Fog and Cloud Computing
Lab

Daniele Santoro (*dsantoro@fbk.eu*) - Expert Research Engineers
Silvio Cretti (*scretti@fbk.eu*) – *Senior* Research Engineers

RiSING (Robust and Secure Distributed Computing)
Fondazione Bruno Kessler (FBK)

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Fog and Cloud Computing
Lab Agenda/Topics

- Lab Intro & Env Setup
- IaaS examples and OpenStack
- Automation, IaC and Immutable deployment
- Cloud from a developer perspective
- Cloud-Native approach
- Linux Containers and Docker
- Docker usage and exercises
- Container Orchestration: Kubernetes
  - Basic and Advanced k8s resources
  - Single(multi)-node Clusters and Installation
  - Networking
  - Scheduling and Placement
- Fog Computing with FogAtlas

Lab Resources

- Shared Etherpad: https://annuel2.framapad.org/p/6s5u416vo7-9t4b

- White Board: https://tinyurl.com/2p8j7yra

- Interaction:
  - Etherpad
    - *Exercises check, Share Troubleshooting, Questions and Logs*
  - Zoom Chat (for those remotely connected)
    - *Discuss with your colleagues during exercises or directly/privately with me*
  - Rise your Hand (also via Zoom)
    - *If you need my attention or want to speak, don't be shy !!!*
  - Course Forum: https://tinyurl.com/27vmd9pj
    - *Questions and answers could be useful to others, be collaborative*

Lab Resources

- Slides
  - Uploaded before any lesson in Moodle

- Repositories of exercises (in support to slides)
  - https://gitlab.fbk.eu/dsantoro/fcc-lab-2022

- Lab Virtual Machine:
  - Vagrant and VirtualBox on your laptop
    - https://www.virtualbox.org/, https://www.vagrantup.com/ and https://gitlab.fbk.eu/dsantoro/fcc-lab-2022

Today Lesson & Disclaimer

- Setup of personal environments via 3 exercises
- Individual support for environment setup during exercises
- We did not test ALL Operating System, especially we did little tests on Windows
- For any issue we will try to help you as much as possible to setup a stable Lab environment
- Tune based on your skills, issues etc…
- May be boring for those that already have experience on these tech
  - But you can help your colleagues ;D

RiSING (dev team) - What

- Team of ~14 researchers/developers working on different projects involving Security, Networking and Cloud and Fog Computing technologies
- DECENTER https://www.decenter-project.eu/
  - A research and innovation project aiming to deliver a robust Fog Computing Platform that will provide application-aware orchestration and provisioning of resources, driven by methods of AI.
- FogAtlas https://fogatlas.fbk.eu/
  - A software framework aiming to manage a geographically distributed and decentralized Cloud Computing infrastructure providing computational, storage and network services close to the data sources and the users, embracing the Fog Computing paradigm.

RiSING (dev team) - What

- **DEV**elopment
  - Develop PoC and Demo
  - Mostly using microservices approach
    - 1 app → N microservices
  - RESTFul API and interoperability across different programming languages and microservices *(anyone is free to write his/her code in any language and ship the builds in a containerized runtime)*
  - Experiments/Enhance/Customization mainly on/of Kubernetes

