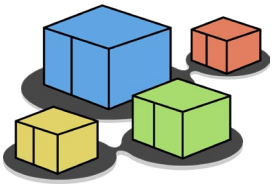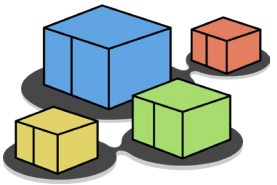# Kathará

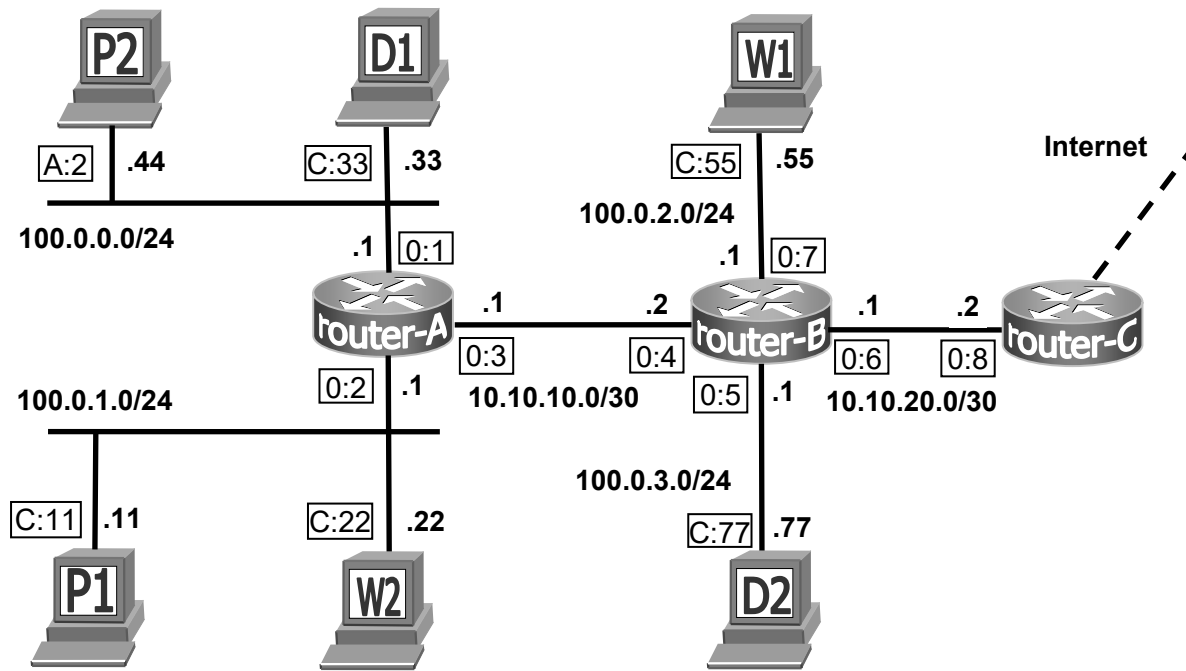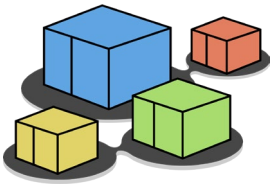A container-based framework for experimenting computer networking

About computer networks

- **Computer networks are quite complex**
  - Several devices (computers, routers, etc.)
  - Several interfaces
  - Several protocols running
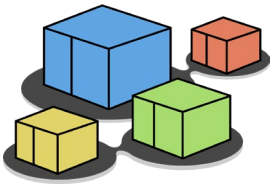 - Physical interconnections originate complex topologies
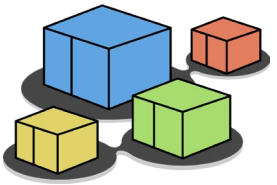
Example of a computer network

How to perform experiments?

