

EUT<sup>+</sup>

## EUROPEAN UNIVERSITY OF TECHNOLOGY

Deliverable 38

D3.5.2 Pedagogical datacenter interconnection

Del. Rel. No 3.5.2

WP 3

Description: User training, report on interconnection status

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Dissemination level: **PU**-Public

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## FOREWORD TO DELIVERABLE 3.5.2

The Educational Datacenter – EDC ( le Data Center Pédagogique - FR ) of UTT is a physical computers and networking infrastructure dedicated to full scale teaching experimentation in the wide field of Information Technology IT.

The datacenter was launched by UTT in 2010 to support with the Master’s program « Networking and telecommunications – Réseau Télécommunications». At that time, IT services production was chosen as the focus with two others being « Communications Security » and « Internet of Things ».

The Educational Datacenter offers an environment close to a real company datacenter.

This deliverable, D38 – 3.5.2 describes the EDC, who it is useful for and how it is used today at the University of Technology of Troyes (UTT). Equally, it explores ideas concerning how the EDC could be exploited to by the EUT+ partners to contribute to the pedagogical aims of the initiative.

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## Part 1 Introduction

The UTT Educational Datacenter (EDC) is a full-scale tool permitting virtual studies and practice in various aspects of IT services production, automation of production, and networking. For professors, this is a powerful tool to strengthen students' skills in example of « how to do ». Partnership with VMware and Cisco make it possible to gain access to the most recent networking technology like Cisco Software Defined Networking proposal for datacenters. The EDC is exploited daily at the university to produce the infrastructure the students need to study and to train on. It offers support for project-based teaching because of free remote access, and flexibility of the software production.

EUT+ partners are offered the opportunity by UTT to use the EDC platform for development of shared modules or student projects. It's exploitation for pedagogical purposes can be applied to different themes of study. New EUT+ project-based modules could be developed through the harmonisation of EUT+ partners already existing modules, with the idea of « putting together what we have best ». The focus would on domains where innovation and opportunities are strongest in line with social priorities and industry needs. Internet of Things - IoT may be seen as an example, but other fields may appear IT security, green in IT production, energy management, complex system instrumentation, smart cities, environmental protection, etc...

## Part 2 Benefits of the EDC

### Who is the EDC useful for?

**Students** – Provides each with the dedicated computer infrastructure they need for their activities: courses illustration, practical training session, projects, evaluation, etc...

The advantages for students:

- + Being able to work whenever they want at their convenience
- + To find their work in the same condition and state they left it
- + Access a resource adapted to their learning needs

**Professors and colleagues**, Provides access to experimentation ecosystems: testbed and site for pre-production.

The EDC offers:

- motivating tool to design practical activities.
- lack of constraints common to production issues such as scaling(number of students), access management, availability, and resource dimensioning.
- a platform to work together with other colleagues designing composite educational activities.

**Professionals** – Can be given access to demonstrate advanced products.

### How is the EDC is used at UTT?

- + Examples of how the EDC is used at UTT as part of the pedagogy and formation offered to students:
- + Datacenter architecture : one module, partially project based, is designed to let the students explore these architectures. The EDC is designed to allow the production of virtual servers and networking machines, permitting each student to build his own datacenter (nested datacenter).
- + Company Networking : this module aims to train students to the design of companies networking infrastructures. This is classical networking teaching module, focused on IP ecosystem, routing optimisation, campus extension, and multicast services delivery.
- + Operator networking : supports one project-based teaching module centered on operator IP extensions technologies. Students are given access to a dedicated platform, containing suitable Cisco operating systems and a physical equipment emulator, so with free remote web access, and they each find there everything they need to startup a full-scale operator network. In this way they study, develop and trial interconnection technologies, and services delivery.

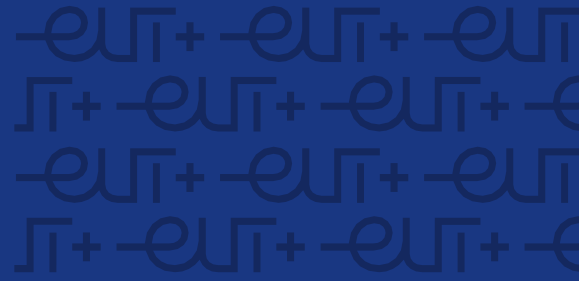


Fig. 1 below presents the access between the students and professors and the EDC.

