

Credits: **5**

Overview

This course will present advanced virtualization technologies used today for both research and industrial applications, including embedded systems, networking, cloud computing, and telecom devices. The course will provide the students with the basis for developing experimental testbeds and novel systems with high-performance and reliability properties in their own research field. Every lesson consists of a first part with an overview of the specific virtualization technology, and the second part of a hands-on session to show how to use that technology in practice. At the end of the lesson, students are encouraged to start a discussion on why and how to adopt that virtualization approach in their research activities.

To earn the credits, at the end of the course students need to provide a good quality presentation about the potential application of virtualization in the context of their research field, with the current state-of-the-art. Students' presentations will take place in the last lesson. Details about the presentation format and schedule of the presentations will be given during the course.

Schedule

Lecture	Date	Time	Topics	Lecturer
1	Jan. 08, 2024	10:30 – 12:30	Virtualization and Virtual Machines	Prof. Luigi De Simone
2	Jan. 11, 2024	15:30 – 17:30	Virtualization and Virtual Machines (hands-on)	Prof. Luigi De Simone
3	Jan. 15, 2024	10:30 – 12:00	Para-virtualization	Prof. Luigi De Simone
4	Jan. 19, 2024	15:30 – 17:00	Para-virtualization (hands-on)	Prof. Luigi De Simone
5	Jan. 23, 2024	15:00 – 17:00	Container-based Virtualization	Prof. Luigi De Simone
6	Jan. 25, 2024	15:30 – 17:30	Container-based Virtualization (hands-on)	Prof. Luigi De Simone
7	Jan. 29, 2024	10:30 – 12:30	Virtualization for High-Performance and Reliable Systems (part 1)	Prof. Luigi De Simone
8	Jan. 31, 2024	10:30 – 12:30	Virtualization for High-Performance and Reliable Systems (part 2)	Prof. Luigi De Simone
9	Feb. 05, 2024	10:30 – 12:30	Virtualization for Real-Time Systems (part 1)	Prof. Luigi De Simone
10	Feb. 07, 2024	15:30 – 17:30	Virtualization for Real-Time Systems (part 2, with hands-on)	Prof. Luigi De Simone
	Feb. 26, 2024	10:30 – 14:30	Assessment Test	Prof. Luigi De Simone

Content details

Lesson 1 and 2 - Virtualization and virtual machines. Basic concepts of virtualization. Types of virtualization. Full-virtualization, hardware-assisted virtualization. CPU Virtualization. Memory virtualization. I/O virtualization.

Technologies: KVM/Qemu. VMware. OpenStack platform.

Hands-on session: KVM/Qemu VM configuration. OpenStack.

Lesson 3 and 4 - Para-virtualization. Introduction to para-virtualization. Exokernel architecture. Para-virtualization vs. full-virtualization. Para-virtualized Disk and Network.

Technologies: Xen. VirtIO. Vhost.

Hands-on session: The Xen project.

Lesson 5 and 6 - Container-based virtualization. Introduction to containers. Containers vs. Virtual Machines. Kernel namespaces and cgroups. Microservices

Technologies: LXD. Docker and Docker Swarm. Kubernetes.

Hands-on session: Docker and Docker Swarm; Example on High-Available testbed deployment.

Lesson 7 and 8 - Virtualization for high-performance and reliable systems. The Unikernel approach. Unikernel vs. Virtual Machine. Hypervisors and unikernels. Unikernels in telecom and network applications.

Technologies: MirageOS. OSv. LightVM. Tinyx. ClickOS. ukvm. Nabla. Unikraft

Hands-on session: Unikraft.

Lesson 9 and 10 - Virtualization for real-time systems. Virtualization in real-time systems. Real-time hypervisors. Hardware-assisted virtualization for real-time. Virtualization in IoT. Safety standards and virtualization.

Technologies: Real-time KVM, RT-Xen. PikeOS. NOVA hypervisors. Jailhouse. LTZVisor. RT-CASEs. ACRN IoT hypervisor.

Hands-on session: Jailhouse with FreeRTOS guest.

Assessment. The lesson is dedicated to the final assessment.

By **7th January 2024**, participants are requested to join the following MS Teams group:

https://teams.microsoft.com/l/team/19%3AlgXNb8iet0qhgQb03XLbWh-M3JQWzvbjL3sHRL2fWVg1%40thread.tacv2/conversations?groupId=def50cf0-b676-4b46-80c8-5f4bbc977b0f&tenantId=

Once accepted in the Teams group, students **must fill the following .xlsx file** with their information (i.e., Student name and surname, e-mail, name of the PhD course, PhD cycle):

https://communitystudentiunina.sharepoint.com/:x:/s/2023_2024_VirtualizationTechnologiesandtheirApplications/Eb4knGIEfbdNgcLTxAvNZLoBTg5EcF6ge6DrTVMXkWXQyA?e=xTgqYz

The course is conducted on-site (the classrooms will be announced in the coming days). However, students pursuing their PhD period abroad (for research purposes) have the option to request remote attendance for classes via MS Teams.

For information: Prof. Luigi De Simone (DIETI, UniNA) – luigi.desimone@unina.it
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