MicroElectronics Cloud Alliance (MECA)

Concept for the technical cloud environment

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1 About this document

1.1 Basic information

This document describes the concept for the technical cloud environment which is the foundation of the educational cloud in the Microelectronics Cloud Alliance (MECA).

1.2 Version history

This document has undergone the following revisions since its original creation:

Version	Date	Editor	Changes
0.1	16.02.2016	Martin Klossek	Initial version
0.2	14.03.2016	Nico Busch	Added questions to the stakeholders
0.3	01.04.2016	Martin Klossek	Draft version
0.4	06.04.2016	Massimo Ruo Roch, Danilo Demarchi	Document review and integration
0.5	14.05.2016	Martin Klossek	Fixed some minor bugs

1.3 Persons & responsibilities

The following list of persons is involved in this sub-topic of the MECA project:

Person	Institution	Responsibility
Slavka Tzanova	TU Sofia	Project leader
Danilo Demarchi	POLITO	Technical and educational consulting
Massimo Ruo Roch	POLITO	Technical and educational consulting
Nico Busch	eWorks	Software development and consulting
Martin Klossek	eWorks	Technical consulting and management

1.4 Workshops & sessions

The following workshops and sessions have been held within the context of the technical cloud environment:

Date	Location	Reason	Participants
11.02.2016	Sofia	Project kick-off workshop	All delegates from the project consortium

Date	Location	Reason	Participants
- 12.02.2016			

1.5 Glossary

The following technical terms are significant in the context of this document:

Term/Abbreviation	Description
MECA	The abbreviation of the project “MicroElectronics Cloud Alliance“
Apache web server	Extremely popular, proven software to run web applications. "Apache" is open source and may be used free of charge for the own solutions. Please see for further reference: https://en.wikipedia.org/wiki/Apache_HTTP_Server
Java	Compiled language for execution on a so called virtual machine. It allows extremely powerful applications but can be quite costly. Please see for further reference: https://en.wikipedia.org/wiki/Java_(programming_language)
MySQL	Relational database server, mainly used in combination with PHP. MySQL is probably one of the most common database servers in the world. "MySQL" is open source and can be used free of charge in the own solutions. Please see for further reference: https://en.wikipedia.org/wiki/MySQL
NTP	Standard to synchronize clocks between distributed computers and servers typically with a central time source. See https://en.wikipedia.org/wiki/Network_Time_Protocol
Tomcat	A web server extension for running Java applications on web servers. "Tomcat" is open source and may be used free of charge for the own solutions. Please see for further reference: https://en.wikipedia.org/wiki/Apache_Tomcat

2 Objectives of the MicroElectronics Cloud Alliance (MECA)

The “Microelectronics Cloud Alliance” (MECA) is a consortium of 17 partners from higher education institutions (HEIs) and small and medium enterprises. Together they want to build a European infrastructure for education in micro and nano-electronics built on cloud technology.

No one of the partners alone is able to maintain the necessary expensive infrastructure and to permanently update the curricula. Even larger enterprises in this sector have difficulties to compete. So sharing of laboratory experiences, CAD software, project ideas and learning materials seems to be a solution that will technically be realized by a cloud approach.

The main objectives of MECA for an “educational cloud” are:

- Provide a range of open educational resource in micro and nano-electronics
- Remote access to e-learning environments for students, teachers and company employees
- Access to practice-based learning facilities
- Access to educational and professional software
- Sharing of technical resources like servers with computing power and storage
- Speed up the provisioning of technical learning resources
- Sharing of system administration knowledge and experience: Reduction of required manpower with system administration skills due to both the general shortage and the increasing number of duties for system administrators in any kind of institution - both in universities and companies!

For further details see the project and partner description in “2015-project-description 15_02-15.docx”.

3 Concept of the technical implementation

3.1 From hardware over virtualization to cloud computing

The traditional hardware based IT architecture is very often inefficient:

- not used for long periods during the day/weekend/vacation
- waste of energy
- low utilization (around 10% or less[1])
- space for servers required
- high efforts for system administration of hardware servers

The next step was virtualization of computing resources – both servers and desktop infrastructure. So it was easier to share low level resources like power adapters, processors and network cards for some virtual servers, which increased efficiency and reduced the waste of energy. But still many of hours per day, week and month the systems are not in use.

The cloud concept tries to overcome this approach by raising the number of heterogeneous users and applications using the same hardware so that the hardware is used more intensively over time. The idea is that users need the resources at different times, different locations and in different sizes (some kind of time slicing). So sharing of computing and storage resources reduces the waste of unused processing time and data storage space.

3.2 Public and private cloud

There is the public cloud with big players like Amazon Web Services (AWS) and Microsoft Azure on the one site. And on the other site there are private clouds inside of institutions. 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.

