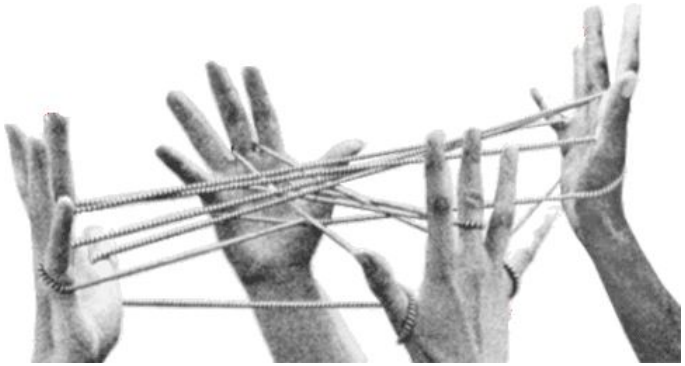
Network Simulation with RouterOS



Patrik Schaub · MUM Krakow · 29.02.2008

Deffinitions for simulation

The term simulation is used in many contexts. Some of the most general definitions from wikipedia include:

- modelling of systems to gain insight into their function
- simulation is the process of analysing systems, that are to complex to be analysed in theory or based on formulars

Applications for simulation

Applications for the simulation of technology include:

- Performance optimisation
- Safety engineering
- Testing
- Training
- Education

Reasons for simulation

Some of the reasons, why to use simulation instead of the real system, include:

- That simulation is cheaper
- It would be to dangerous to use real systems
- It would take to much / much more effort with real systems
- The system, that should be analysed, does not yet exist

Examples for simulation

- Flight simulators
- Crash tests
- Chemical reactions
- Experiments in physics or biology

Types of simulation

- There are different types of simulations
- When simulation networks, we are using
  - Virtual simulations (real people are acting on virtual systems)
  - Constructive simulations (virtual people are acting on virtual systems)

Let's focus on networks, now!

Simulating networks

In the following slides the term simulation refers to:

- Creating realistic networks with virtual devices
- Using only physical devices where necessary for realism
- Analysing these networks by means used with physical networks
- Using automatic analysing processes, that can not be used with physical networks
- Visualise these networks

1 Introduction to simulation
- Simulation in general
- Networks

2 Network simulation
- Goals of network simulation
- Where to use it
- Advantages overwiev
- Education with and without network simulation
- Advantages in detail

3 Our simulation approach
- Requirements when simulating networks
- The simulation framework
- Today and tomorrow

Our goals when simulating networks

- Creating a network environment with the lowest amount of physical resources
- Have the simulated network be realistic (enough) for the given task
- Have an easy to understand (visual) representation for this network
- Be able to manually and automatically create as many real situations (conditions) as possible without physical interaction

Areas of application

Where will network simulation be usefull?

- Learning and teaching (education)
- Planing
- Testing and debugging
- Presenting

Advantages when using network simulation

The advantages as a overwiev:

- Saving space
- Less expensive
- Saving energy
- Faster
- Saving work
- Making things possible, that are not without simulation
- Making things more reliable

A typical computer science semester

A typical computer science semester

- About 100 students
- Split in 5 groups for practical labs
- Labs with 20 students
- Even simple exercises need a lot of hardware

Exercise 1 (Simple routing)

The most basic routing lab would be:

- Two computers
- Seperated by one router

For twenty students the lab room needs this equipment:

- 20 routers
- 20 external power supplies
- 40 computers
- 40 ethernet cables
- 60 power outlets