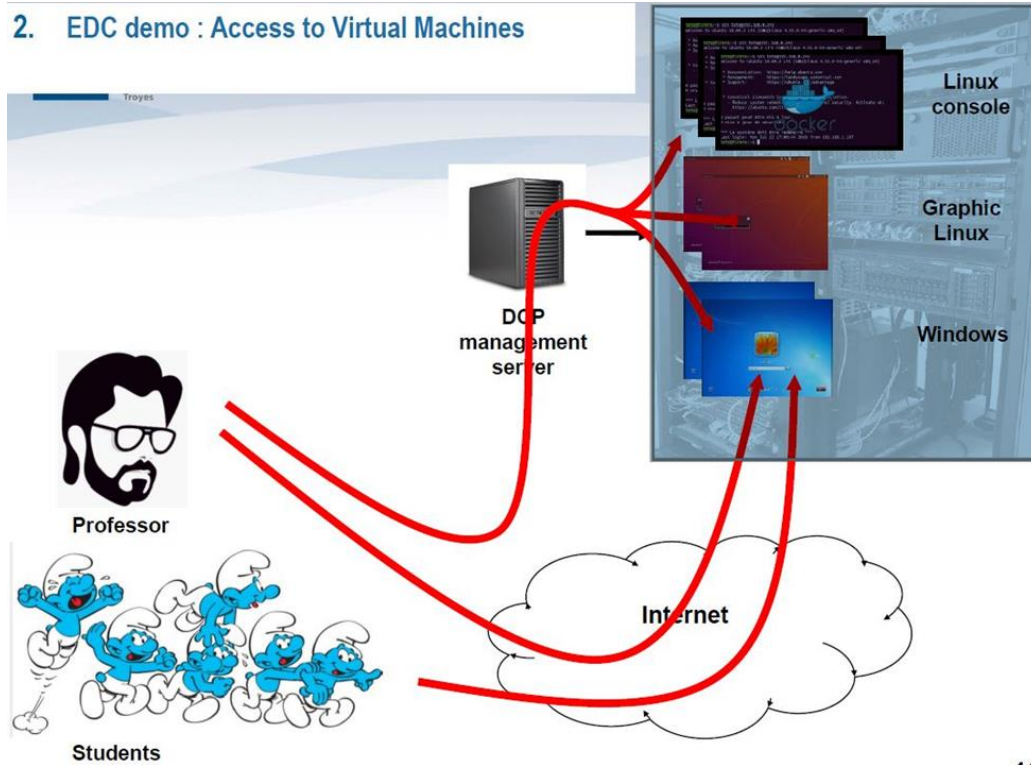


Fig. 1

## Part 3 Collaboration

### EUT+ collaboration opportunities using the EDC

The following possible opportunities for collaboration were proposed too EUT+ partners and discussed as subsequent meeting:

- enrolment of EUT+ students in UTT courses using the EDC (at distance or on an EUT+ mobility at UTT)
- creation of multi-partner groups of students working on telecom project using the EDC as a resource
- collaboration and sharing of knowledge between professors using the EDC to demonstrate and as a platform for practical activities
- creation of new EUT+ joint modules combining partners knowledge, with strong capacity to maintain coherence and using the EDC platform as a key/ shared resource

### EUT+ partner meetings

The UTT Educational datacenter was presented by to WP3.5 task members in March 2022. Interest in a future collaboration was shown by UPCT, UTCN, CUT and TUS. Physical meetings were organised during Troyes Week, September 2022 and follow up online discussions were held on 19<sup>th</sup> October 2022 between:

- UTT representatives
- UPCT representatives
- UTCN representatives
- TUS representatives



Discussions took place about the themes we could choose in order to design a common working platform. Interest was expressed by the partners in the following subjects:

#### UPCT

- Industrial IOT Service

Practical experience for students and student mobility /internships. Alain, UTT also proposed the objective of training students for jobs/ experiences that they may meet in real life.

Interested in computing power for numerical simulations.

Cartagena have a self-drive car project and would be interested in working in the field of AI in a potential EDC project.

#### UTCN

Particularly interested in any projects related to training and the EDC as a teaching platform. Alain confirmed that the EDC provides practical experience to students and access to build a real data center. A virtual data center can be created for each student to work on. The EDC is also a teaching platform that permits the tutors to validate the students learning progress.