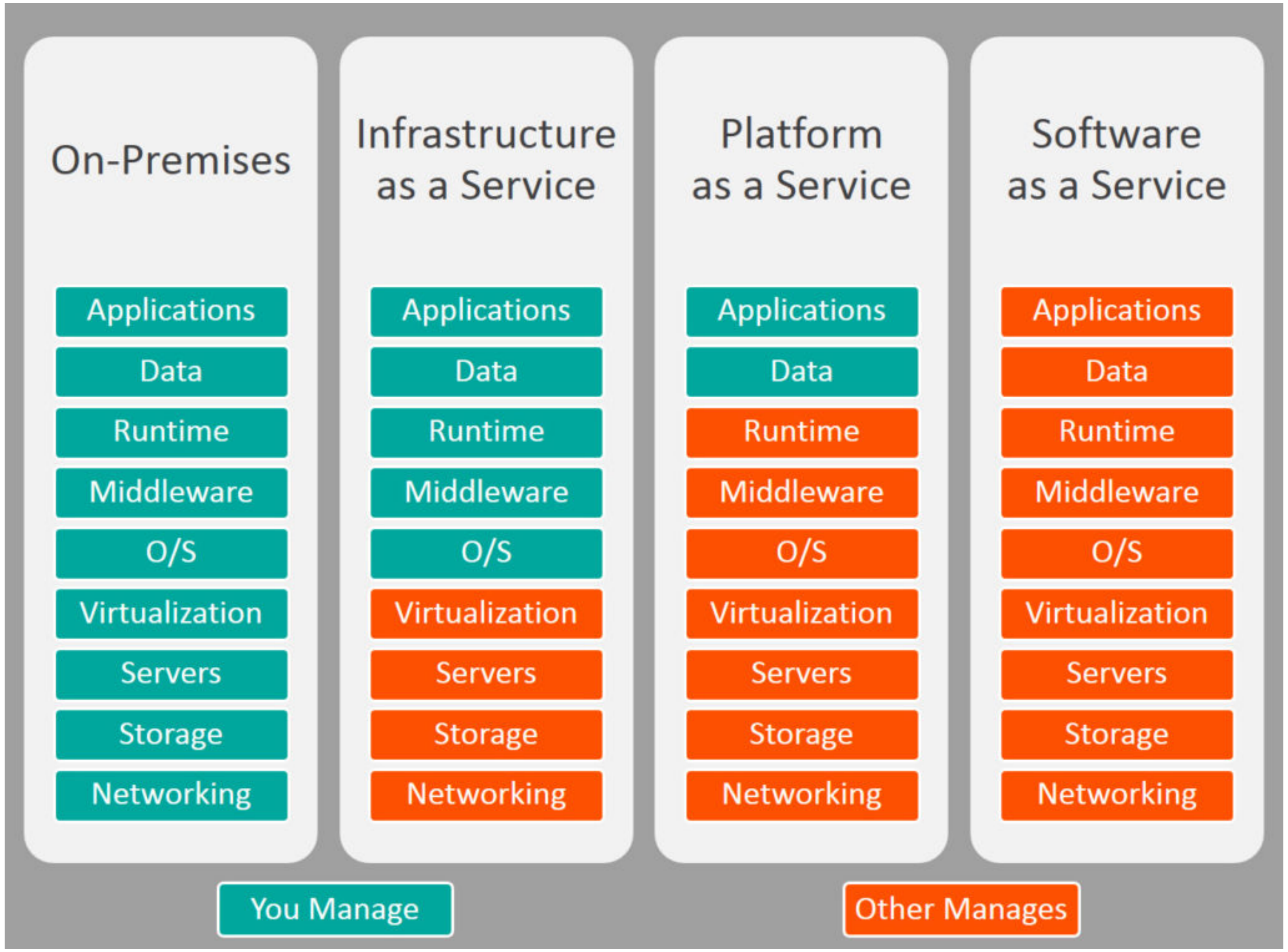
RiSING (dev team) - What

- **OP**eration**S**
  - – Build (simulated/emulated) complex distributed infrastructures
    - Full virtualized (nodes are VMs) or Hybrid (nodes are VMs or physical servers)
  - – Easy to deploy
    - Automatically create environments
    - Every project has multiple environments (integration, testing, demo …)
  - – Easy to destroy and re-create
    - When we encounter issues in a complex infrastructure sometimes is easier/quicker to startup from a fresh one
  - – Easy to reproduce
    - Can't have always up & running environments (cost/availability of resources)

RiSING (dev) – Key Requirements

- Software portability
- API driven approach
- Infrastructure as Code [ref] & IaaS automation
- Automatic Build, Deploy & Testing pipelines
- PaaS (like) approach
  - With lower abstraction than Heroku, Google App Engine, Cloud Foundry
- Private Cloud (on premises)
  - Not anymore
  - Bare Metal as a Service + Public Cloud (Azure, GCP)

