MECA, the MicroElectronics Cloud Alliance

Figure 1: MECA Logo

Abstract—**The MicroElectronics Cloud Alliance (MECA) is a European funded project where 18 higher education institutions, and small and medium enterprises, sited in nine different European countries, have the aim of developing a Cloud-based European infrastructure for improving the education in microelectronics. In MECA open educational resources, educational and professional software, remote access to virtual laboratories are shared, all based on modules and learning facilities remotely available.**

MECA wants to be the one-stop platform of reference for the microelectronics education and the useful tool for sharing resources among institutes working in microelectronics design training. In fact, thanks to the Cloud system built inside MECA Consortium, the resources of all the partners are shared, both hardware and software, excluding licensing of course, for clear legal reasons.

Keywords—E-Learning; Cloud; Microelectronics; Higher Education; Life-Long Learning.

I. INTRODUCTION

Information Technology (IT) infrastructure exploitation in technical learning environment is a tough challenge, both in terms of setup, and in terms of maintenance. IT facilities needed for microelectronics design are increasing in complexity, requiring the installation of expensive computer systems, with a very high computing power, and the use of high performance networks. Moreover, in terms of human resources, IT personnel must be well trained for effectively managing and maintaining the software/hardware platforms. The solutions applied nowadays are related to the installation of private systems by the institutes, giving the management to internal resources that not always can be well trained and updated.

Hardware Virtualisation has become a solution, to avoid the massive use of power-consuming servers, also because the standard needs for microelectronics design classrooms are concentrated in the slots when the hands-on courses are done, leaving for the rest of the time the servers minimally used, wasting computing and electrical power.

In addition to technical aspects, it has the same importance the complexity of the permanent update of curricula. Even larger enterprises in this sector have difficulties to compete in it.

The basic concepts from where MECA took inspiration are exactly generated from the just mentioned issues. The partners shared the difficulty of maintaining by themselves the necessary expensive infrastructure for microelectronics teaching, never sufficient when a large cohort of students is working in the same hands-on class. And they understood too that the sharing of knowledge and teaching facilities could dramatically improve the training quality given to the students.

For these reasons, the project was setup for sharing laboratory experiences, CAD software, project ideas and learning materials. All these requests found the technical answer in the development of a Cloud Infrastructure [1], shared among the partners, and, even more important, fed by them.

Some specific solutions based on WEB "Cloud" are already under development, as the ones proposed by the WEB–based CAD tool named TAMTAMS [2][4]. This tool is a simple and flexible structure, with an Open Access WEB-based concept, which allows the prediction of microelectronic system level features, starting from technology variables.

Private virtual environments are already used in several Institutes too, to provide to students the access to course software 24/7 and from everywhere (campus, home, traveling, ...).

These are some good examples of the use of the network for micro–nanoelectronic design, but can be considered part of a more complete solution that MECA wants to provide.

With these premises, the MECA concept of "Educational Cloud" has as main objectives:

- to provide a range of updated and open educational resources in microelectronics;
- to allow the remote access to e-Learning environments to students, teachers and company employees;
- to open the access to hands-on learning facilities remotely accessible;
- to give access to hardware resources shared among the partners, as servers with computing power and storage, speeding up the provisioning of technical learning resources;
- to share the technical platform among system administrators, improving their knowledge and experience;
- to reduce the required manpower with system administration skills due to both the general short-

age, and the increasing number of duties for system administrators in any kind of institute.

II. Need Analysis

For understanding the needs of the final users (students, teachers, company experts) a Need Analysis has been done, collecting the feedbacks of all the interested categories.

On-line questionnaires have been prepared, different for each type of user. 152 answers from students, 59 from teachers and 23 from industry representatives were collected. From the study, it resulted that 89% of the students use Open Educational Resources (OERs), and those who do not use them are willing to learn with OERs. 73% considered that the learning is more attractive with OERs. Most of the educators believe that the use of OERs would improve their practice and reduce their efforts and time used for teaching.

The industrial experts involved in the analysis gave as feedback that the proposed courses can fulfil in the short term the average needs. Effective communication with groups, presentation techniques, project management and survival on the labour market are considered highly important by almost all respondents.

Additional topics were suggested in power electronics, graphene technologies and system integration.

III. Project Targets

The targets of MECA are several. The goal is not to conceive the system for students only, but to take the opportunity of developing a common platform in which training institutes can take material, ideas and, the most important aspect, to share the knowledge.