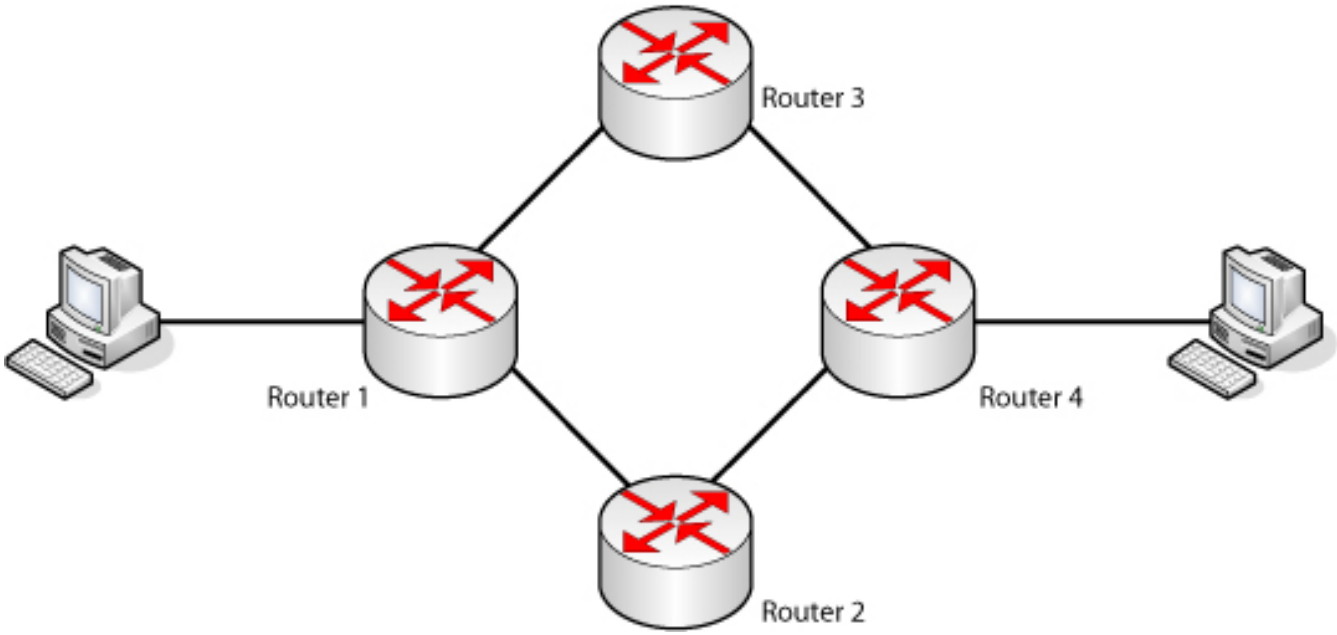
Phyisical parts/devices needed in total:

- 120 items
- or even 180 including the power outlets

Exercise 2 (Advanced routing 1/4)

A more advanced routing lab might look like this:

- Four routers connected in a circle
- Two host computers connected at opposite routers



Exercise 2 (Advanced routing 2/4)

For each student the lab room needs this equipment:

- 4 routers
- 4 external power supplies
- 2 computers
- 6 ethernet cables
- 6 power outlets

Total phyisical parts/devices needed per student:

- 16 items
- or 22 including the power outlets

Exercise 2 (Advanced routing 3/4)

For 20 students the lab room needs this equipment:

- 80 routers
- 80 external power supplies
- 40 computers
- 120 ethernet cables
- 120 power outlets

Total phyisical parts/devices needed in the lab:

- 320 items
- or even 440 including the power outlets

Exercise 2 (Advanced routing 4/4)

What do 80 routers look like?

Approach 1 - Desktop simulation (1/2)

Simulation on the student's desktop computer:

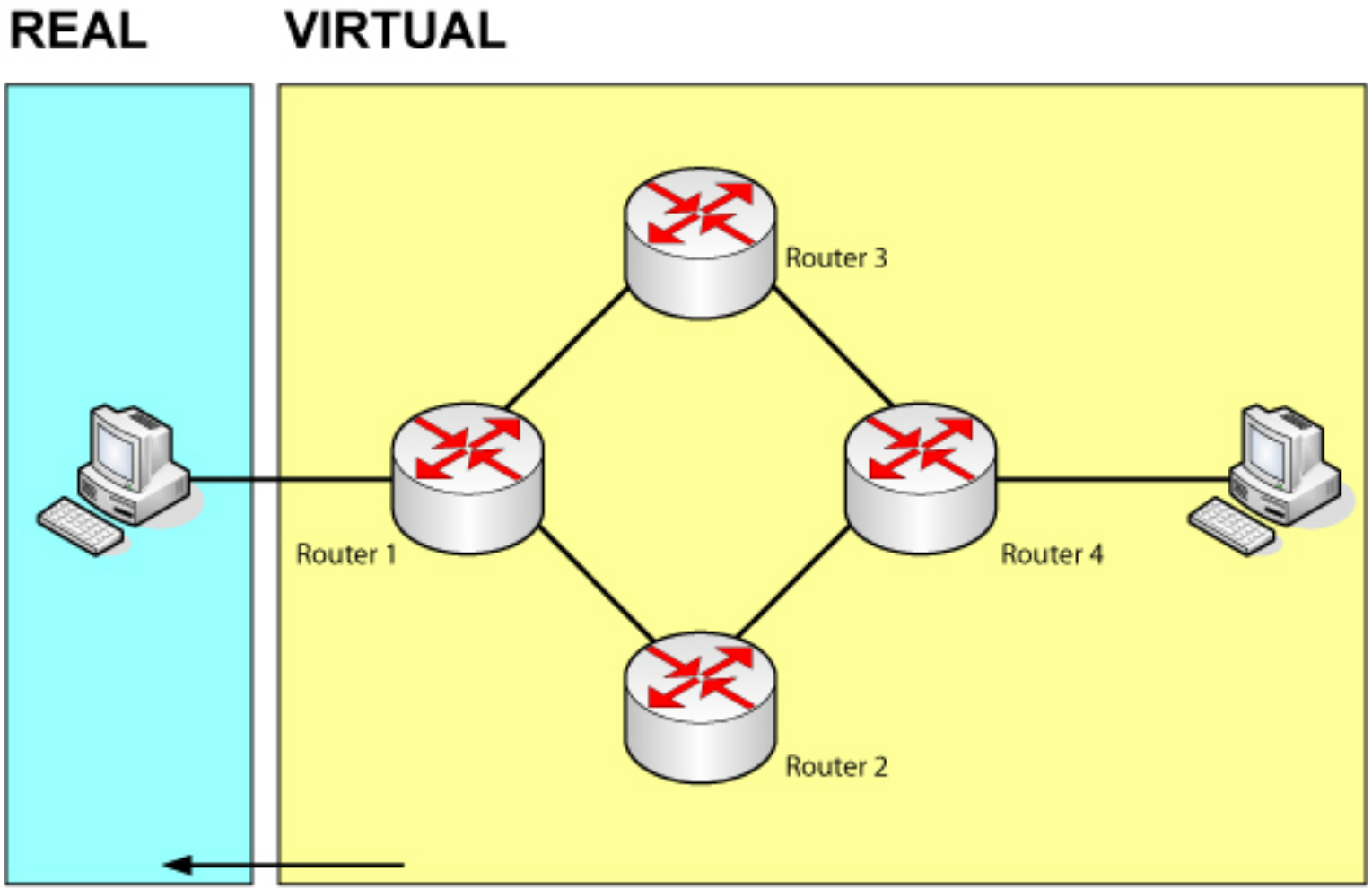
- Only physical device: one desktop computer per student
- Computer should have an extra GB RAM
- Most modern CPUs will be sufficient (even an Athlon XP @ 2GHz will do)
- Even more complicated exercises possible

Total phyisical parts needed in the lab:

- 20 desktop computers
- 20 power outlets

Approach 1 - Desktop simulation (2/2)

Simulating the advanced lab on a desktop computer



Approach 2 - Central Simulation

Simulation on a central simulation server:

- 1 simulation server
- 20 client PCs (one for each student)
- 21 ethernet cables
- 1 VLAN capable switch

Total phyisical parts needed in the lab:

- 43 parts
- 22 power outlets

Comparison

Direct comparison of the approaches:

ROUTING LAB	PHYSICAL	DESKTOP SIM	SERVER SIM
BASIC	120 parts 60 p.out	20 parts 20 p.out	43 parts 22 p.out
ADVANCED	320 parts (16x ←) 120 p.out	20 parts 20 p.out	43 parts 22 p.out

Advantages when using network simulation

- Saving space
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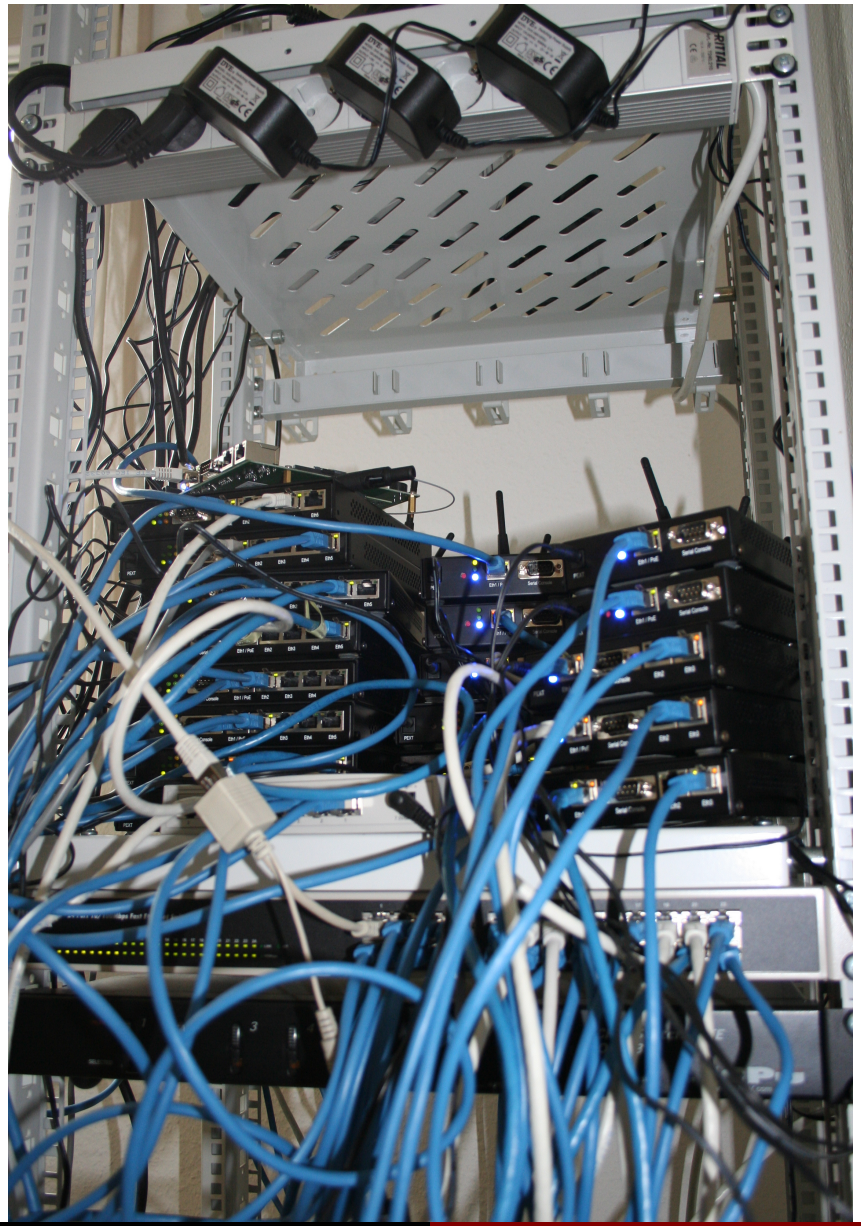
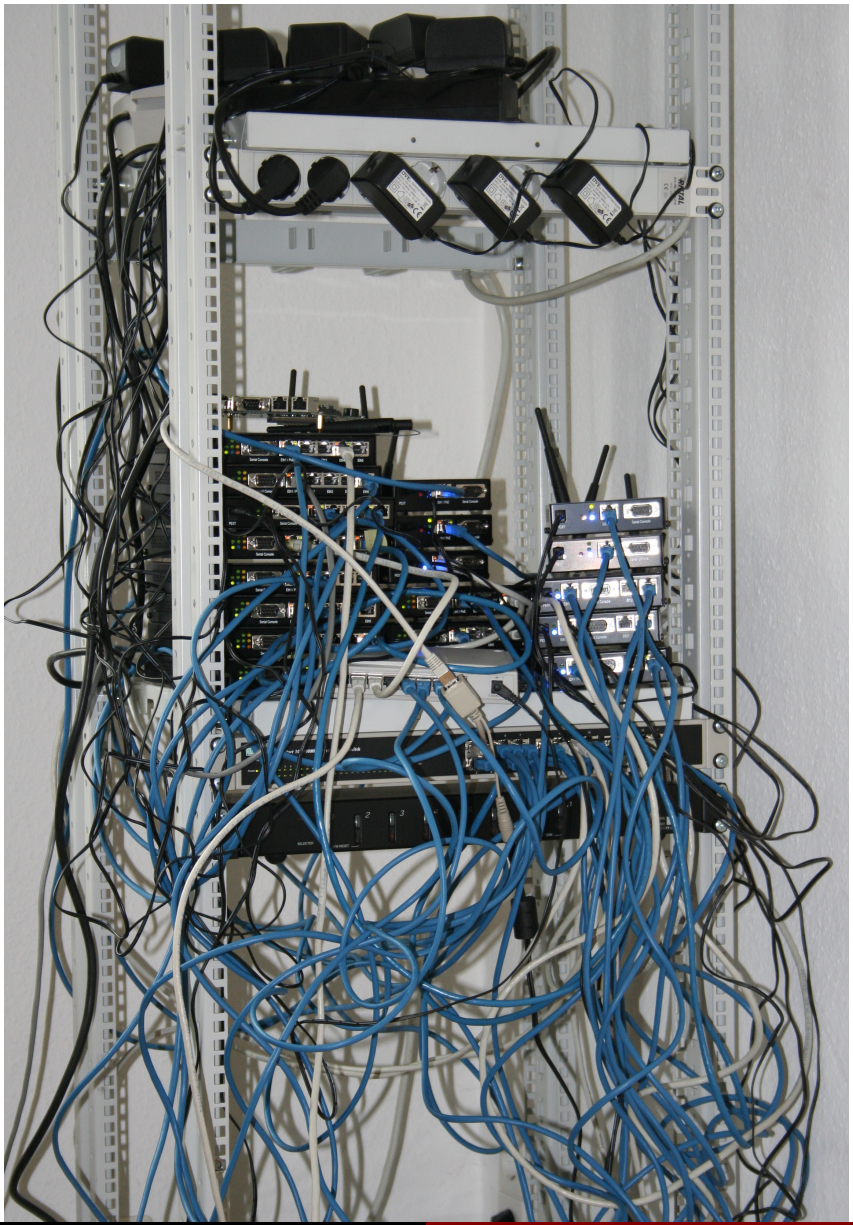
- Faster
- Saving work
- Making things possible, that are not without simulation
- Making things more reliable

Test setup (1/2)



Test setup (2/2)



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Requirements when simulating networks

- Virtualisation of all major network devices
- Integration of physical devices, that can not (yet) be virtualised
- And optionally, for convenience and usability
  - Visualisation of the whole network (simulated and physical)
  - A scripting API to control the simulation

Needed virtual devices

- Routers
- Access concentrators
- Firewalls
- Traffic shapers
- DHCP servers
- Client computers
- Server computers like
  - web server
  - mail server
  - samba server
  - DNS server
- HUBs, switches
- Network cables

The simulation framework (1/3)

- Virtualisation: Free VMWare Server, VMWare ESX Server
- Visualisation: The Dude
- Network OS: RouterOS
- Client PCs: Linux, BSD, Windows ...
- Server PCs: Linux, BSD, Windows ...