IaaS vs PaaS 1/2

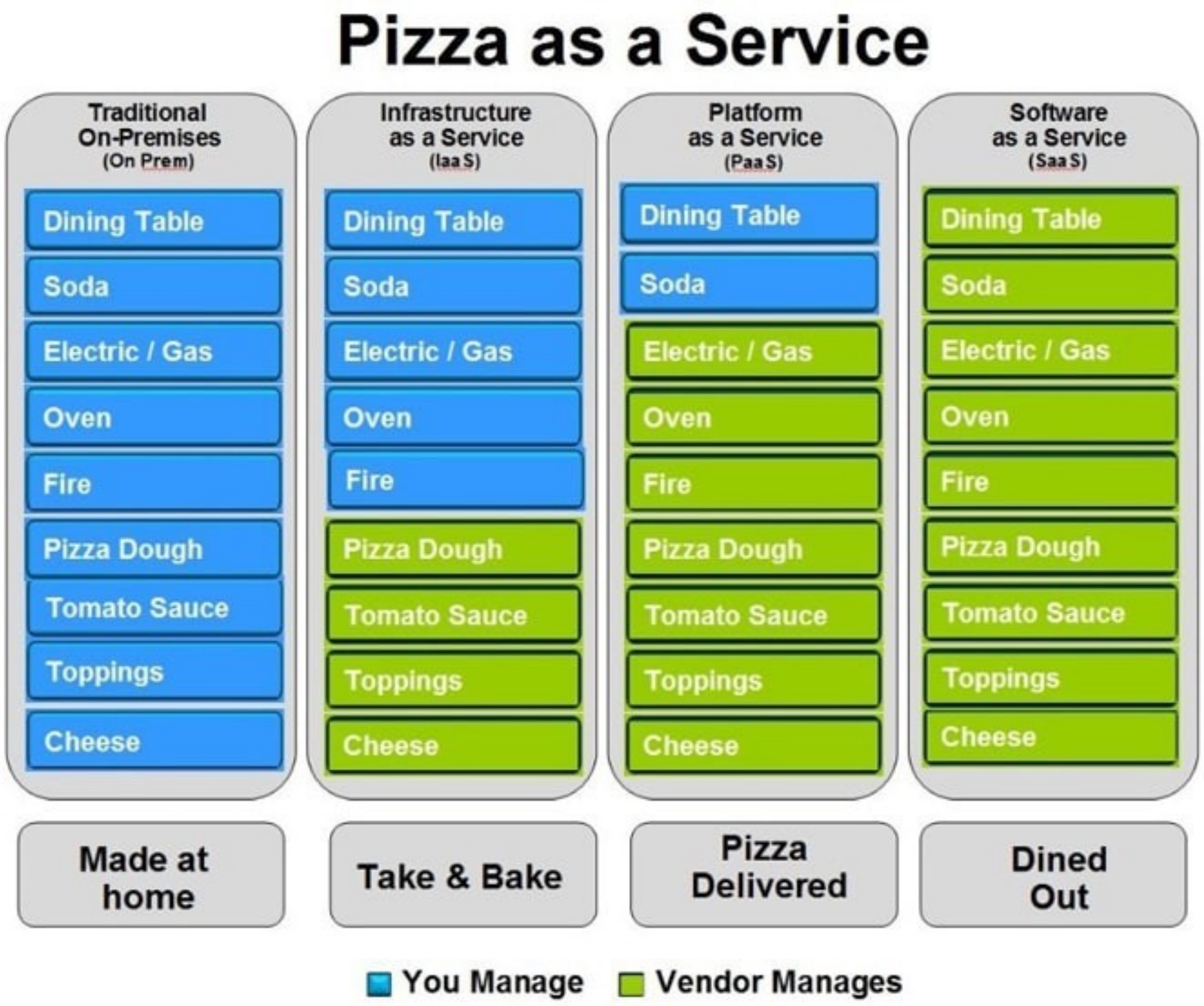


On-Premises	Infrastructure as a Service	Platform as a Service	Software as a Service
🟩 Applications	🟩 Applications	🟩 Applications	🟥 Applications
🟩 Data	🟩 Data	🟩 Data	🟥 Data
🟩 Runtime	🟩 Runtime	🟥 Runtime	🟥 Runtime
🟩 Middleware	🟩 Middleware	🟥 Middleware	🟥 Middleware
🟩 O/S	🟩 O/S	🟥 O/S	🟥 O/S
🟩 Virtualization	🟥 Virtualization	🟥 Virtualization	🟥 Virtualization
🟩 Servers	🟥 Servers	🟥 Servers	🟥 Servers
🟩 Storage	🟥 Storage	🟥 Storage	🟥 Storage
🟩 Networking	🟥 Networking	🟥 Networking	🟥 Networking