Subjects of interest for UTCN include:

- Group working au signal processing.
- Platforms for networking and Inter-cloud connections.
- AI - would include other colleagues from UTCN.
- Traffic predictions.

#### TU Sofia

TUS do not have the same type of EDC in Sofia and would be happy to use the UTT EDC. Potential subjects:

- Computer networks
- Network security
- IOT – web technologies. Smart home security used case from TUS could be a good starting point.

## Discussion and next steps

During discussions between EUT+ partners, it was agreed that the objective of a collaborative project would be to design an educational tool for training that would include skills validation that is to say, "Learning Outcomes Validation", as a fundamental aspect of the project.

The platform should be designed to be useful for students training in complex, real life-like situations, in order for them to be able to combine Knowledge and Know-how. These students would usually be enrolled in "Computer science", "Telecoms" and "Data science" programs.

The partners would aim to design and deploy a technical ecosystem, whose characteristics should be:

- real life scale
- wide enough to include a combination of different aspects of computer science and to contribute to relevant to professional employment fields.

Internet of Things IoT was a subject of interest to all participating partners and a good starting point. Following the last meeting, the partners agreed to discuss with colleagues at their faculties of telecommunications and explore the potential organisation of a shared project taking advantage of the EDC of UTT as a shared pedagogical purpose.

## Conclusion

Following the last meeting, the partners agreed to discuss with colleagues at their faculties of telecommunications and explore the potential organisation of a shared project taking advantage of the EDC of UTT as a shared pedagogical purpose. UTT would act as organising partner and technical manager.

There are clear advantages for EUT+ in using an existing platform and benefiting from the experience of UTT staff. Sharing of tools and expertise between partners is also a positive outcome of the EUT+ alliance. Colleagues from TU Sofia explained that they do not have this kind of platform available at their university, hence their interest in using the EDC.

A project is proposed by UTT about the Internet of Things (IoT). IoT services and platform instances are well within the scope of the EDC application and are considered a good starting training point. Its components are classical software instances that EUT+ partners know how to deploy: database, dataset, web interfaces for administration and use, data analysis modules, data presentation modules, application program interface, security modules, etc.

It is envisaged that a group of students from different EUT+ partners could work as a 'project organisation team' supervised by nominated teaching staff, each contributing to a single project.

At this time, the choice of theme and definition of the parameters of the shared project remains to be concluded by the partners.

## Appendix

Presentation 'Educational datacentre in UTT / DataCenter Pédagogique à l'UTT.

EUT+ task 3.5

March the 30th

Educational DataCenter in UTT : EDC

*A platform for EUT+ partners to collaborate for PBL in the telecom field*

Le DataCentre Pédagogique de l'UTT : DCP

Alain Ploix : [ploix@utt.fr](mailto:ploix@utt.fr)

## Datcenters : IT operations everywhere

- set of equipments and softwares for data storage and application delivery
- almost every service (web, mails, content delivery, etc..) we use through the networks is hosted in a datacenter
- support for PaaS, IaaS, SaaS, « Cloud Computing », IoT applications
- operator, companies, organisations (either public or not) use datacenters
- some are geographically located, others are distributed
- big employer area and interesting employment opportunities for our students



## Keywords

- operating systems
- virtualization
- networking
- services production
- automation of services production

## Part 1 : EDC

Part 2 : examples of activities

Part 3 : collaboration

## Part 1 : EDC

- What is it useful for ?
- What is it ?
- What does it look like ?
- How is it maintained and how is it exploited daily ?
- Functional representation

## A datacenter, what is it useful for ? (1/3)

- production of software occurrences (instances) of computers and services, virtual machines and containers:
  - servers (services delivery through the network: web, and all well known services...)
  - workstations (not so easy to deliver : screen and keyboard over IP...)
  - with all flexibility due to the software character of this production:
    - resource consumption and sharing,
    - back-up management,
    - duplication,
    - easy to go back to previous state, etc...
  - remote access : anywhere in UTT, from EUT+ partners campus, from the Internet



## A datacenter, who is it useful for ? (2/3)

- Are concerned:
  - students, group of students, to provide each with the dedicated computer infrastructure they need for their activities:
    - courses illustration,
    - practical training session,
    - projects,
    - evaluation, etc...
  - colleagues, with comfortable access to experimentation ecosystems:
    - testbed
    - pre-production
  - professional actors (you invite in a course session for example):
    - comfortable accomodation for live demonstrations, etc...