Project target categories and their related actions, derived from the results of the Need Analysis too, can be listed as:

- *Students in microelectronics*, with the goal of providing them high–quality educational materials and up–to–date courses;
- *Lecturers*, that will take benefit of modern course delivery approaches and of the teaching materials shared inside the MECA Cloud;
- *University System*, exploiting the European vision in higher education given by MECA;
- *Future Employers of the Students*, who will find young specialists more empowered by the new learnt skills, ready for the new jobs in microelectronics design.

IV. Planned Courses

In MECA a set of courses has been already planned. At the date, they are under development. They are proposed by the different Institutes and Companies, partners of the project, as indicated:

- “eLearning Courses, CAD in Microelectronics and in Nanomaterials using CADENCE” (TUS, Technical University of Sofia, Bulgaria);
- “Design and realisation of Micro-NanoBioSensors” and “Modelling and Design of ULSI circuits and systems” (Politecnico di Torino, Italy);
- “Assembling and Inspection Technologies”, “Multi-Media Enhancement of Teaching Sensors and MEMS” and “Technology of Electronics Products” (Budapest University of Technology and Economics, Hungary);
- “Design for Manufacturing of Microsystems, Electronic Packaging and Assembling Technologies of Microsystems” (University of Bucharest, Romania);
- “Electromagnetic Compatibility of Integrated Circuits” (Institut National des Sciences Appliquées de Toulouse, France);
- “Electronic Maintenance in Renewable Energies” (INOMA Renovables, Cadiz, Spain);
- “Fabrication & Application of Solar Cells” (National Solar Energy Institute, Chambéry, France);
- “Micro–and Nano Sensors and Actuators” and “Semiconductor Device Modelling” (University “Sts. Cyril and Methodius”, Skopje, Macedonia);
- “Microelectronics literacy and technologies & Integrated circuits and design” (National Distance Education University, Spain);
- “Microsystems Design and Fabrication” (AMG Technology Ltd., Botevgrad, Bulgaria);
- “Superconductive materials” (Technical University of Berlin, Germany).

V. Technical Infrastructure

Big players like Amazon Web Services (AWS) [5], Microsoft Azure [6] or Google [7] are engaged in the Cloud market. And on the other side there are private Clouds inside of institutes.

Also, a mixed flavour exists where private Clouds are extended with computing power, additional features like high performance computing and machine learning, or just storage from the public Cloud. This mix can be used for example when there are peak usage requirements during a short period of time – e.g. a summer camp at a university for which it would not be worth to buy several new computers.

These layers of virtualization and packaging of computer resources leads automatically to thinking not so much in single computers anymore, but thinking in applications for the end user.

The solutions that can be implemented, listed in an ascending path, are:

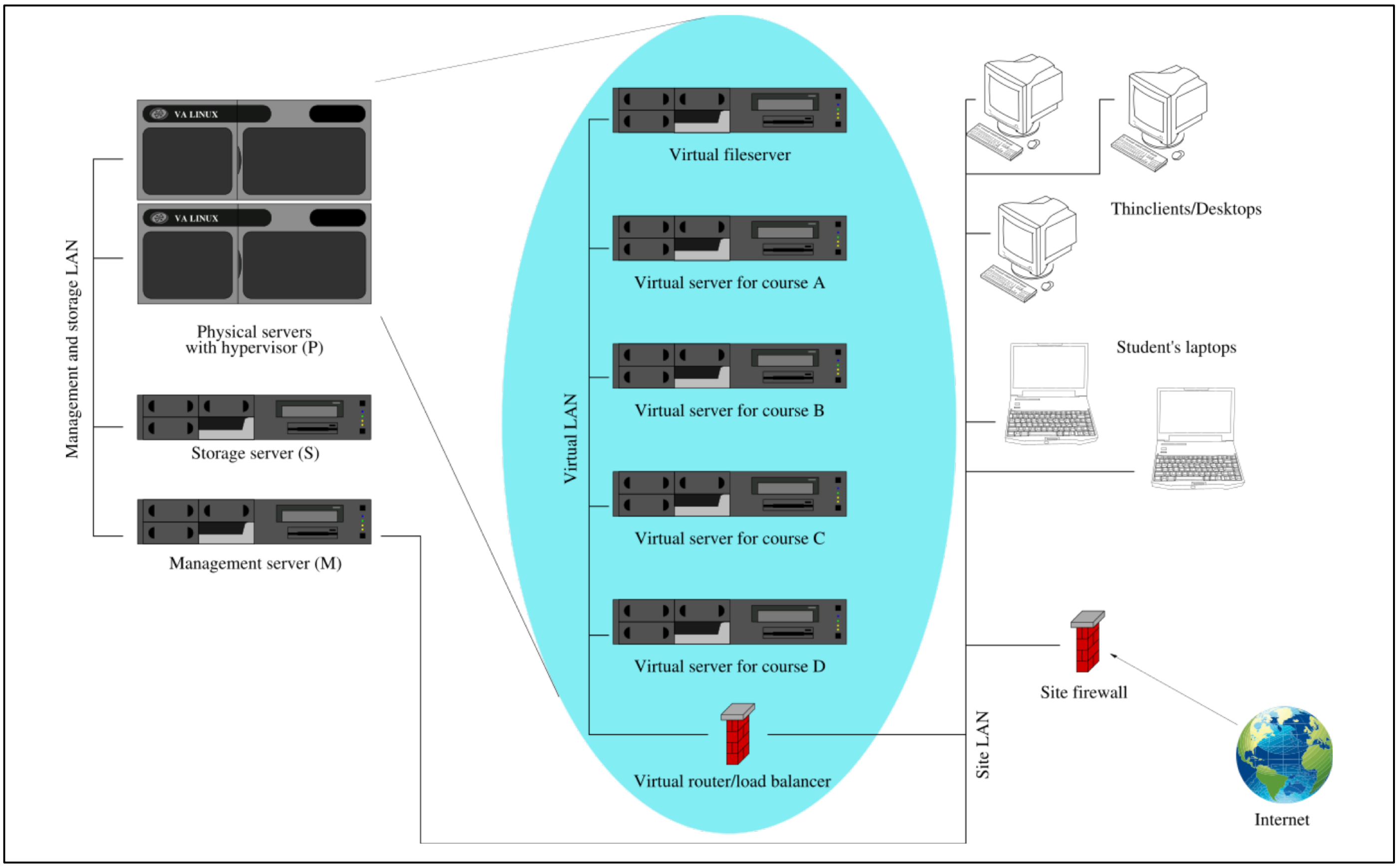

Figure 2: MECA Infrastructure

- *Infrastructure as a Service* (IaaS), where it is implemented a full access to virtual computers;
- *Platform as a Service* (PaaS), where the software development layer is fully administrated by the Cloud provider, e. g. a PHP/MySQL web server;
- *Software as a Service* (SaaS), where the complete application is fully administrated by the Cloud provider like a WordPress website or a Moodle e-learning installation.

In MECA, all the different levels will be exploited, depending on the application needs. The basic pillar of the infrastructure is the Open Source Solution of Apache Foundation named CloudStack [8]. For MECA purposes CloudStack:

- is an open source Cloud management software that fits the needs;
- supports all important hypervisors (KVM, VMware, Hyper–V, XenServer);
- controls the virtual machines with agents or APIs and so can be connected to vendor specific hypervisors, or even extended to satisfy new needs;
- works with any client as desktops, notebooks, tablets;
- the configuration is very transparent because it is stored in a MySQL database, easily accessible for obtaining the needed information, and the management interface is a Java Web Application.

In a first step, each university will install its own technical infrastructure, without immediately converting the whole existing university equipment to be under control of CloudStack.

A step–by–step strategy will be applied, starting from the services that the institute considers more critical using a classical infrastructure, for moving to the rest of the training services in further steps.

For setting up the system:

- a map of the participating High Education Institutes (HEIs) with their servers has been done;
- the best place for the CloudStack controller has been individuated;
- the first installed service has been the Moodle Web Application;
- common CAD software installations have been shared among the partners;

- the Monitoring System has been implemented.

The technical structure of each site is shown in Figure 2. A complete IaaS based Private Cloud is implemented, with the following components:

- one or more physical machines, hosting course virtual instances (Virtual Machines, VMs), and system services VMs (load balancers, routers, network services providers, etc.);
- one or more storage servers, which host VMs disk images, and templates used to generate new ones;
- one or more management server, hosting the MySQL configuration database, and the Web Application based SysOp's User Interface;
- a virtual LAN, used to connect virtual instances;
- a storage and management isolated LAN, to support intra–Cloud traffic.

The Cloud is then connected to the site LAN, and, through the institution border router, to the Internet. Access to computing services can be obtained both through the inner LAN, or even directly from the Internet, with different security access policies.

The next step is the connection of different sites, to allow global resource sharing. Available resources are computing and storage capabilities, and prebuilt VM templates for specific needs.