🟩 You Manage

🟥 Other Manages

IaaS vs PaaS 2/2

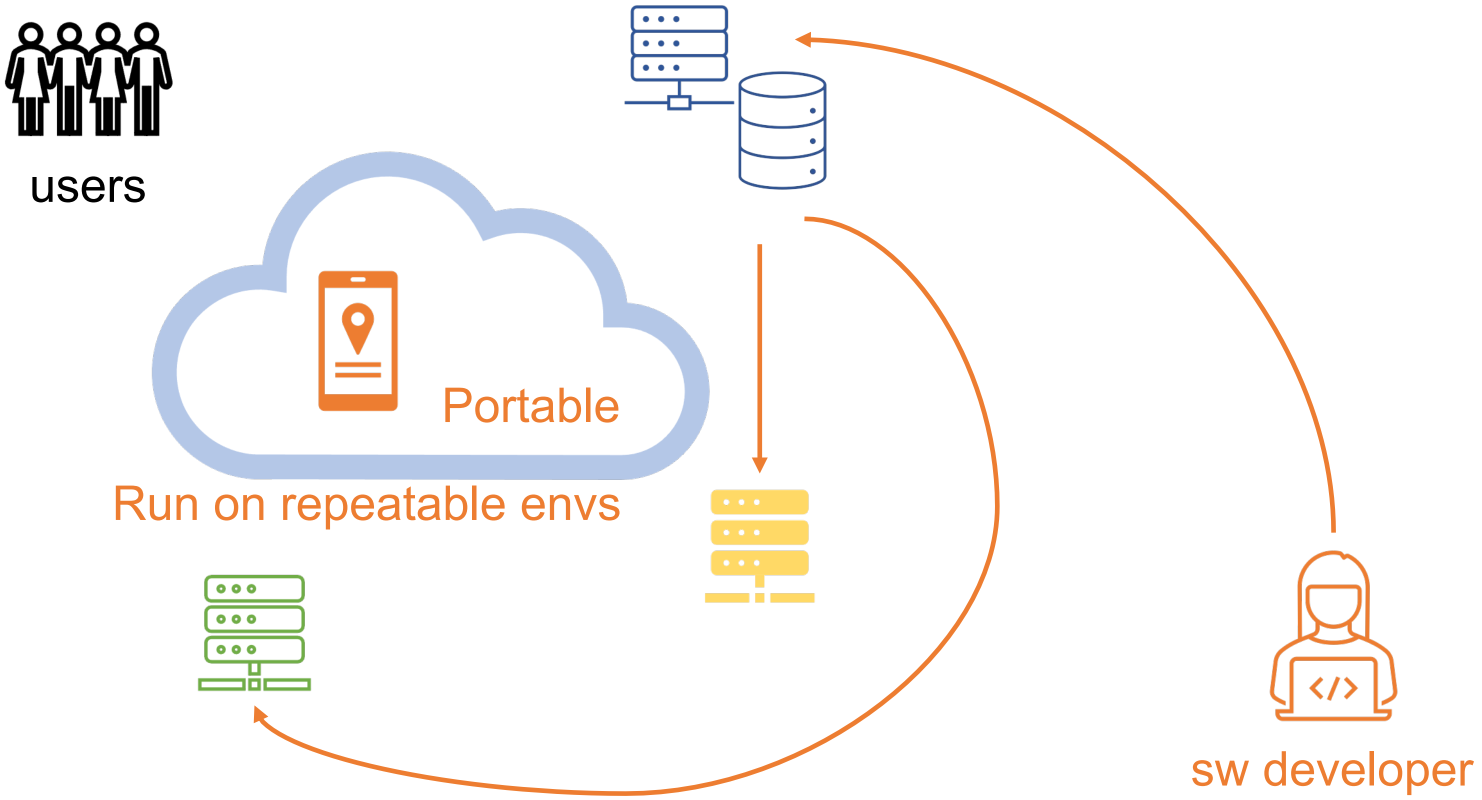


Pizza as a Service

Traditional On-Premises (On Prem)	Infrastructure as a Service (IaaS)	Platform as a Service (PaaS)	Software as a Service (SaaS)
🟦 Dining Table	🟦 Dining Table	🟦 Dining Table	🟩 Dining Table
🟦 Soda	🟦 Soda	🟦 Soda	🟩 Soda
🟦 Electric / Gas	🟦 Electric / Gas	🟩 Electric / Gas	🟩 Electric / Gas
🟦 Oven	🟦 Oven	🟩 Oven	🟩 Oven
🟦 Fire	🟦 Fire	🟩 Fire	🟩 Fire
🟦 Pizza Dough	🟩 Pizza Dough	🟩 Pizza Dough	🟩 Pizza Dough
🟦 Tomato Sauce	🟩 Tomato Sauce	🟩 Tomato Sauce	🟩 Tomato Sauce
🟦 Toppings	🟩 Toppings	🟩 Toppings	🟩 Toppings
🟦 Cheese	🟩 Cheese	🟩 Cheese	🟩 Cheese
Made at home	Take & Bake	Pizza Delivered	Dined Out