## A datacenter, who is it useful for ? (3/3)

- students point of view:
  - each user gains exclusive resource allocation and access
  - they can work whenever they want
  - they will find their work in the same condition and state they left it...
  - resource is always adequate fitting the work needs
  - backup is available enabling return to previous state
- professor and professional point of view:
  - motivating tool to design practical activities: from demonstration to PBL
  - released of production issues like : scaling (number of students), access management, availability, and resource dimensioning
  - a place to work together with other colleagues designing composite educational activities
- administrator point of view:
  - user access right management
  - resource allocation policy (dynamic)
  - production scaling tools : back-up, duplication, affiliated clones

## A datacenter, what is it ? (1/2)

- this is a **physical infrastructure**:
  - compute servers: RAM,  $\mu$ P, high speed access storage, network cards, graphics card, GPU...
  - storage servers: disks arrays, tools for material management of disks, high I/O capacity (network cards), and protocols to let outside systems access the storage
  - network devices: switching capacity, some routing capacity
  - power supply (protected), air conditioning, physical security...
- this is a **software infrastructure**:
  - hypervisor: the operating system for the compute servers (VMware ESX)
  - OS for storage servers (various : Dell, FreeNAS, TrueNAS)
  - OS of networking devices (cisco)
  - interface de gestion du datacentre (VMware Vcenter Server)
- this is **connected with the university network** to gain access to the university services (account base) and to the Internet

## A datacenter, what does it look like? (1/2)

- for once in the network and computer science: something to show ...



## A datacenter, what does it look like? (2/2)

- rooms next to DCP





## A datacenter, what does it look like? (2/2)

- rooms next to DCP



## A datacenter, what does it look like? (2/2)

- rooms next to DCP



## A datacenter for pedagogy : how to exploit, how to maintain ?

- there is work for more than professor prerogatives
  - design of courses and associated activities: professor prerogatives
  - daily exploit and maintain the datacenter: certainly not professor prerogatives...
- it is a laboratory, just like for example in mechanics or chemistry:
  - it is a work environment for professor to prepare labs and design activities
  - it is the place labs are delivered to the students
- need for an engineer:
  - maintains resource availability
  - gives access to users and allocates resources
  - helps professors to design meaningful activities
  - captures professor proof of concept
  - deploys instances for the students for the time it is necessary
  - deals with students requests concerning access, etc...
- UTT DCP administrator engineer: Philippe PEREIRA



Philippe PEREIRA



Who is supposed to do what?  
this depends on the use-case...



