TCP/IP Networking

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Understand what’s behind TCP/IP
Your Team

Lecturer: J.-Y. Le Boudec

Teaching Assistants

- Dr. Jagdish Achara (head TA and webmaster)
- Dr. Eleni Stai
- Maaz Maashod
- Roman Rudnik
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Whom is this course for?

Master students in electricity, communication systems and computer science

Who will have to work with computer communication

Requirements

- Experience with using one programming language
- No prior knowledge of TCP/IP is required
- We will practice with computers in a virtual environment – expect to spend time on your computer

Preparation for

- Advanced networking
- Smart grid
- Distributed systems
- Information Systems
The RAKE philosophy

Viewpoint 1: « I want this course to teach me all the details of all networking protocols »

Viewpoint 2: « TCP/IP is a mountain of details, I will learn when and if the need arises »

We will use the RAKE philosophy
- Depth in carefully selected labs
- Extrapolation (Research Exercise)
Learn by both Examples and Concepts

Computer networking is ≈ 50 years of design experience

- First paper on packet switching: 1961 (Kleinrock)
- First router built (connection oriented): 1969 (ARPAnet)
- TCP/IP is not a random collection of protocols, it is based on a few ideas

  in this course we will learn the concepts

“The devil’s in the detail”

- it is easy to misunderstand concepts if you do not have practical experience: ex: difference between a router and a bridge?

  in this course we will gain practical experience by carefully selected practical
What, Why, How

I will try and teach you to always ask first

- **Why** was this stuff invented, what problem is it solving?
- **What** is it doing?
  
  before asking:

- **How** does it do its job?

This is important if you plan to become a technical leader or a manager!
Organization of the course

Lecture
Every week
12:15-14:00
CM 2

Test (quiz) on
weeks 2, 4, 6, 8, 10, 12, 14
11:15-11:30 INF 1

Final exam
Winter exam session

Lab
Every week
Friday
11:15-14:00 INF 1
or
(extra session)
Tuesday
16:00-18:00 INF 019
Courseware

Textbook

On Moodle
▶ Enrolment automatic after course registration
▶ slides, lab and research exercise
Labs

A total of 7 labs (lab 0 to lab 6)
Labs are mandatory and graded
Main slot for labs is on Fridays from 11:15 to 13:00
Extra lab slot on Tuesdays 16h-18h in INF019 – Internet Engineering Workshop

▶ Bring your own PC

You work in groups of 2

One written report per group

▶ Fill in the answers directly in the assignment PDF file
(Use Adobe Reader XI, not all PDF readers support saving forms)

▶ Upload it on Moodle

Deadline for uploading the lab report:

▶ Given on Moodle, but typically is the week after the last session of the lab, at 23:55, Wednesday the day before the lecture on Thursday.
Network Emulation

We will mostly use Mininet to emulate the communication network in a single computer

We will give you a virtual machine with Mininet installed
- Single virtual machine for all labs.
- Python-based scripting

To play a bit with real (small) network, we let you manipulate a small network we setup for you in INF 019 in Lab 2 and Lab 5

Some labs require a public IPv6 address for your computer
- If you don’t have one at home, you can use the lca2-tcip-labs WiFi AP (in or around INF 019) that provides both IPv4 and IPv6 addresses via DHCP(6)
- Password is ....
Labs 0 and 1

Lab 0 – introductory (Half-lab)

- Network tools on your PC
- IPv4 / IPv6
- Recommendation: Finish it ASAP to leave more time for lab 1
- **Deadline:** Wed, September 27, 23h55 (in one week!)

Lab 1 – virtual environment – important for next labs!

- The main objective: getting used to VirtualBox & Mininet
- Other objectives: static network address configuration, iptables
- Do it as soon as possible, things can go wrong...

Students, with no or little background in computer networks, may need to work harder to get up to the speed with others

- Provision of extra slot on Tuesdays
- No need to do the **optional** research exercise question in Lab 0
You will need access to INF 019

Access to INF019 (IEW)

- Lab2 and lab5 will require access to do some network manipulation
- You can access any time of the day and of the week (exception: maintenance periods)

What you need to do:

- Go to Moodle and fill in the “Lab Utilization Questionnaire”
- **You should do it before next Thursday (September 28).**
- We will then give you access to INF 019.

In particular:

- Keep all lab material in good state and put them back after using
- Watch out for mysterious activities when you are in the lab (you are responsible for lab activities during the time you are in the lab)
- Respect the EPFL network rules
Organizational stuff

TAs are here to help – ask questions!

► Also, Google, stackoverflow, etc. are your friend

There is a different TA in charge of each lab

► ... and of grading it!

Give **brief but complete** answers in the report

► They should convince the grader that you really understand, without being too boring

No cheating

► There have been cases in the past – just don’t do it, it’s embarrassing!
► Labs are not very difficult, they just require some time
Enjoy!
Tests

7 Tests (short quizzes)

- INF1 on Fridays of even weeks 11:15-11:30 sharp
- Program of test is: everything up to and including the lecture of the week before the test
- Best 5 tests used for grading
- No replacement if sick or other excuse

All tests are written, closed book, no electronic equipment only one pen/pencil allowed on table
We use speakup for in-class MCQs
Please go to speakup.info or start speakup app
Join the room number written on the board

A. I already took a bachelor computer networking course
B. I never took any computer networking course
C. I don’t know if I ever took a computer networking course
D. I don’t know how to answer this question
Please use speakup **ethically**
– don’t abuse anonymity
I am in...

A. Computer Science
B. Communication Systems
C. Electrical Engineering, Smart Grid
D. Electrical Engineering, other orientation
E. Mechanical Engineering
F. Maths
G. Other Section
Final Exam

One final exam in exam session
▶ See last year’s exams on moodle
All tests/exams are written, closed book, no electronic equipment
The “exam booklet” is allowed
Research Exercise (Optional)

You are asked to study a for-bonus-question in 5 labs (labs 0,1,3,4,5)

Self-study – things that go beyond what we saw in class
Opportunity to exercise the differential encoding method – learn how to learn

Optional and for bonus
Added to lab grade
**Grading**

**Theory Grade** $T = \max(0.4 \, C + 0.6 \, F, F)$

where $C =$ test grade (average of best 5 tests)

$F =$ final exam

**Lab grade** $L_{avg} = \frac{0.5L_0 + L_1 + \cdots + L_6}{6.5}$ (lab0 counts as $\frac{1}{2}$ lab)

$RE_{avg} = \frac{RE_0 + RE_1 + RE_3 + RE_4 + RE_5}{10}$

where $RE_i \in [0,1]$ is the bonus at lab $i$ (max bonus = 0.5 on scale 1-6)

$L = \min(6, L_{avg} + RE_{avg})$

**Final grade** $G_1 =$ harmonic mean of $T$ and $L$ (where $T$ and $L$ are in scale 1-6, not rounded)

Final grade $G =$ round($G_1$) where round is to the nearest quarter-integer.

All grades except $G$ are non-rounded.
Roadmap

Module 1
Network Layer Basics
Labs 0 and 1

Module 2
Network Layer, (advanced) MAC layer
Lab 2

Module 3
Transport layer
Socket programming
Lab 3

Module 4
Single Domain Routing, SDN
Lab 4

Module 5
Traffic Control
Lab 5

Module 6
Internet Routing
Lab 6

Module 7
Interworking 6-4, Distance Vector