🟦 You Manage 🟩 Vendor Manages

Heterogeneity and Dynamicity of Resources



users

Portable

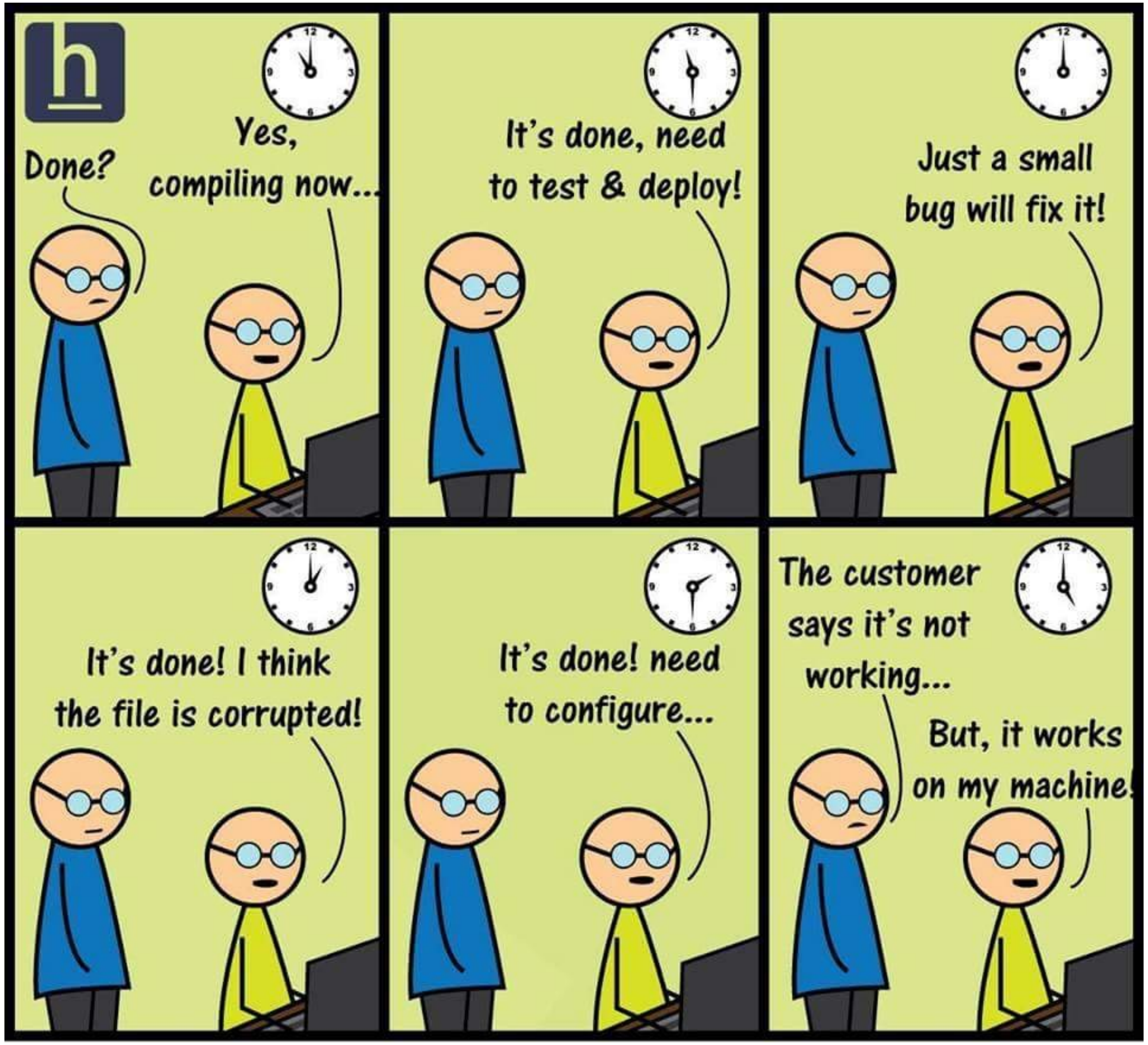
Run on repeatable envs

sw developer

Portable Application & Repeatable Environments

Today's target is to setup an environment which is equal for every student even if we are using different OS and hardware.

Learn techniques in order to create such environments


Done?
Yes, compiling now...
It's done, need to test & deploy!
Just a small bug will fix it!
It's done! I think the file is corrupted!
It's done! need to configure...
The customer says it's not working...
But, it works on my machine!

OS Survey

- How many of you use:

Windows ?

MacOS ?

Linux ?

Tools

- Vagrant (portable dev environments)
  - https://www.vagrantup.com/
- VirtualBox (virtualize an OS)
  - https://www.virtualbox.org/
- OpenSSH (use remote servers)
  - https://www.openssh.com/
- Notepad++ *(text editor)*
  - https://notepad-plus-plus.org/
- Cmder *(terminal emulator)*
  - https://cmder.net/
- Git *(Version Control System)*
  - https://git-scm.com/