The simulation framework (2/3)

- VMWare
  - Virtual switches and network cables
  - Integrating physical devices into the simulation by bridging virtual switches or NICs to physical NICs of the simulation host
  - Run a broad range of client and server OS as VMs
  - API for scripting the simulation
  - Run RouterOS as a VM
- The Dude
  - Graphical representation of simulated and physical devices
  - Fast access to configruation utilities
  - Monitoring and tools like ping, traceroute, snmp walk
- RouterOS
  - Straigth forward to run as a VM
  - Provides it's famouse felxibility
  - As router, access concentrator, firewall, and much more

The simulation framework (3/3)

A example for simulation on a desktop computer:

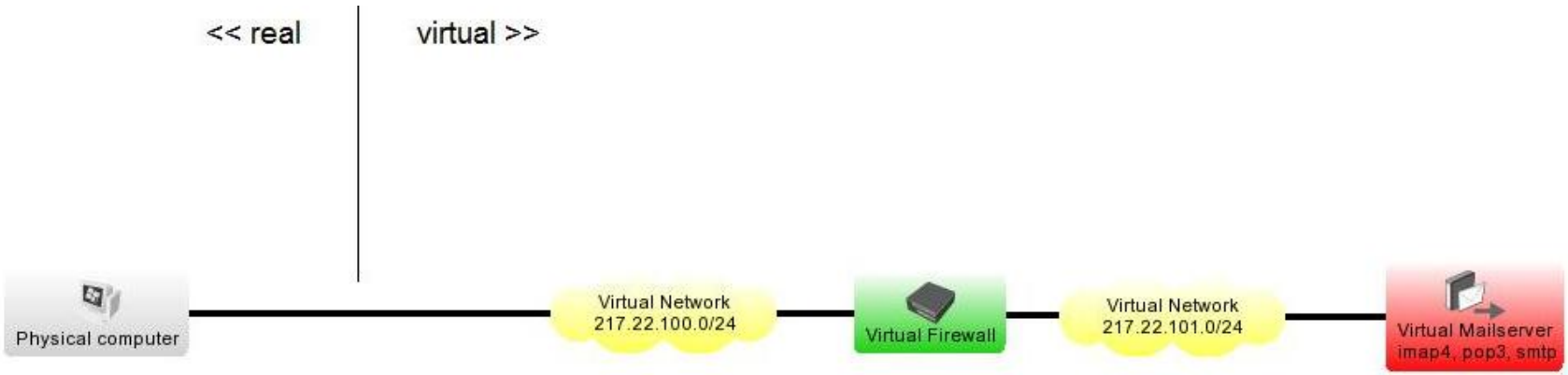
- 1 x VMWare Server (free)
- 1 x The Dude (free)
- 1 x RouteOS Level 4 (30,- EUR)
- Total cost about 30,- EUR

What to do with it?

- Get a ready-to-run mailserver as VM
- Get a port and vulnerability scanner
- Setup virtual network and RouterOS firewall
- Test the setup

Dude - visualisation and monitoring

Graphical representation and service monitoring



Today and Tomorrow

Sounds good, but what's reality like?

- FMS uses desktop simulation every day
  - Customer site RouterOS presentations
  - Testing smal and medium configurations
  - Planing customer networks
- The near future
  - A large inhouse simulation server for support and consulting
  - A customised simulation server for a German university
  - A hosted simulation server for remote training

Thank you

Thank you for listening

Any questions?

Contact

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