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A blueprint for the new research instrument

Damien Saucez

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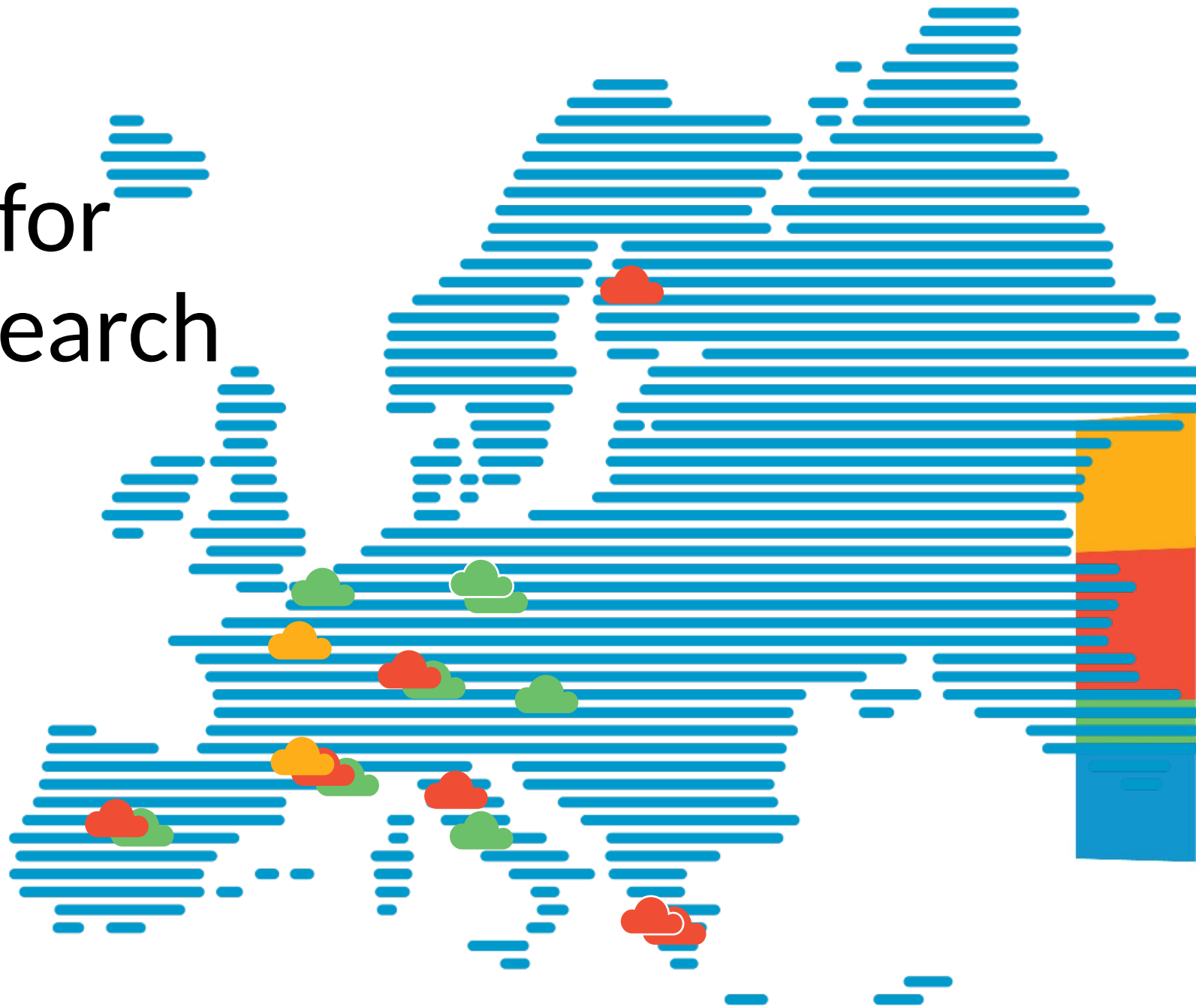
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A blueprint for the new research instrument

