Practical activities in network courses
for MOOCs, SPOCs and eLearning
with Marionnet

Camille Coti, Jean-Vincent Loddo, Emmanuel Viennet

IUT de Villetaneuse, Université Paris 13, Sorbonne Paris Cité

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General introduction to Marionnet

Developped at Univ. Paris 13, released under GNU GPL licence

Goal: provide a **virtual network laboratory** to each student

- No specific hardware required
- Each students works on his/her own network
- Configure all the network elements like real hardware

Virtualized

- Machines and routers: based on User-Mode Linux
- Switches and hubs: based on VDE
- Cables: virtualized by Marionnet (both straight and crossover)
- Access to the rest of the world: gateway

Virtual Machines

Virtual machines are based on **User-Mode Linux**

- Linux kernel executed in user-mode
- Several distributions available: Debian, Mandriva, Pinocchio
- Save your own modifications: define a *variant*
- Machines saved in *copy-on-write* (COW) mode

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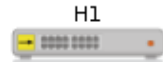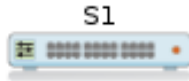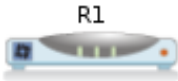
Virtual network devices

Hubs and switches are based on **VDE**

- Possibility to choose the number of ports
- Switches can be configured from a terminal

Routers are **Linux-based virtual machines**

- Access to a terminal for full configuration
- Provides dynamic routing protocols through *Quagga*

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Configuration of a Marionnet network

Hardware setup

- Choosing, installing the devices
- Wiring (with the appropriate cables) the devices
- Turning on the devices!

Network configuration

- Addresses can be configured from the GUI
- ... or directly on the machines/routers
- Terminal access on machines, routers and switches
- Routing: static or dynamic

Service configuration

- Linux machines: services can be configured directly on the virtual machines

Injection of experimental conditions

- Cables can be plugged/unplugged at run-time
- Errors can be injected in cables
- Devices can be "unplugged" unexpectedly or suspended to simulate hardware failures

Saving and sharing

Set-up a network $=$ create a **project**

- Projects can be saved and opened
- Contains both the network configuration and the COW files of the machines

Size of the .mar file: from 10 kB to 100 MB

- Can contain a **pre-configured network**
- Can contain a student's work

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Marionnet for distant learning

Network lab: requires specific hardware

- Switches, routers, several computers...
- Not everyone has this at home!

$\rightarrow$ Virtualize it!

Marionnet allows **practical activities in distant learning programs**

- Practical activities: necessary for technical education
- Students can practice on the labs using Marionnet

Student-instructor exchanges

Instructors can provide a **pre-configured network**

- Easier start at the beginning of a class
- Pre-cabled network, or even pre-configured devices
- Students download the .mar file and open it to start the lab

Students can send their work to the instructor

- To ask for some help
- For exam grading

Example: configuration of network services

Example: Configure network services on a set of servers

- DHCP, NIS, NFS, NTP...
- Configured on *computers*
- The installation, wiring and configuration of the network is not the core topic of this lab: avoid spending time on this part!
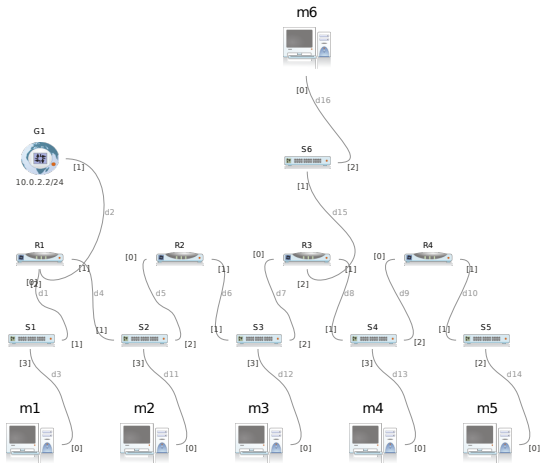
$\rightarrow$ Provide a pre-configured network and as the students to work on it
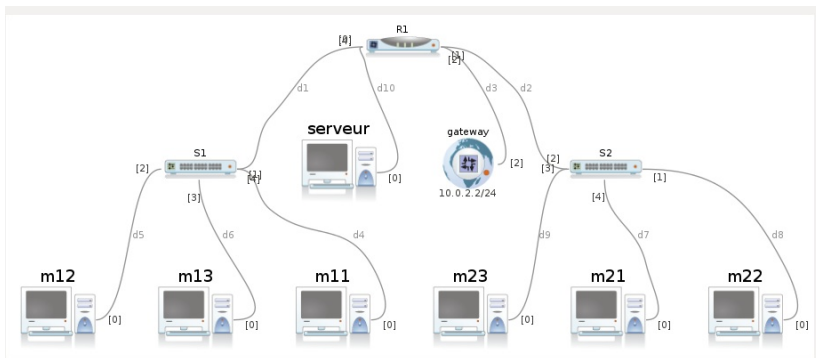
Example: configuration of network devices