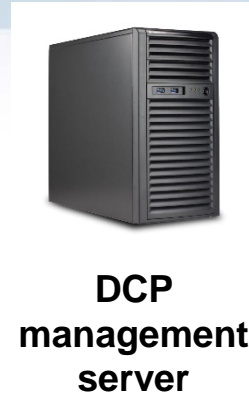
Administrator



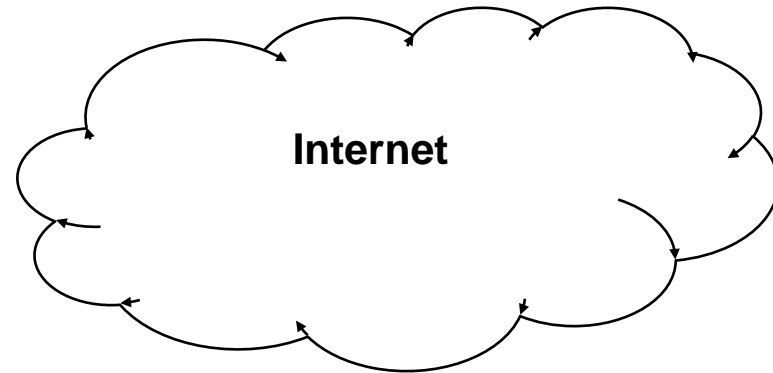
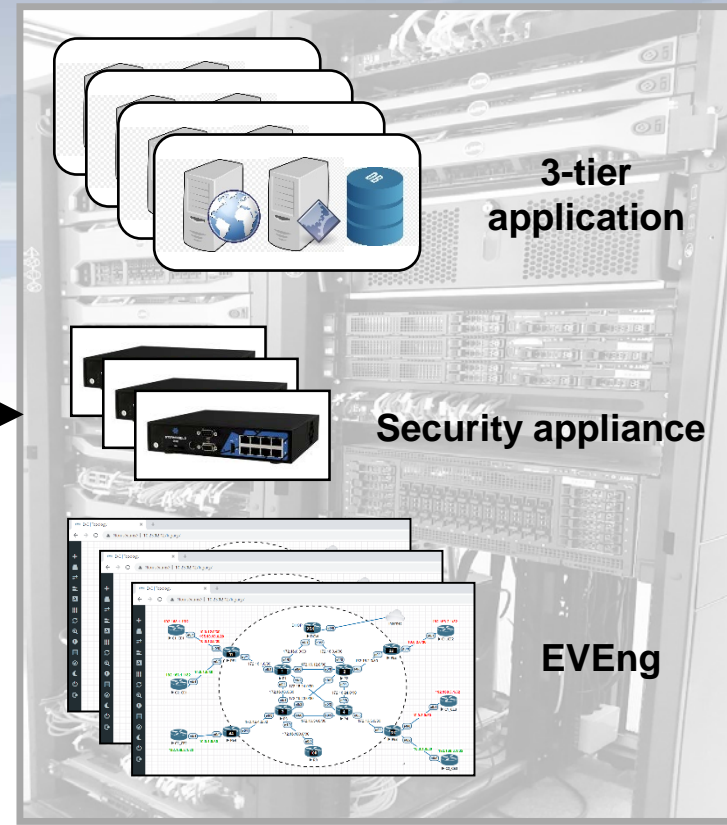
Professor