This 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. There is an ascending path from:

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

[1] add some reference!

4 CloudStack for a private cloud

For a private cloud these days there are two popular standards available: Apache "CloudStack"[2] and "OpenStack"[3].

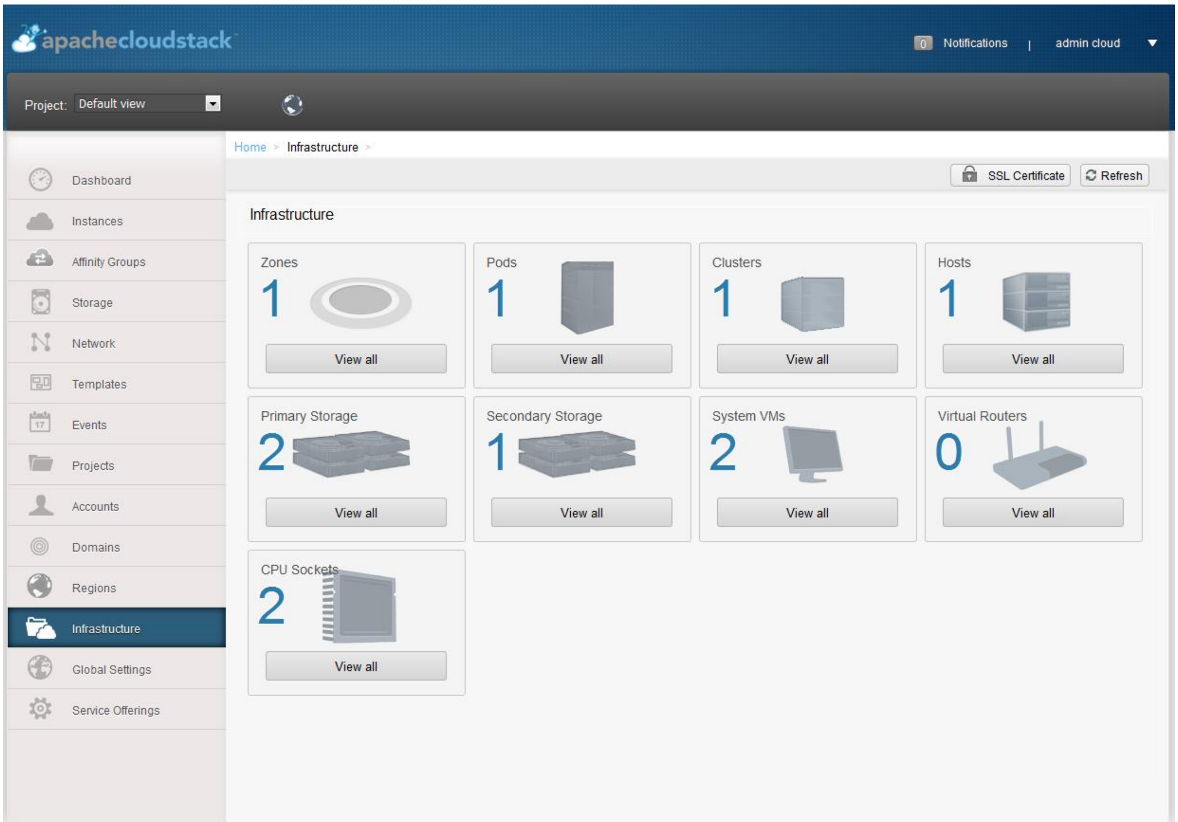
We will concentrate on CloudStack because there are good experiences at POLITO since four years with new microelectronics and microsystems courses, which require the use of complex CAD software. For further details see Danilo Demarchi's presentation: "2016-02-13 MECA_kick-off_meeting-POLITO-short.pdf"

Some facts about CloudStack:

- is an open source cloud management software.
- supports all important hypervisors like KVM, VMware, Hyper-V and XenServer.
- is mainly a Java web application (Tomcat) with an API and a web GUI that allows to overview, organize and manage virtual machines and to create virtual machine templates
- controls the virtual machines with agents or APIs of the vendor specific hypervisors
- is end-point agnostic: desktop, notebook, tablet
- a good network infrastructure is mandatory
- configuration data is stored in a MySQL database , so very transparent

A further step in automatization is Cloudify which could be used in this project as well. Cloudify is "The master of the orchestra"[4]. This has to be evaluated later.

Below is a screenshot for an example screen of the CloudStack web GUI:



1 Infrastructure overview screen in CloudStack web GUI

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[2] see https://cloudstack.apache.org/

[3] see https://en.wikipedia.org/wiki/OpenStack and http://www.openstack.org/

[4] see http://getcloudify.org/

4.1 Use cases

4.1.1 User self-service:

Setup resources like virtual computers and applications like CAD software on their own by an easy-to-use and comfortable web application (instead of command line tools or something comparable).