Damien Saucez, Inria

01/29/2024



core



edge



RAN

The blueprint concept in a nutshell

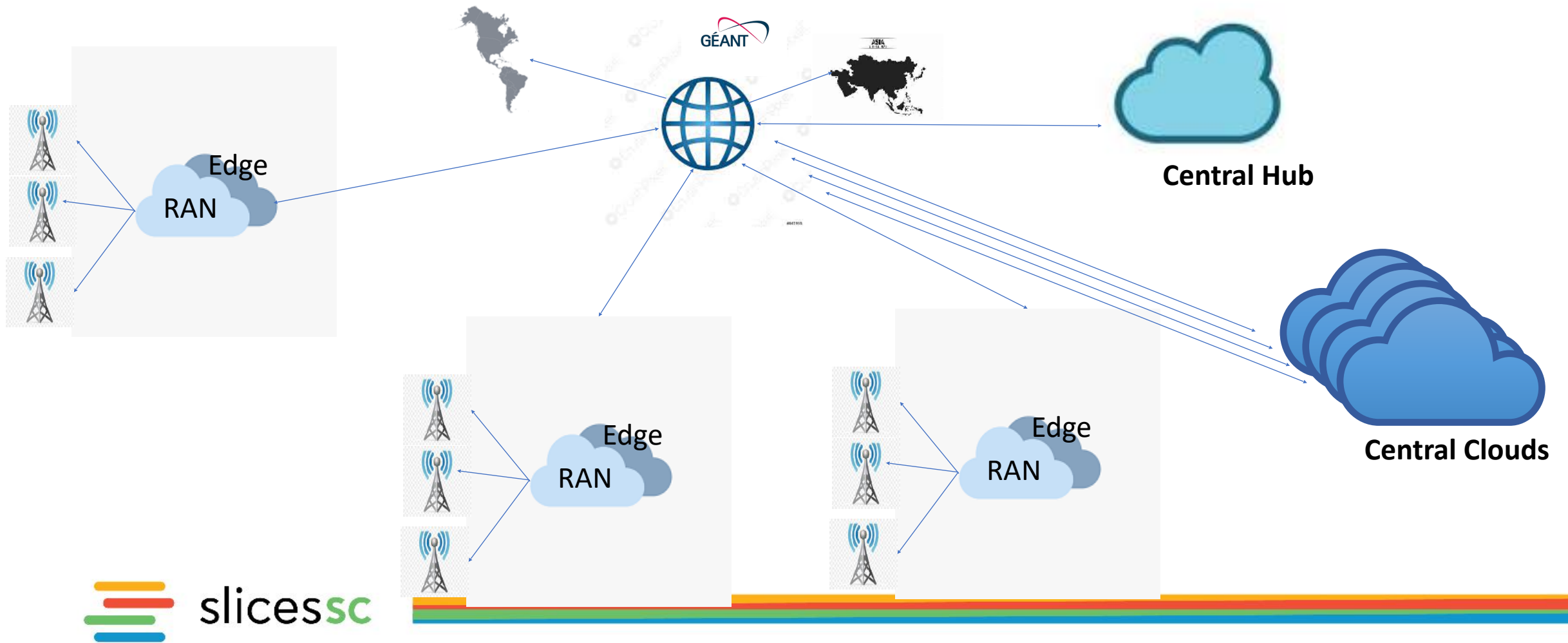
- Help collaboration between engineers and non-engineers to work together on developing applications.
- Define a common terminology that doesn't require in-depth, technical knowledge
 - to produce consistent vision on the application with a focus on the future objective.
- Pick up the right resources, be iterative, review and validate, and keep it as a baseline.
- Adapted from [0a, 0b]



[0a] <https://dev.to/jayjayjpg/what-is-a-software-blueprint-5388>

[0b] <https://www.qrpinternational.fr/blog/faq/blueprint-quest-ce-que-cest/>

A post-5G research infrastructure



What for?

- Vertical service integration and testing (e.g., LiDAR)
- Software Defined Networking (e.g., xAPP)
- Radio/network development software (e.g., custom PHY)
- Low-level access to radio resources (e.g., THz)
- Joint use of post-5G infrastructure and HPC resources (e.g., digital twin, code generation, fuzzing)

What for?

- Vertical service integration and testing (e.g., LiDAR)

Repeatability (Same team, same experimental setup)

Reproducibility (Different team, same experimental setup)

Replicability (Different team, different experimental setup)

Documented and with reference implementation

- Concepts fully documented
- Reference implementation:
 - Terraform (AWS/GCP/OpenStack) + Ansible for deployments
 - k8s
 - OAI
- Software and/or hardware
 - USRP/AW2S
 - Tofino/Tofino2 with SD-Fabric
- **Complete documentation and SLICES academy integration**



Documented and with reference

SLICES-RI blueprint

SLICES-RI is defined as a specific instrument to support the discovery process related to the future emerging digital infrastructures. It is a partnership between the EU and the member states, on the GCR4¹ (bootstrap since 2021).