- Performing experiments may be unfeasible
- A live network cannot be exploited for experiments
  - It hosts services that are critical for the company
  - It would be necessary to coordinate different departments of the company
- Network equipment is expensive
  - Sometimes, even for performing simple experiments, several equipment should be available in the same test bed
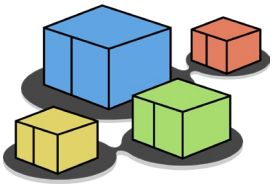
Simulation vs. emulation

- Emulation and simulation systems put at user's disposal a virtual environment that can be exploited for tests, experiments, measures

- Simulation systems aim at reproducing the performance of a real-life system (latency time, packet loss, etc.)
  - e.g.: ns, real, …

- Emulation systems aim at accurately reproducing the functionalities of a real-life system (configurations, architectures, protocols), with limited attention to performance
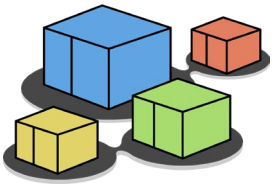
What is Kathará?

a system for emulating
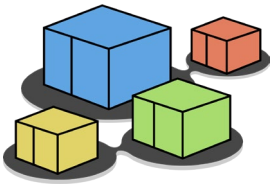computer networks

Emulating a network

- **Basic idea:**
  - <u>several containers</u> are created inside a single host machine
  - containers are connected to <u>virtual collision domains</u> and thus <u>can communicate with each other</u>
- Each container can be configured as a device that plays the role of a regular host, of a router, of a switch, ...
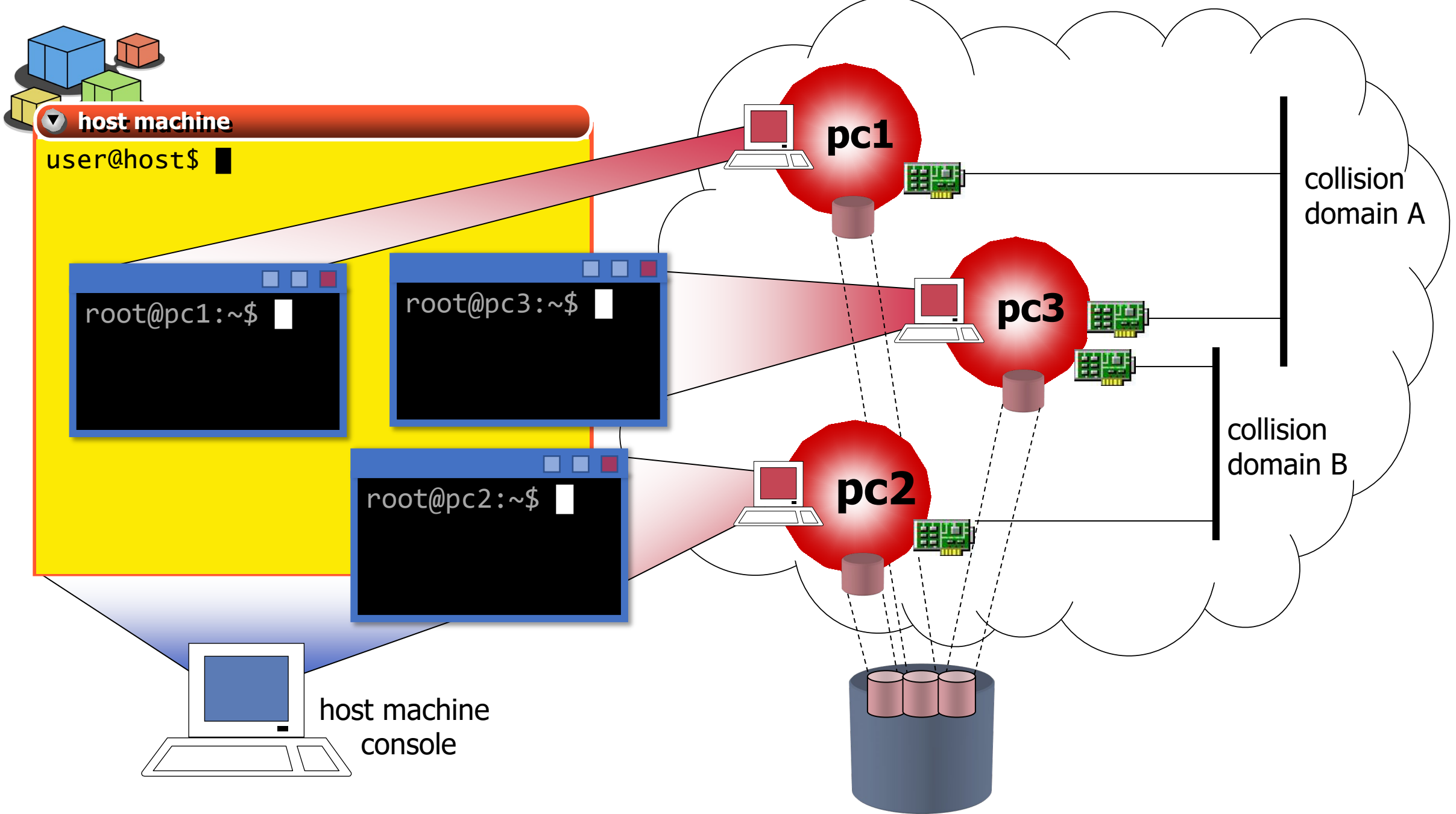
Kathará
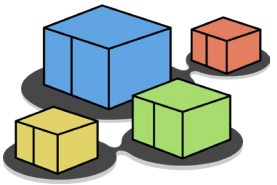
- Based on Docker
- Each emulated network device (in what follows *device*) is a container
- Note: several container images available, e.g.:
  - Base (DNS, Web Server, network utilities)
  - Quagga (standard routing protocols)
  - **FRRouting (standard routing protocols + EVPN + MPLS)**
  - Open vSwitch (Open Flow enabled switch)
  - Behavioral Model (software implementation of a P4 switch)