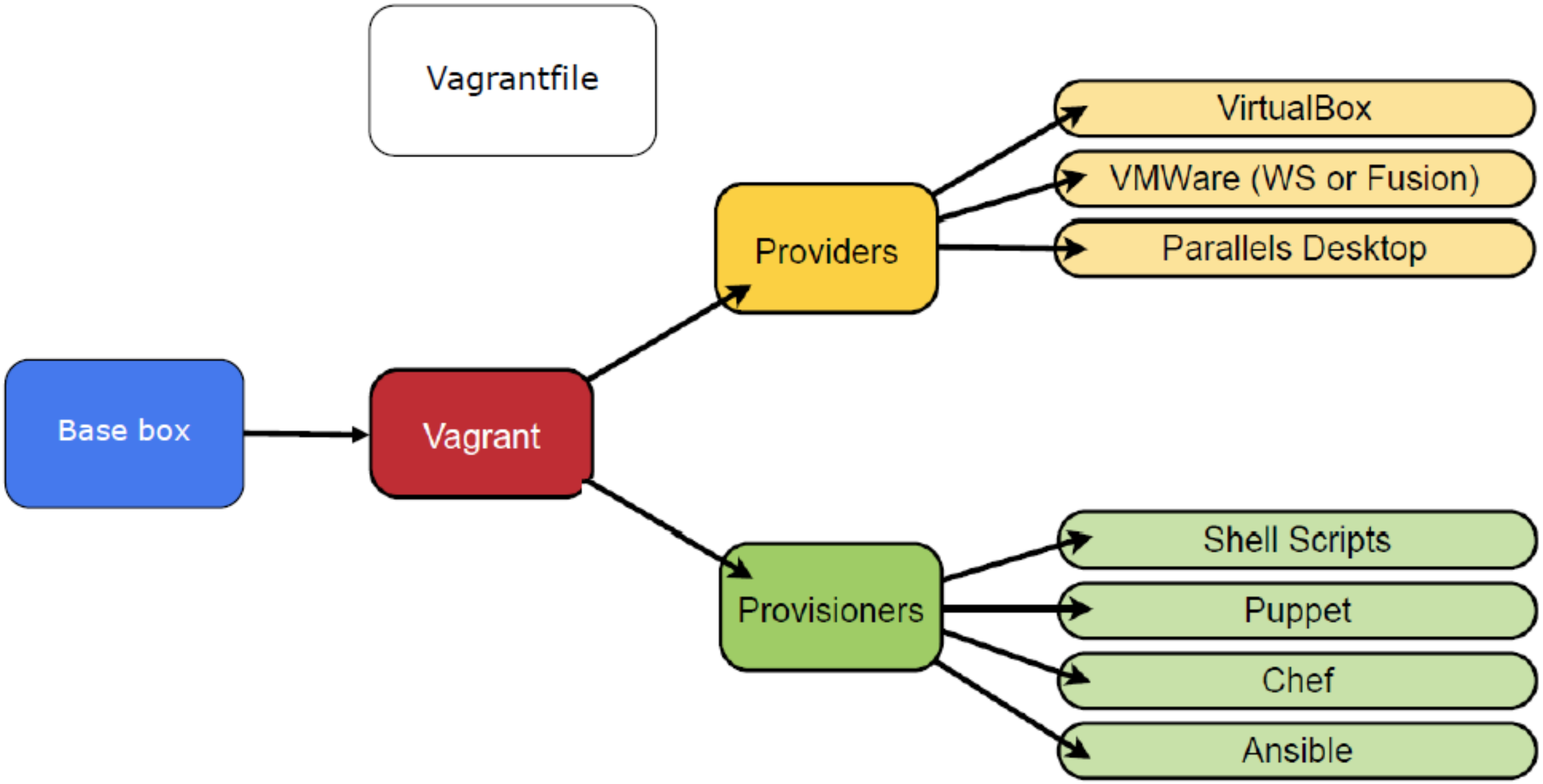
Exercise 1 – Install required tools

- **Time:** ~20 minutes
  - *Try by yourself then Check, Verify, Ask*

- **Description:**
  - Properly install all the mentioned tools or ensure to have an alternative on your machine. Required for all:
    - Vagrant
    - VirtualBox

- **Instructions:**
  - https://gitlab.fbk.eu/dsantoro/fcc-lab-2022/-/tree/master/e01

Vagrant HowTo 1/2



Vagrant HowTo 2/2

- `vagrant help`
  - Get info on all commands
- `vagrant COMMAND -h`
  - Get help for COMMAND
- `vagrant init [box]`
  - Create a Vagrantfile
- `vagrant up`
  - Create and provision the VM
- `vagrant provision`
  - Only provision the VM
- `vagrant ssh`
  - Enter the VM via SSH
- `vagrant status`
  - Get VM status
- `vagrant global-status`
  - Get all VM status
- `vagrant plugin list`
  - List all plugins
- `vagrant box list`
  - List all boxes

Exercise 2 – Start and Check your 1st Environment

- **Time:** ~30 minutes
  - *Try by yourself then Check, Verify, Ask*

- **Description:**
  - Start to provision a Virtual Machine using Vagrant. Look at the log file and follow steps specified in the provision script. Once ready connect with the Virtual Machine. Finally try using an external provisioning script and explore connection details.

- **Instructions:**
  - https://gitlab.fbk.eu/dsantoro/fcc-lab-2022/-/tree/master/e02

Exercise 3 – Customise and Share the Environment

- **Time:** ~20 minutes
  - *Try by yourself then Check, Verify, Ask*

- **Description:**
  - Destroy the previous Virtual Machine. Modify the provisioning script and create a customized new Virtual Machine. Share the environment with your teammate (different OS preferred) and test if the environment is portable as expected.

- **Instructions:**
  - https://gitlab.fbk.eu/dsantoro/fcc-lab-2022/-/tree/master/e03