4.1.2 Sharing of processing power, data and virtualized software

It will be possible to share computers and processing power, sharing of data and storage and virtualized software.

But not: Sharing of commercial software licenses due to legal restrictions. A WEB-based CAD tool TAMTAMS was developed at POLITO. For additional details see Danilo Demarchis presentation: "2016-02-13 MECA_kick-off_meeting-POLITO-short.pdf". Evaluation of possible strategies for licensing control will be performed in this project, discussing among partners different possible solutions.

4.1.3 Bring in own student computers

Students with their own computers using remote desktops (some kind of thin client[5]):

- No university PC for each student required
- Students know their own machines
- Can work around the campus or at home (depends on security restrictions, might be solved by a virtual private network VPN with encryption)
- Freezing sessions and continue somewhere else

4.1.4 Remote access to laboratories

- Common experiences of students of different countries based on similar infrastructures, tools, lab organization, learning improvement, thanks to the optimization of laboratories and courses.
- sharing of laboratory experiences

4.1.5 Delivery of an e-learning environment:

Moodle as an open source software might be an adequate solution (especially in the newest version with responsive design theme which works on desktop, tables and mobile phone)

- installed on several servers across Europe to be closer to the learners (could reduce the problem of network latency)
- maybe distributed installations to have content synchronized between the universities and to be more stable in case of unavailability of single machines

[5] see https://en.wikipedia.org/wiki/Thin_client

- data loss prevention because of replicating the course materials (in opposition to an installation with a single point of failure)
- Specification of auto-provisioning logic to scale the web eLearning environment depending on the load, especially for usage peaks and for the mobility of eLearning resources (Cloudify based[6]).

4.1.6 Some sort of cooperative work software

It would be useful to share project ideas, courses, files and teaching experiences between teachers and teachers or students and students. This should be supported by the educational cloud.

4.2 Infrastructure overview

Each university will install its own technical equipment, but the idea is to share between each other. Of course we do not have to convert the whole existing university equipment to be under control of CloudStack! But instead we should develop the solution in iterative way:

Start with three servers on three partner's sites and see, how it will be accepted and what we can learn from it. CloudStack controllers will be distributed on the different premises to avoid SPoF (Single Point of Failure). CloudStack allows redundant controllers and the best choice is to have at least one per site.

To be done:

- A map of the participating HEIs (logos) with their servers
- Outline on how to setup CloudStack on each partner's site
- Moodle web application installation
- CAD software installation
- Monitoring

4.3 Outcomes

- Proof of concept for the feasibility with at least 3 participating universities
- Sharing of setup guidelines
- Virtual machine templates (VMs) for end-user self-service (e. g. for teachers or in companies)
  - Pre-installed Moodle environment
  - CAD software pre-installed (find a solution for license keys)
  - other learning relevant software pre-installed
  - Student learning desktop
- FAQ with the most frequently asked questions for the system administrators
- Training material for system administrators

[6] see http://getcloudify.org/

4.4 Technical requirements

To be defined, see open issues at the end. This depends heavily on the answers to the questionnaire in the next section.

4.5 Timeline

To be defined, see open issues at the end.

5 Need analysis

5.1 Stakeholders

In the project consortium several stakeholders like teachers, students, employees and system administrators are involved with different ambitions and expectations towards the cloud experience. Several questions have to be asked to each of them and they will have a number of questions vice versa.

Probably the most crucial question for each stakeholder is:

> What will be the benefits for me using the educational cloud?

A sufficient answer to this question will decide if the private cloud implementation will be successful or not at all. Only if the benefits are higher than the personal efforts and costs every partner has – and actually can contribute – the motivation will be high enough.

5.2 Teachers

We have to discuss how the cloud approach can help teachers in classroom trainings and in e-learning.

1. Which programs / software are used in classroom trainings and in e-learning? e. g. simulation, software development, video playback, text editors, test processors like Microsoft Word
    1.1. What is the license type? e. g. classroom, for a number of students, students can install it on their own computers additionally, open source
    1.2. How long and how often is this software used per week? Is there a schedule?
2. Which CAD software is used in classroom trainings and in e-learning?
    2.1. What is the license type? e. g. classroom, for a number of students, named-users, students can install it on their own computers additionally, open source
    2.2. Do students have 24/7 access to the software and / or computers or is it restricted
3. Do they access the software from campus network only or from outside/home as well?
4. Virtual laboratories: What is already available? What is possible?
5. Question: How many users? Cloud is very good for auto-scaling

5.3 Students

It would be helpful to ask a test group of students (approx. 20 students) from each university regarding their current personal computer infrastructure and computing habits. So we could discover regional differences across Europe and the current situation in 2016. It might be that our expectations differ from those of the young generation of students.