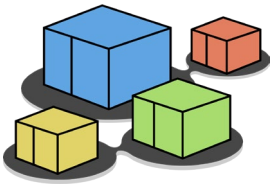# Emulated network devices

- Each device has:
    - A console (a terminal window)
    - A memory
    - A filesystem
    - (zero, one or more) network interfaces

- Each network interface is connected to a single (virtual) collision domain

- Each virtual collision domain can be connected to several interfaces

host machine
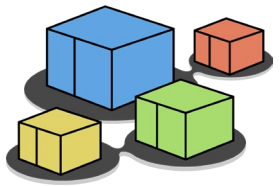
`user@host$` ▉

`root@pc1:~$` ▉

`root@pc3:~$` ▉

`root@pc2:~$` ▉

host machine console

pc1

pc3

pc2

collision domain A

collision domain B

Kathará - Introduction

last update: Oct 2023

Setting up Kathará

Setup manual

Installing Kathará

- Available for:
  - Windows
  - Linux
  - MacOS
- Download at https://www.kathara.org/
- Follow the wiki
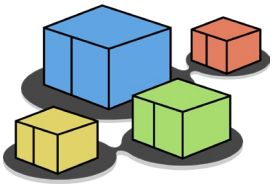
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Changing the default Docker Image of Kathará

- Run `kathara settings`
- Select `Choose default image` by pressing 2
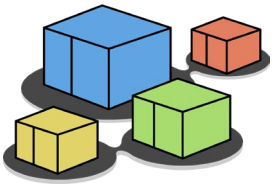- Select `kathara/frr` by pressing 2
- Confirm and exit

Using Kathará

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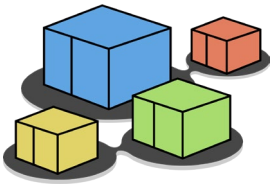# Kathará commands

- Kathará provides users with three sets of commands
  - v-prefixed commands (v-commands)
  - l-prefixed commands (l-commands)
  - Global commands
- v-commands act as low-level tools for configuring and starting up a single device
- l-commands provide an easier-to-use environment to set up complex labs consisting of several devices
- Global commands are mainly management commands
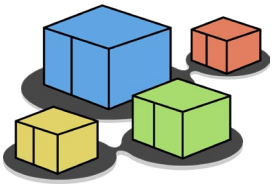
Kathará v-commands

- Allow to startup a single device with arbitrary configurations (network interfaces, etc.)
  - vstart: starts a new device
  - vconfig: attaches network interfaces to a running device
  - vclean: halts a device
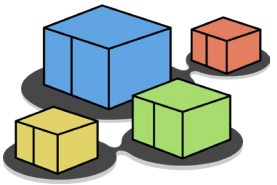
Kathará l-commands