Example: Configure the network devices of a non-trivial network
- Routing tables of routers and machines, VLANs on switches...
- $\rightarrow$ Provide a pre-cabled network

Example of a routing backbone:
- backbone: 4 routers
- 6 "user" subnetworks, 4 "backbone" subnetworks
- 6 switches, 6 machines
- 1 gateway

Example: Build a network from scratch

Eventually: ask the student to build a network from scratch

Hardware configuration

- Choose the right devices, the right cables...
- Wire them properly!

Network configuration

- IP configuration of the elements
- Routing tables, VLANs...

Service configuration

- Once the network works, do something with it

Drawbacks

Main drawback: **lack of contact with real hardware**

- Virtualized hardware is "too easy" to handle
- Where do we connect to get access to a switch's configuration? To a router? How different do straight cables look from crossover cables?
- → Some contact with real hardware is necessary to **transpose skills acquired on Marionnet into the real world**

Some ideas:

- For eLearning students who can come to our University (during in-house sessions)
    - Use visits at the University to **show them physical hardware** and **make labs on real hardware**
- For remote students (MOOC programs...)
    - **Show videos** of real hardware, instructors configuring it, etc

Academic Context

IUT: University Institutes of Technology

- created in 1966 for universities to offer short technical curricula
- 113 IUT in France
- 23 subjects ranging from humanities to sciences

Curricula offered

DUT *Diplôme Universitaire de Technologie*: 4 semesters of technical education

LPro *Licence Professionnelle*: technical bachelor degree, 2 additional semesters

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Licence Pro ASUR program

Licence Pro program focusing on **IT security** and **system administration** training for positions such as:

- Network Administrator.

- Network Assistant engineer.

- Safety and Quality systems.

- Head of IT.

- Network Architect, Project Manager deployment networks

Code	Module	Hours
M01	UNIX Operating Systems (intro)	24
M02	Introduction to programming (Python)	30
M03	Basic concepts of IT Security	12
M3i	Networking	35
M5u	UNIX Administration	36
M6p	Cryptography	30
M3r	Routing	22
M3a	Network Services	30
M3w	Wifi	30
M7	Protection and Monitoring of Networks	30
M3v6	Introduction to IPv6	12
M4	QoS and VoIP	30
M5a	Windows Administration	36
M6s	Attacks' Techniques	22
M8p	Client/Server Programming	25
M1e	Oral & Written Communication	30
M1a	English	30
M2g	Project Management	18
M2d	Laws and Norms	20
M9	Project	30
Mx	Misc (CISCO, Conferences)	20
	Total	550

eLearning training plan

Program made of a two complementary approaches:

- **Small Online Private Courses** (SPOCs)
  - Using Marionnet
  - Network configuration, supervision, system administration...
- Conventional, face-to-face teaching
  - Human interaction: communication, group projects
  - practice on real devices: IPBX, network configuration...

Goal: **75% online**, 130H in face-to-face classes.

Organization of a module

Sequence of activities such as:

- Video lectures.
- Written tutorials;
- Quizz and online evaluation.
- Individual help: mentoring by chat, visioconference or e-mail.
- Group activities: forums, group chats sessions.

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Conclusion

Marionnet allows **practical activities** in (computer) network courses on a single personal computer with **no specific hardware**

- Very interesting tool for distant learning
- Students can train on realistic networks of non-trivial size
- Instructor ↔ students made possible using .mar files
- Progressive difficulty is possible: can provide partially configured networks

Drawback: no contact with real devices

- Need to complement with other ways to show the hardware
- Better than no labs at all!

Future implementation in an eLearning program.