The latter greatly reduce the effort needed at each site to implement new courses, as previous experiences can be easily capitalized.

Two models have been examined to perform the connection:

1. a *loosely coupled model*, based on the concept of regions, naturally available in the CloudStack environment. Each site represents an independent region, with its own database and management server, but everything can be globally administered through credential sharing;
2. on the other hand, a *tightly coupled model* is built with redundant replica database and management servers deployed in several sites. Here the system act as a single entity, but a high bandwidth site–to–site VPN must be available, to link every management and storage LAN in a single network.

VI. MECA Cloud Status

The project is ongoing and at November 2017, as depicted in Figure 3, six MECA nodes are active:

- TUS, Bulgaria;
- eWorks, Germany;
- BME, Hungary;
- Politecnico di Torino, Italy;
- UKIM Skopje, Macedonia;
- CETTI, Romania;

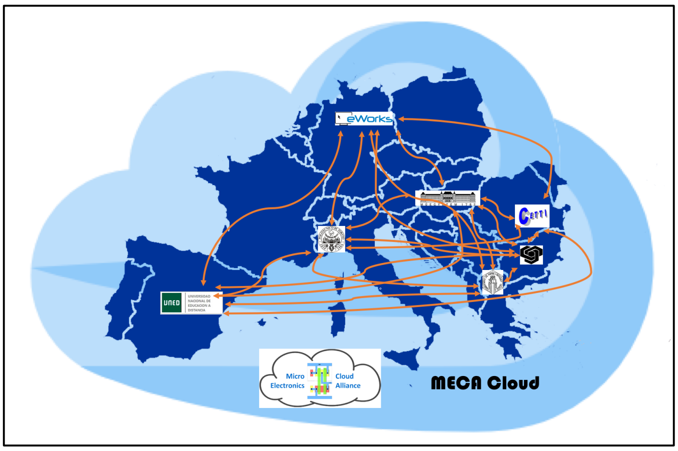

Figure 3: MECA Cloud Nodes at November 2017

- UNED, Spain.

And in parallel the courses are under development, with several Moodle Servers installed in the different HEIs. The courses are implemented following different educational methods, as HTML interactive pages or video eLearning contents supported by PDF material.

Particular attention will be devoted to the implementation of tasks, questionnaires, practical projects, homeworks, on-line feedback, face-to-face meetings for each developed course, and interactivity among courses.

By industrial partners some very interesting courses have been setup. Four of the business partners developed job-related courses:

- "Electronics maintenance in Renewable Energy" by INOMA;
- "Design, Prototype Fabrication and Challenging Applications of Silicon Microsystems with Piezoresistive Feedback" by AMG Technology;
- ''Silicon Homojunction Solar Cells" by INES;
- ASTEL created a Video Lesson about main criticisms in handling semiconductor devices manufacturing. In this course, the design of an optical inspection station of semiconductor wafers is presented [9].

VII. Conclusions

In this paper, it has been presented the concept of the European project MECA, with the educational and technical reasons that induced a team of Universities and Companies to setup a Cloud system focused on microelectronics training.

The project is ongoing and the infrastructure will be released for December 2018. The first tests have been done proving the efficiency of the solution and preliminary classrooms have been involved in some pilot tests.

Acknowledgment

The authors would like to thank European Community support for the funding received by Knowledge Alliance Action, Project n. 562206-EPP-1-2015-1-BG-EPPKA2-KA, MECA - MicroElectronics Cloud Alliance.

References

[1] L. Cruz, How Cloud Computing is Revolutionizing Ed- ucation, Cisco's Technology News Site, August 2012

[2] https://tamtams.vlsilab.polito.it/intro.php

[3] M. Vacca, G. Turvani, F. Riente, M. Graziano, D. Demarchi, G. Piccinini, TAMTAMS: An open tool to understand nanoelectronics, 12th International Conference on Nanoelectronics (IEEE-NANO), Birmingham, UK, 20-23 August 2012, pp. 1-5

[4] M. Vacca, M. Graziano, D. Demarchi, G. Piccinini, TAMTAMS: a flexible and open tool for UDSM process-to-system design space exploration, 13th International Conference on Ultimate Integration on Silicon (ULIS), Grenoble, France, 6-7 March 2012, pp. 180-183

[5] https://aws.amazon.com

[6] https://azure.microsoft.com

[7] https://cloud.google.com

[8] https://cloudstack.apache.org

[9] https://www.youtube.com/watch?v=ViO4O1jSEYk