SLICES enables fragmentation and achieves critical mass by bringing together research communities related to network protocols, radio technologies, data collection, protocol and software computing and especially cloud-edge based computing and resource utilization.

SLICES is a flexible platform designed to support, especially, experimental research focused on a domain related to digital infrastructures [1].

As opposed to other initiatives within the SLICES ecosystem with a leading timeline until 2026:

The SLICES program focuses on being the same to use and build on existing infrastructure (plan for the long-term development of SLICES-RI).

In this program we propose to make the infrastructure based on a generalizable and reusable implementation, which aims at being a base on the specific of the program, but it is flexible and modular to adapt to the needs of the users of the program. The research results to be shared by the SLICES program will be provided by the SLICES ecosystem that will be supported by the SLICES ecosystem (research and deployment strategy) that will start in 2026.

The SLICES-RI program includes a multi-level (technical, functional, and social) model and a social model for the ecosystem for both user and community.

References

- [1] [https://www.slices.eu/ri/](#)
- [2] [https://www.slices.eu/ri/](#), extended comments to 2025.
- [3] Sergio P. P. de Araujo, Marcos Pereira, Sotiris Nikas, A. K. Katsipis, M. E. P. Pereira, C. A. Oliveira, C. R. E. Ochoa, A. J. S. Mendes, T. M. de Melo, R. A. S. Neves, S. C. S. Neves, A. S. Neves, Instituto Federal de Educacao, Ciencia e Tecnologia, Fortaleza, Brazil, 2023, Paper 188-203.

Concept and philosophy

- The SLICES-RI concept is a multi-level concept.
- Objectives to be achieved by the SLICES-RI ecosystem
 - Type 1 studies: Network service innovation and testing
 - Type 2 studies: Software Defined Networking
 - Type 3 studies: Low level development on resources
 - Type 4 studies: Novel Research
 - Type 5 studies: cross-layered and resources
- Research goals research
- Software

5G blueprint

The 5G blueprint provides a set of standards, software, hardware, and methodology to make experimental research with 5G (network 5G) environments more precisely with the 5G blueprint, all is oriented to deploy a high performance, scalable multi-tenant 5G network with cloud-native-deployed 5G core serving up to 20k and run experimental research on it.

In details

- 5G blueprint
 - 5G architecture
 - 5G Core Network
 - Open RAN systems
 - Hardware
 - User Plane Components
 - Software UPF
 - Hardware UPF
 - Network Management
 - Core RAN operation
 - Schedulers
 - Data analytics
 - Research network backbone
 - Public Internet
 - Mobile service application

... must be used to connect the RI to the EU. Actually, to guarantee

... the switches need to support the implementation via PDP [14]

... agree on the mechanism that will be used by the RI, they would become more specific.

Files

- develop
- Go to file
- development
- Automation
- SONIC
- docs
- edge-core
- intel_connectivity_research_progr...
- k8s
- oel5g
- sopnode
- DHCP
- ether
- ansible
 - collections
 - files/chassis_config
 - inventories
 - misc/ssh
 - roles
 - 5g
 - authentication
 - certificate
 - common
 - container
 - openstack/omnilinks
 - fabric-switch
 - ha
 - k8s-cc-certificates/keys

SLICES / ansible / ansible

This repository provides Ansible playbooks and roles to automate the deployment of a Fabric-TNA environment on SophiaNode

Setup automation environment

We use Ansible to deploy the different services on the SophiaNode infrastructure. The playbooks require Ansible 2.13 or higher (we tested them on Ansible 2.13.2). The present section presents instructions on how to setup the environment on GNU/Linux Ubuntu 20.04.

To interact with the infrastructure we rely on `ansible.posix`, `community.kubernetes`, `cloud.common`, `kubernetes.core`, `community.crypto`, `community.general`, `community.docker`, and `netbox.netbox` collections that can be installed with `ansible-galaxy`:

```
ansible-galaxy install -r collections/requirements.yml
```

To allow non-interactive ssh password authentication we rely on `sshpass` that can be installed as follows:

```
sudo apt install sshpass
```

To interact with Netbox inventory, `netaddr`, `pyntbox`, `PyYAML`, and `requests` are required. They can be installed with pip as follow:

```
pip3 install -r requirements.txt
```

Deploy the services on SophiaNode

Ansible uses inventories to determine on which hosts to execute its tasks. Our inventories are provided in the `inventories` directory.