It is important to have a discussion about the importance of having as much as possible Open-Source solutions. In this case the problem of the license is not present and we exploit at maximum the benefits of a cloud system for the end users.

Such questions are:

1. Which kind of private computer do you have? e. g. Notebook, Desktop PC, Tablet, etc.
2. Do you prefer using your own computer or university equipment?

3. Which operation system do you prefer? e. g. Windows, Linux, Mac OS X, Android, iOS
4. What are your preferred text editor and text processing application? Open source is recommended, e. g. OpenOffice.
5. Where is the primary place you access the e-learning environment? e. g. at home, at the university campus, in the classroom, in the train
6. Which kind of mobile internet do you use for e-learning? 3G, 4G/LTE, Wi-Fi/WLAN
7. How useful would it be to access CAD software on a tablet for you?
8. Would it improve your learning experience if you could share your own CAD, texts, presentations and spreadsheets during exercises with other students?
9. Would it be interesting to share those files with students from other countries?
10. How long do you expect to spend on a typical e-learning session?

5.4 Employees in companies

1. Another group of stakeholders are the employees and professionals in companies working in the MECA sector. In contrast to teachers and students the requirements and use cases are not so obvious and have to be developed.
2. How can employees use the e-learning courses?
3. How should they be integrated in the educational cloud?
4. Is there a need for both e-learning in the form of courses and in the form of training of software (CAD, simulation, other) as well?
5. How is the license situation for those software programs?
6. What kind of end user computer equipment is available? PCs, Workstations, Windows, Mac OS X, Linux?
7. How could the sharing of server resources be organized? schedule, on-demand, locks during periods of university classroom trainings
8. Would an exchange between company users from different companies be interesting? e. g. forum, chat or sharing of created CAD files/exercises?

5.5 System administrators

Probably not the biggest stakeholder group in numbers of people, but in impact, are the system administrators in the participating higher education institutions. Without their support the project of the educational cloud will not succeed

1. How is the current situation for classroom training and for e-learning for the students: e. g. PC classroom installations, workstations, thin-clients, remote access, PCs in laboratories, etc.?
2. Which Hardware and operating Systems are in use?
3. Network parameters: How can these machines be accessed? Which are the firewall policies of the HEI? Is it possible to change them for setting up the MECA system?
4. Are there central directory services (LDAP, Active Directory, eDirectory, other) at your site for managing users?

4.1. If yes, is it mandatory to use them for any kind of project and software or are there local users for specific applications as well?

5. Which numbers of computers could you bring in to the private educational cloud?
   5.1. At the beginning for a proof-of-concept only: We could start only with some computers and span this private cloud over different locations in Europe
   5.2. Later: If the demand increases with more machines
6. Would it be an option to rent some public cloud resources for testing purposes and to integrate them in the private educational cloud? Is there funding for a temporary allocation at Amazon Web Services or Microsoft Azure (e. g. 200 € per month for some resources that can be cancelled every day). Probably this is not a feasible solution but we wanted to ask.
7. What kind of software requirements like operating system and version and hardware requirements like CPU, RAM and hard disk does the CAD software have?
8. How useful would it be to have virtual machine templates that we create during the MECA project and that are ready-to use? e. g. with the operation system and CAD software pre-installed? Or with an operating system, web server, MySQL, PHP and Moodle as e-learning software?
9. How is your experience in Linux and / or in Windows?
10. Do you have experiences with Java and application servers (like Tomcat)?
11. Do you have experiences with cloud computing? Which platform?
12. Have you already used Apache Cloud Stack?
13. What time can you spent on this project per month for the next 2 years?
14. What would motivate you most in the scenario moving from hardware over virtualization to a private cloud?

6 Open Issues

The following list is the collection of the issues currently open. This list is not complete. Some additional questions will be added in the next version of this document.

6.1 Technical issues

1. What about network latency?
2. How to transfer large virtual machine templates between countries (e. g. 10 GB each)?
3. How to detect and stop abandoned remote sessions?
4. CloudStack vs. Open Stack should be investigated
5. Evaluate possibilities of Cloudify for automation
6. Define the technical requirements
7. Can there be several CloudStack controllers or must there be a single instance?
8. Map of HEIs (servers, CloudStack controller, users, Moodle, etc.)

6.2 Organizational issues

1. Maybe some kind of user interfaces for scheduling, managing and applying for sessions?
2. How to meet the expectations of the users regarding speed, usability, cost, sharing mentality only to use?
3. Timeline for the education cloud setup
4. More references to external sources in this document
5. To organize inside each HEI specific workshops/courses for internal system admins, technicians and teachers.

7 Disclaimer

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This publication reflects the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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