Students



DCP  
management  
server



Part 1 : EDC

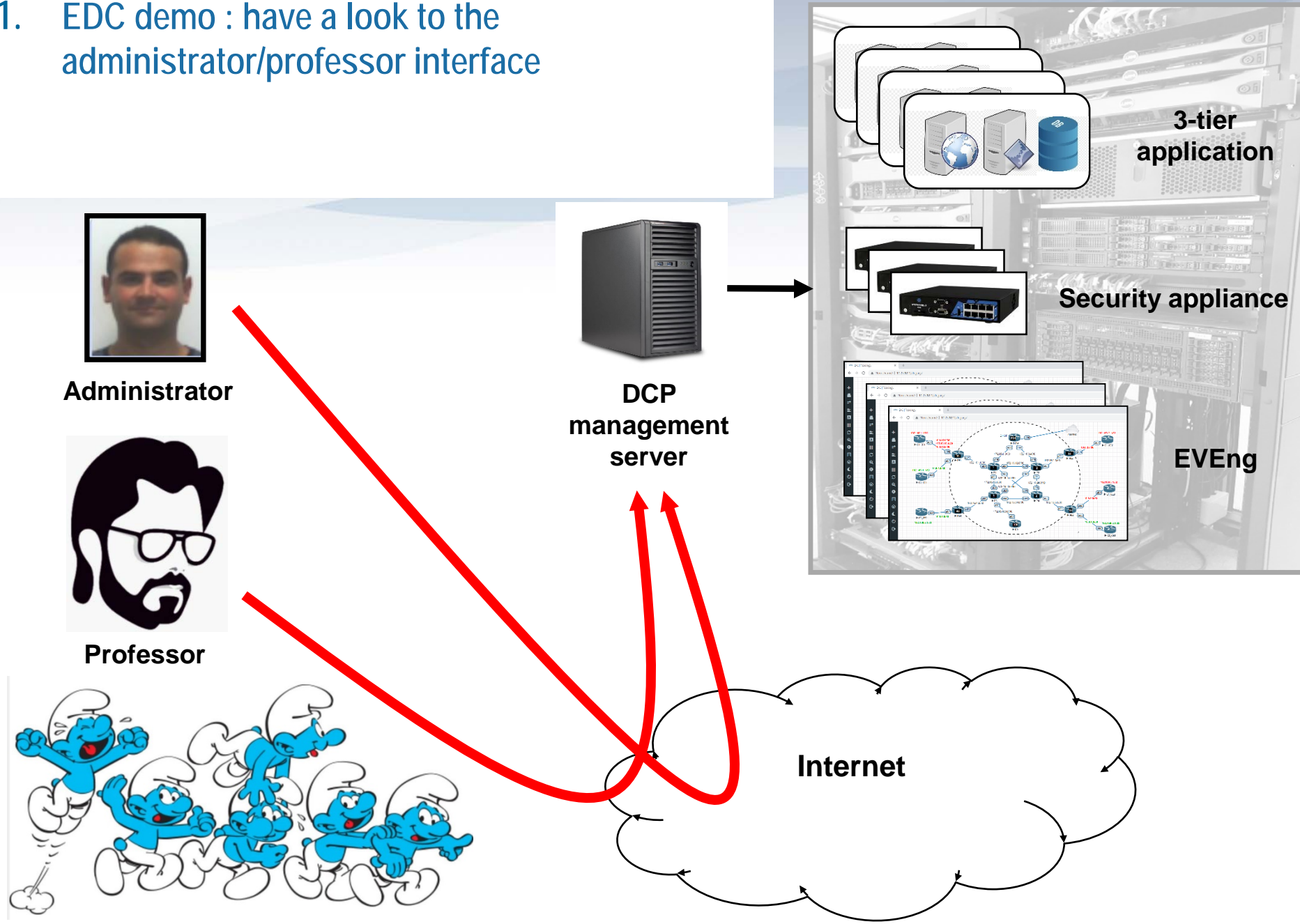
**Part 2 : demo and examples of activities**