- Ease setting up complex labs consisting of several virtual machines

  - **lstart**: starts a Kathará lab

  - **lclean**: halts all the devices of a lab

  - **lconfig**: manage the network interface of a running lab

  - **lrestart**: halts all the devices of a lab and start them again

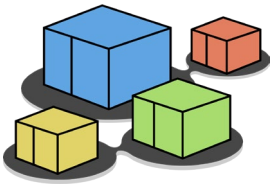 - **linfo**: provides information about a lab

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Kathará global commands

- **Management commands**

  - **check**: Check your system environment

  - **connect**: Connect to a running Kathará machine

  - **list**: Show all running Kathará machines of the current user

  - **settings**: Show and edit Kathará settings

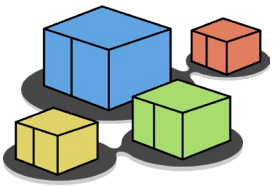 - **wipe**: Delete all Kathará machines and links, optionally also delete settings
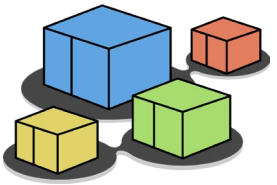
Testing Kathará

Testing Kathará

- To test if your setup works correctly run:
  - `kathara check`
    - This command will run automatic tests to your environment
  - `kathara vstart -n pc1 --eth 0:A`
    - This command will start a new device called `pc1` and connected to the virtual collision domain `A`
    - A terminal window will open allowing to run commands inside the device
  - `kathara vclean -n pc1`
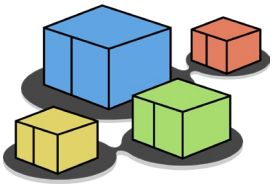   - This command will stop the previous started device

Preparing a Kathará lab

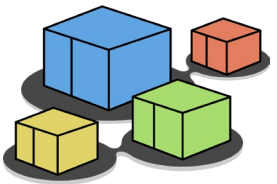# Kathará lab

- a Kathará lab is a set of preconfigured devices that can be started and halted together

- a basic Kathará lab is a directory tree containing:

  - a lab.conf file describing the network topology

  - a set of subdirectories that contain the configuration settings for each device

  - <device_name>.startup files that describe actions performed by devices when they are started

lab.conf

- describes:
  - The topology of the network that interconnects the lab's devices
  - The devices to be started
- contain a list of `machine[arg]=value` lines where:
  - `machine` is the name of the device (e.g. pc1)
  - if `arg` is a number, then `value` is the name of a collision domain to which eth`arg` should be attached
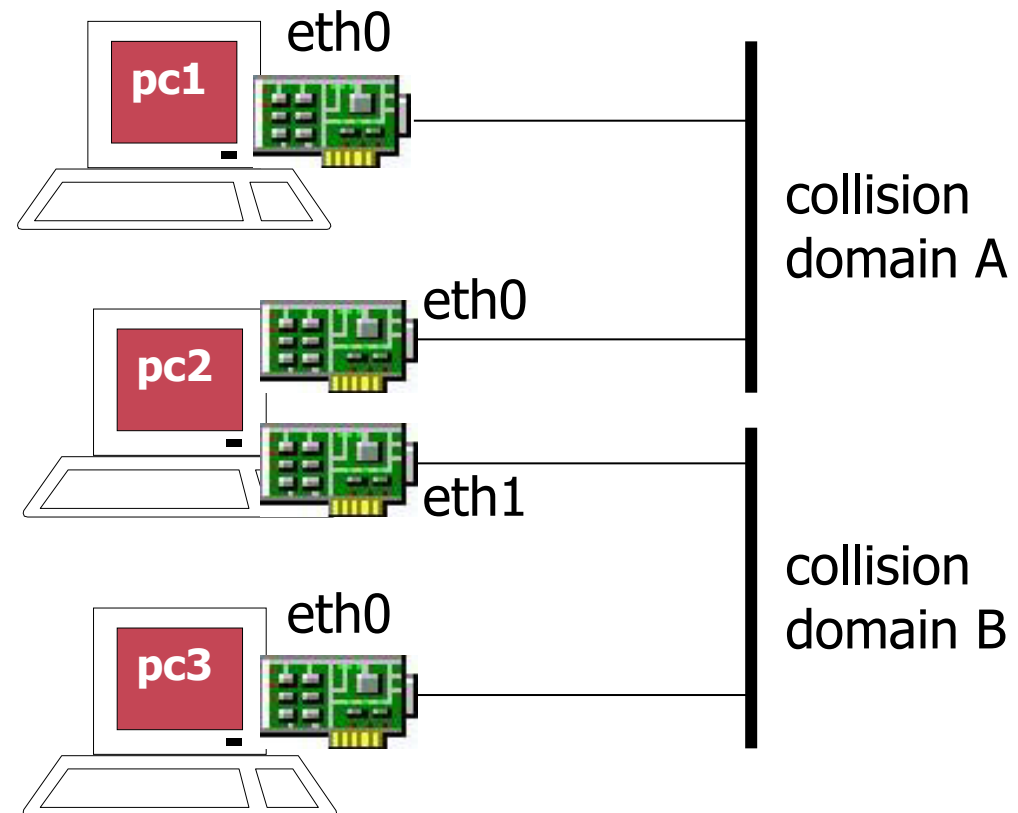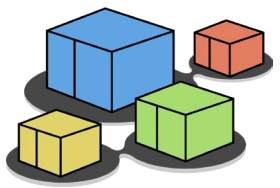 - if `arg` is not a number, then it must be an option and `value` the argument

