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

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1 Presentation of Marionnet
   - General presentation
   - Virtual devices
   - Saving and sharing

2 Marionnet for remote lab activities
   - Marionnet for distant learning
   - Examples of practical activities for a network course
   - Drawbacks

3 French IUT Curricula
   - Academic context
   - eLearning training plan

4 Conclusion
General introduction to Marionnet

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

Goal: provide a virtual network laboratory to each student

- No specific hardware required
- Each student 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
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
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!

→ 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: 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!

→ 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...
  → 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
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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

<table>
<thead>
<tr>
<th>DUT</th>
<th>Diplôme Universitaire de Technologie: 4 semesters of technical education</th>
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<tr>
<td>LPro</td>
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### Academic Context

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*Slide kindly provided by Laure Petrucci*
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.

<table>
<thead>
<tr>
<th>Code</th>
<th>Module</th>
<th>Hours</th>
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<tbody>
<tr>
<td>M01</td>
<td>UNIX Operating Systems (intro)</td>
<td>24</td>
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<tr>
<td>M02</td>
<td>Introduction to programming (Python)</td>
<td>30</td>
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<td>M03</td>
<td>Basic concepts of IT Security</td>
<td>12</td>
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<td>M3i</td>
<td>Networking</td>
<td>35</td>
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<tr>
<td>M5u</td>
<td>UNIX Administration</td>
<td>36</td>
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<tr>
<td>M6p</td>
<td>Cryptography</td>
<td>30</td>
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<td>M3r</td>
<td>Routing</td>
<td>22</td>
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<td>M3a</td>
<td>Network Services</td>
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<td>M7</td>
<td>Protection and Monitoring of Networks</td>
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<td>M3v6</td>
<td>Introduction to IPv6</td>
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<td>M4</td>
<td>QoS and VoIP</td>
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<td>Windows Administration</td>
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<td>Attacks’ Techniques</td>
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<td>M2d</td>
<td>Laws and Norms</td>
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<td>M9</td>
<td>Project</td>
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<tr>
<td>Mx</td>
<td>Misc (CISCO, Conferences)</td>
<td>20</td>
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Total: 550
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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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.