The inventories are composed of the following groups:

- `controllers`: group all the hosts that will run the SDN controller.
- `computes`: group all the compute nodes managed by the k8s cluster.
- `switches`: group all the switches.

deployment

SLICES Academy | Scientific Learning

Scientific Learning Infrastructure for European Communication Experimental Studies

SLICES RI

SLICES Academy

Training Events

Webinars

theNetworkingChannel

MOCs

Code Repository

Filter Courses by Category: all

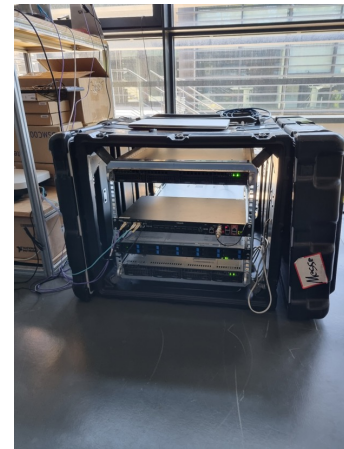
Sort by: default asc

- Distributed post-5G Network (FREE)
- OpenDaylight at 5G (FREE)
- Quick overview of the post-5G network (FREE)
- Running OpenWiFi on a testbed (FREE)

- Sof
- Cor

Lessons learned – Diversity (1/2)

- On-prem
 - Core + HW RAN @ Eurecom
 - Core + HW RAN @ Inria Sophia
 - Core/RAN split
 - Local 200Gbps fiber: Core @ Inria Sophia / HW RAN @ Eurecom
 - International dedicated VLAN 1Gbps/10ms: Core @ imec / RAN @ Inria Sophia
 - Commercial Internet:
 - Core @ Sorbonne Université / RAN @ UTH
 - Core @ Sorbonne Université / RAN @ Inria Sophia
 - Split 7.2 Core + RAN @ Inria Sophia
- Public cloud aided
 - Core by Inria @ GCP / HW RAN @ Eurecom
 - Core by Inria @ GCP / HW RAN @ UTH
 - Core @ CNR / RAN by Inria @ GCP
- In testbeds
 - Summer school in TUM testbed, Virtual Wall



Lessons learned – Diversity (2/2)

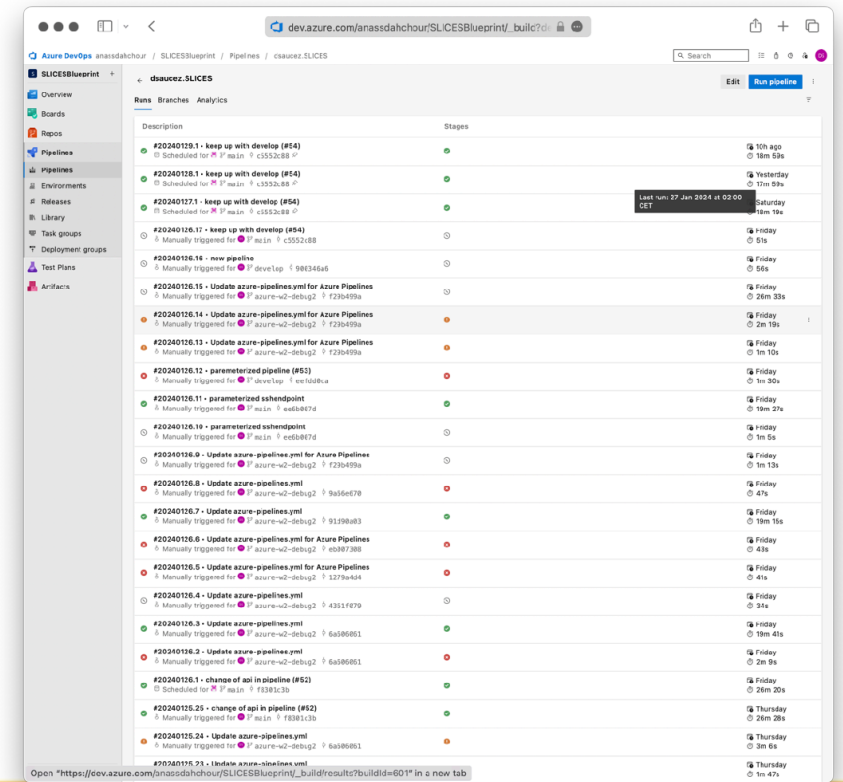
- Network interconnect
 - Commercial Internet accessible
 - Dedicated links
 - VPN service
- Identification / Authentication
 - Users based on the light federation from SLICES (OIDC) is ok
 - PKIs... how to unify certificates
- People test first in virtual environments (**must support VM**)