Part 3 : collaboration

**Part 2 : demo and examples of activities**

1. Have a look to the administrator interface and professor interface
2. Access to Virtual Machines
3. Access to EEng and PNETlab
4. An ultimate example of practical activity : the building of a datacenter

# 1. EDC demo : have a look to the administrator/professor interface



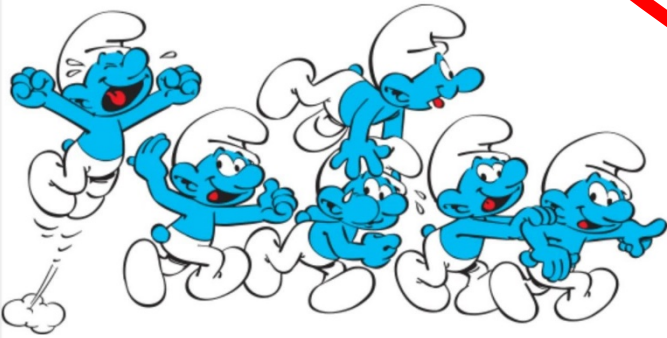
Students

## 2. EDC demo : Access to Virtual Machines

Troyes



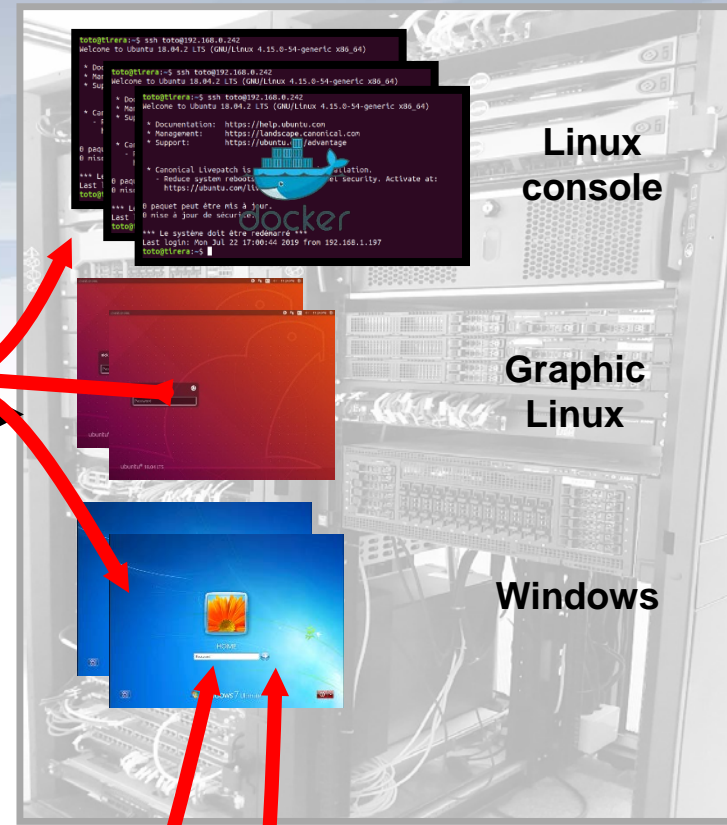
Professor



Students



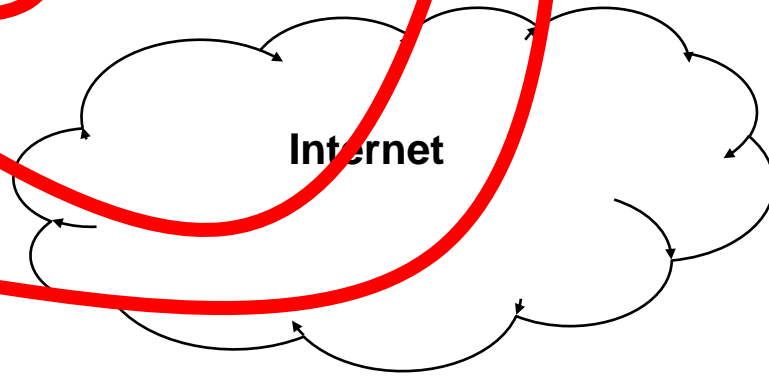
DCP  
management  
server



Linux  
console

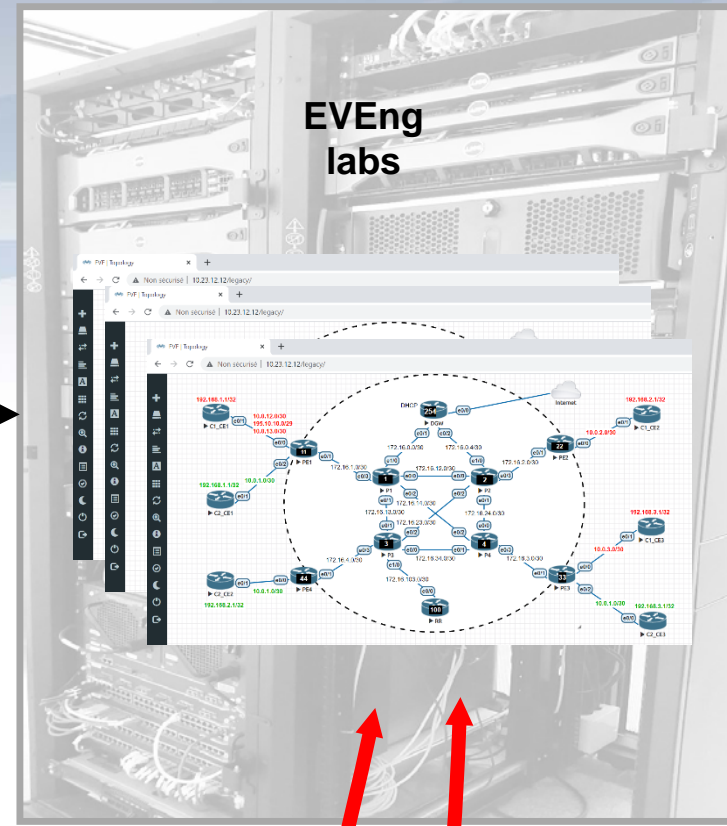
Graphic  
Linux

Windows



Internet

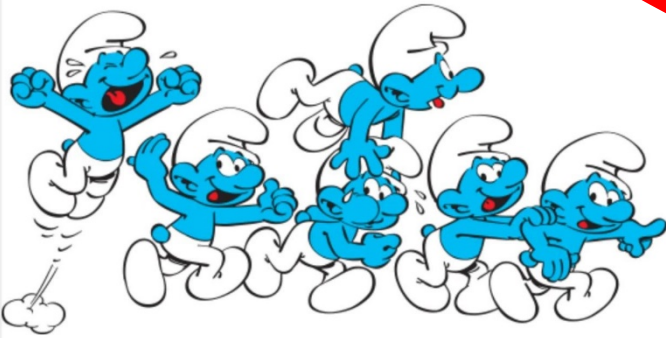
### 3. EDC demo: access to EVEng and PNETLab



