COM-407

Advanced networks

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Cursus	Sem.	Type
Computer science minor	H	Opt.
Computer science	MA1, MA3	Obl.
Cyber security minor	H	Opt.
Cybersecurity	MA1, MA3	Obl.
Electrical and Electronical Engineering	MA1, MA3	Opt.
SC master EPFL	MA1, MA3	Obl.

Language of teaching	English
Credits	8
Session	Winter
Semester	Fall
Exam	Written
Workload	240h
Weeks	14
Hours	**6 weekly**
Courses	2 weekly
Exercises	2 weekly
Lab	2 weekly
Number of positions	

Summary

This advanced course in computer networks offers an in-depth exploration of how the Internet is designed and operates. Students dive into the architecture of the Internet and gain hands-on understanding of the key protocols that power it.

Content

In the lectures, students will learn and understand the main ideas underlying Internet architecture, as well as the various ways computer networks are built and operated today.
In the labs, they will gain hands-on experience using Mininet and Zebra (to exercise practical configurations and study IP, OSPF, TCP congestion control, and BGP behavior), along with other tools like Wireshark (to monitor and analyze network traffic). Additionally, students will apply socket programming for both unicast and multicast communications using Python.

In particular, the topics covered are:
Layer 2: CDMA in the context of Wi-Fi, Switched (full-duplex) Ethernet and STP, VLANs.
Layer 2.5: ARP, NDP.
Layer 3: Differences between: IPv4 and IPv6 configuration mechanisms (focusing on DHCP and SLAAC), Unicast and multicast (with emphasis on BIER), Routing principles (such as Longest-prefix match, Source and segment routing, SDN flow-based routing, Policy routing (with a focus on OSPF and BGP));
Tunneling: VPN, MPLS, VLANs over IP (similar to Cisco TRILL);
NAT: Traditional operation, full-cone and symmetric NATs.
Layer 4: The self-clocking nature of TCP, Theory of congestion control, Fairness, Congestion control algorithms (Reno, Cubic, DCTCP, BBR), QUIC (if time allows for it).
Application Layer: DNS, Application-layer gateways and proxies (e.g., HTTP, ARP).

Important Note: The above-mentioned topics are tentative and will be explored at different depths. In class participation is strongly recommended---there is a strong correlation between students who participate in class and those who get a good grade.

Keywords

TCP-IP
Computer Networks

Learning Prerequisites

Required courses

- An undergraduate course on Computer Networks

- A first programming course (preferably Python)

Learning Outcomes

By the end of the course, the student must be able to:

- Run and configure networks
- Understand the main ideas that underlie the Internet
- Write simple communicating programs
- Use communication primitives for internet and industrial applications

Transversal skills

- Access and evaluate appropriate sources of information.
- Continue to work through difficulties or initial failure to find optimal solutions.

Teaching methods

Lectures.
Online quizzes.
Labs on EPFL's VDI infrastructure.

Expected student activities

Participate in lectures
Participate in online quizzes
Make lab assignments (in the rule, every other week)

Assessment methods

Theory grade = final exam
Practice grade = average of labs
Final grade = weighted average of theory and practice grades.
A research exercise at each lab may add a bonus of at most 0.5 points in 1-6 scale to the practice grade.

Supervision

Office hours	Yes
Assistant.e.s	Yes
Forum	Yes

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

"Computer Networking: A Top-Down Approach (6th or later Edition)". James F. Kurose and Keith W. Ross. 2012. Pearson.

"Computer Networking : Principles, Protocols and Practice". O. Bonaventure, open source textbook, http://inl.info.ucl.ac.be/CNP3

Ressources en bibliothèque

- Find the references at the Library

Références suggérées par la bibliothèque

- Computer Networking / Bonaventure (3rd ed interactive)

Moodle Link

- https://go.epfl.ch/COM-407