2EL6110 – Advanced computer networks

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Department: CAMPUS DE RENNES
Language of instruction: FRANCAIS
Campus: CAMPUS DE RENNES
Workload (HEE): 60
On-site hours (HPE): 35,00
Elective Category : Engineering Sciences
Advanced level : Yes

Description

This elective course is part of the InfoSec Track, but is accessible to any 2nd year student validating the prerequisites. It aims to present advanced concepts of Computer Networks architecture and is based on the fundamental concepts presented in the elective course "Network and Security " of 1st year.
The classic paradigms of Computer Networks related to the creation of Internet (layered models, TCP/IP protocols, client/server model, etc.) have become widely adopted. However, changes in user needs in terms of data availability and volumetrics as well as the emergence of new applications and new services (support of "heavy" applications as Wep Apps, Cloud Computing, cryptocurrency, etc.) lead to significant changes in traditional architectures of Information Systems. These architectural evolutions, as well as the rise of associated technologies, can also be explained by two current trends:
- The outsourcing of network and hosting infrastructures, and even of applications themselves;
- The optimisation of the use of these infrastructures.

This implies in particular:
- Dynamic, on-demand adaptation capabilities, including the ability to distribute storage and processing but also to quickly reconfigure infrastructures;
- Resource sharing capabilities (compute, storage and network), generally based on the virtualization of infrastructures;
- The use of decentralized, peer-to-peer models;
- Scalable resource allocation models, etc.

Quarter number

SG6

Prerequisites (in terms of CS courses)
1CC1000 – Information Systems and Software Development
1EL6000 – Computer Networks and Security

Syllabus
Lessons 1 to 5 (7,5h):
- Cloud computing
- Data center networks
- Software-Defined Networking (SDN)

Lessons 6 and 7 (3h):
- IPv6

Lab (3h):
- IPv6

Lessons 8 and 9 (3h):
- Distributed Architectures (Cluster)
- Distributed File Systems
- Cluster Management, 0rchestration
- Load Balancing

Lessons 10 and 11 (3h):
- Message queuing systems

Laboratory study (15,5h): implementation of a software network and a distributed service with OpenStack

Class components (lecture, labs, etc.)
A large place is left to practical aspects.
The lectures are punctuated with demonstrations and manipulations.
A long-term laboratory study, including a part of homework, makes it possible to gradually implement the technologies presented in classroom.

Grading
Final written exam: coefficient 0.5. Defence of the laboratory study: coefficient 0.5.
The lab study is always taken into account in the final mark (N1), even if it is lower than the mark of the written exam.

Course support, bibliography

- Teachers Slides
- Paul Goransson, Chuck Black, Timothy Culver, « Software Defined Networks A Comprehensive Approach", 2nd Edition, Morgan Kaufmann

- William B. Norton, The 2014 Internet Peering Playbook: Connecting to the Core of the Internet

Resources
Software tools used on the students' PCs (all free and multi-platform): VirtualBox, OpenVPN client, SSH graphical connection;
Software tools introduced or used (all under free license): OpenLDAP, OpenStack, Open vSwitch, HAProxy, ONOS/OpenDaylight, RabbitMQ...
Hardware platform: 5-server OpenStack cluster, accessible via VPN.

Learning outcomes covered on the course
At the end of this course, students will be able to:
- design an architecture based on an Infrastructure as a Service;
- deploy an IPv6 network using dedicated address attribution mechanisms;
- deploy and configure a message broker for distributed applications;
- explain the principles of elasticity and resource management in Cloud Computing;
- explain the principles and pro & cons of resource virtualization;
- explain the principles of peer-to-peer networks for data exchange or Blockchain management.

Description of the skills acquired at the end of the course
C1.1 - Analyze: study a system as a whole, the situation as a whole. Identify, formulate and analyze a system within a transdisciplinary approach with its scientific, economic, human dimensions, etc.
C2.1 - Deepen a field of engineering sciences or a scientific discipline
C7.1 - Know how to convince: Structure ideas and arguments, be synthetic (assumptions, objectives, expected results, approach, and created value)