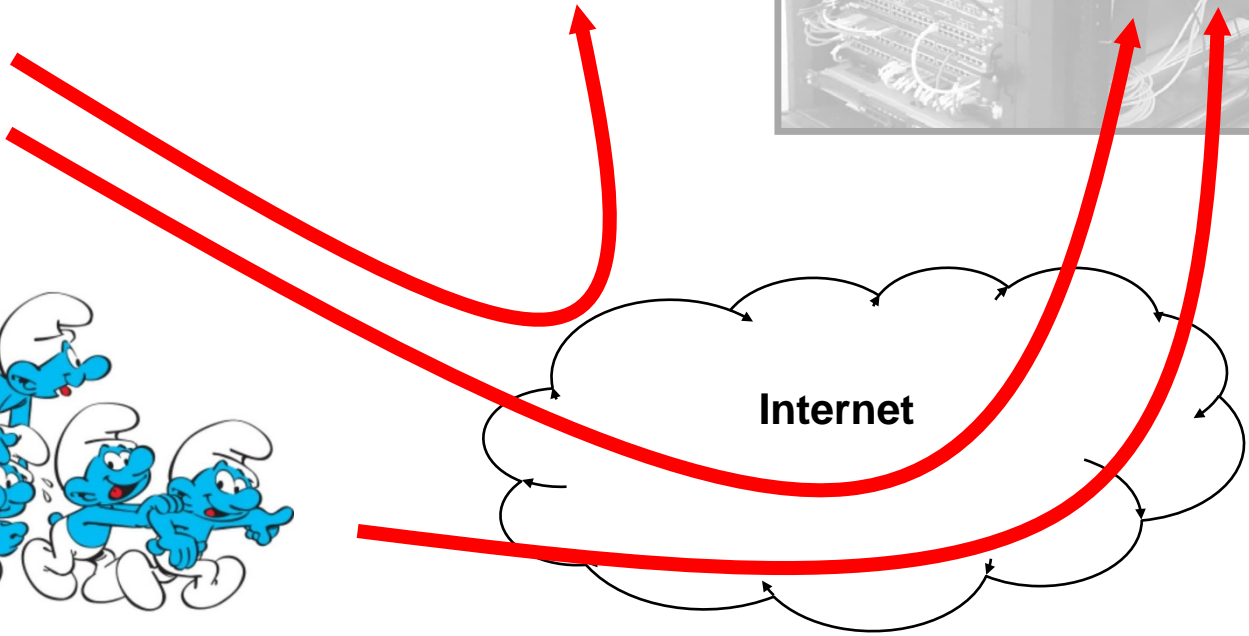
DCP  
management  
server



Professor



Students







Part 1 : EDC

Part 2 : demo and examples of activities

**Part 3 : collaboration**

## **Part 3 : collaboration**

1. Technologies
2. Work together
3. Possible steps
4. A « up to date » ecosystem to launch collaboration

### Hypervisors and entourage:

- VMware : hypervisor (ESX), management tool (vCenter)
- Microsoft : hyperV
- Free (linux KVM) : Openstack, Proxmox

### Development tools:

- Terraform, Ansible, Puppet, etc...

### Automation of VMs production, interfaces :

- Microsoft PowerShell, Python, Openflow, REST APIs, Netconf, Opflex etc...

### Containers deployment and orchestration:

- Docker, Kubernetes, etc...

### SDN/NFV :

- Free SDN controller Open Daylight, or not free (really not...) like cisco ACI

### Too wide for one professor :

- requires knowledge in networking, operating system, web, automation, programming, services marketing, security ...



## Will we work together in order to:

- propose lifelike labs for student capacity assessment ?
- put together what we are good at in the telecom field to design PBL we could not propose alone ?

## This is a question of will:

- we do in UTT, we are ready to share experience and to contribute to projects
- do you already have similar tools compared UTT EDC ?
- are you interested in designing PBL platform that could combine with UTT EDC ?
- ...

## This is a question of ressources:

- in time, in knowledge, in money
- ...

## This is a question of organization and administrative barriers :

- students and colleagues accounts, remote access, synchronization, credits delivery, ...

### From « possible now » to « potentially possible »:

- enrolment of EUT+ students in UTT courses concerned with EDC (distancial or face-to-face)
  - company networking course
  - operator networking course
- creation of multi partners teams of students working on telecom project that require ressources like EDC can provide
- composition of professor knowledge in existing courses (any partner), and demonstration and practical activities in EDC
- specialization creation in existing curricula
- creation of new curriculum combining partners knowledge, with strong capacity to maintain coherence working on a sufficiently generic platform why not based on tools like UTT EDC

## Internet of Things, IoT:

- rich enough, but also well defined perimeter
  - embeded systems
  - networking
  - database
  - data processing and presentation
  - web service
  - marketing, suitability to customer's needs
  - entrepreneurship
- fits well in a datacenter
- really « on the wave »