lab.conf

- example

```
pc1[0]=A

pc2[0]=A
pc2[1]=B

pc3[0]=B
```


pc1   eth0
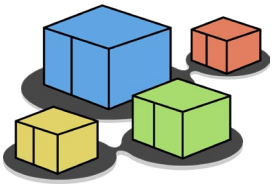
collision domain A

pc2   eth0

eth1

collision domain B

pc3   eth0
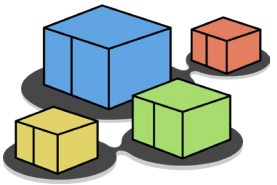
Share files between the host and the devices

- There are two ways to share files between the host filesystem and the device filesystem:
  - Share files mirrored to the device
    - A change inside the device will reflect in the host filesystem
    - A change in the host filesystem will reflect in the device
  - Share files copied to the device
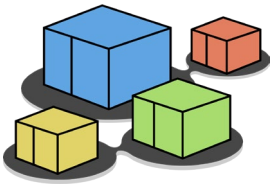   - Two independent copies of the same files

Share files mirrored to the device

- There are two ways to share mirrored files:
  - the `/shared` directory inside a device directly points to the **shared** directory inside the lab
    - by default it is **ENABLED**, you can disable it in the settings
  - the `/hosthome` directory inside a device directly points to the **home directory** of the current user of the host
    - by default it is **DISABLED**, you can enable it in the settings
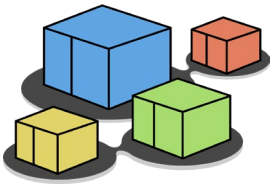
Share files copied to the device

- Can be done through the subdirectories of a lab

- The contents of subdirectory **device** are copied into the root (**/**) of the device named **device** filesystem

  - for example, **pc1/foo/file.txt** is copied to **/foo/file.txt** inside the device **pc1**
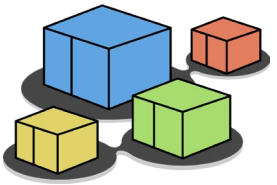
.startup files

- Shell scripts that are executed inside a device right after its startup

- Typical usage of a `.startup` file is to configure network interfaces and/or start network services

  - For example:

```
ip address add 10.0.0.1/24 dev eth0
systemctl start frr
```
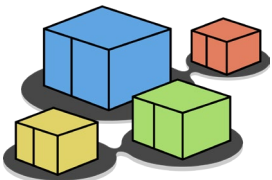
Launching/halting a lab

- Open a terminal

- Enter the lab directory (`cd lab_directory`)

- Launch a Kathará l-command

  - Where l-command could be one of the following

    - `kathara lstart`, to start the lab

    - `kathara lclean`, to stop the lab

    - `kathara lrestart`, to restart the lab

More information

- Further information can be found:
  - On GitHub's Kathará wiki
  - On the official website https://www.kathara.org
  - Inside Kathará man pages
    - On Linux and MacOS accessible by the terminal `man kathara`
    - Available online at https://www.kathara.org/man-pages/kathara.1.html

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