Lessons learned – HW is a real constraint

- O-RAN Open FHI in OpenAirInterface
- Optimized for Intel-based x86-64 (e.g., AVX512)
 - How to move to AMD and ARM?
- Complexity in network infrastructure
 - Raw Ethernet
 - Usually 3 VLAN (need sr-iov): management, control/user plane
 - PTP distribution and PTP HW time stamping on NICs

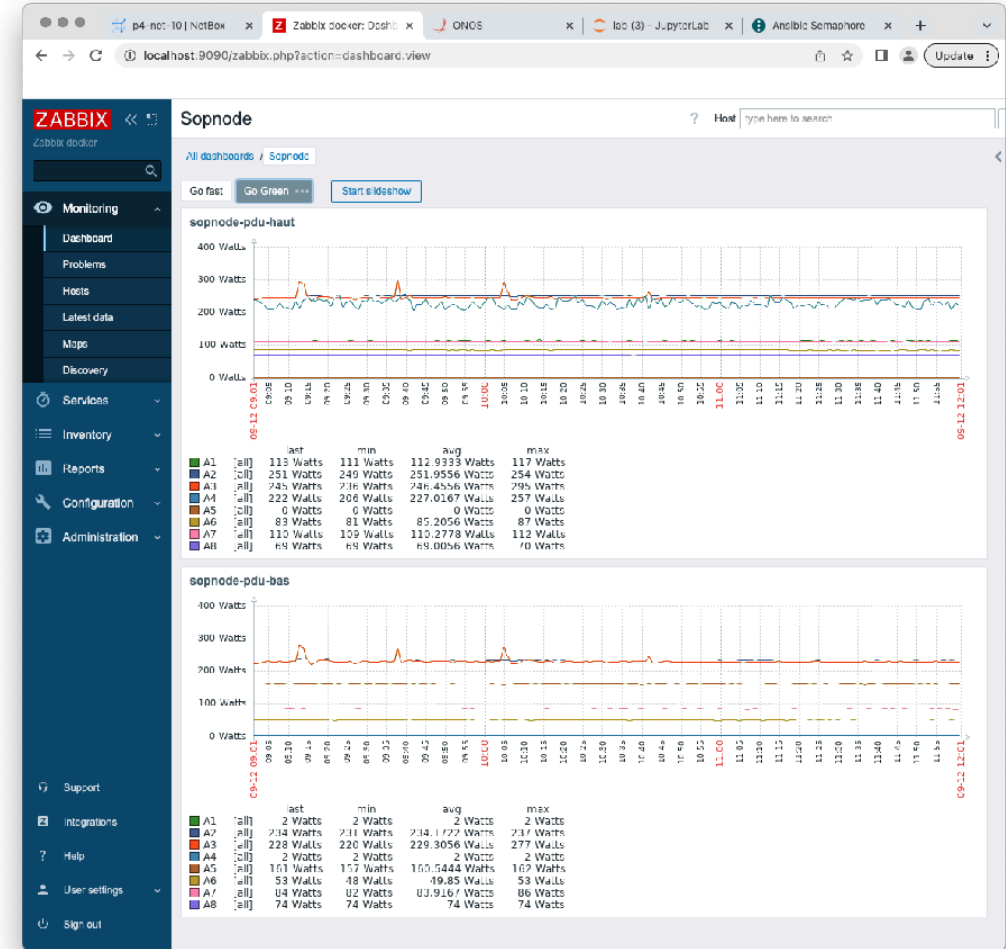
Lessons learned – Doomed by dependencies

- Strong dependency with independent open source projects
 - all with their own agenda
 - dependencies brake frequently
 - freeze versions whenever possible
 - document dependency graph
 - test, test, test



Lessons learned – Monitoring is key

- Passive measurement is hard (e.g., P4, snmp)
- Active measurement is impossible (e.g., LLDP, CPU load)
- **What is really needed?**



Roadmap (->2024)

- Seed ->| 06/2022
- PoC ->| 06/2023
- First deployments ->| 12/2023
- Pre-operation ->| 06/2024

Roadmap (->2024)

- Seed -> | 06/2022
- PoC -> | 06/2023
- First deployments -> | 12/2023

Get involved with our next hackathon!

