# The LF Energy SEAPATH project, Easier Operations in Electrical Substations through Digital Twin Empowerment

FOSDEM 2024 – February 3, 2024

Paul Le Guen de Kerneizon – Embedded software engineer

paul.leguendekerneizon@savoirfairelinux.com

Savoir-faire Linux is a team of experts in in Free, Libre and Open Source technologies in Canada and Europe.

23+

years in industrial product engineering in many areas

**LF ENERGY**

GENERAL MEMBER

THE LINUX FOUNDATION
SILVER MEMBER

Rte Le réseau de transport d'électricité
SUPPLIER TROPHY
2 EDITION
**2022**
Industrial Competitiveness and Excellence

yocto PROJECT
SILVER MEMBER

Software Enabled Automation Platform and Artifacts THerein
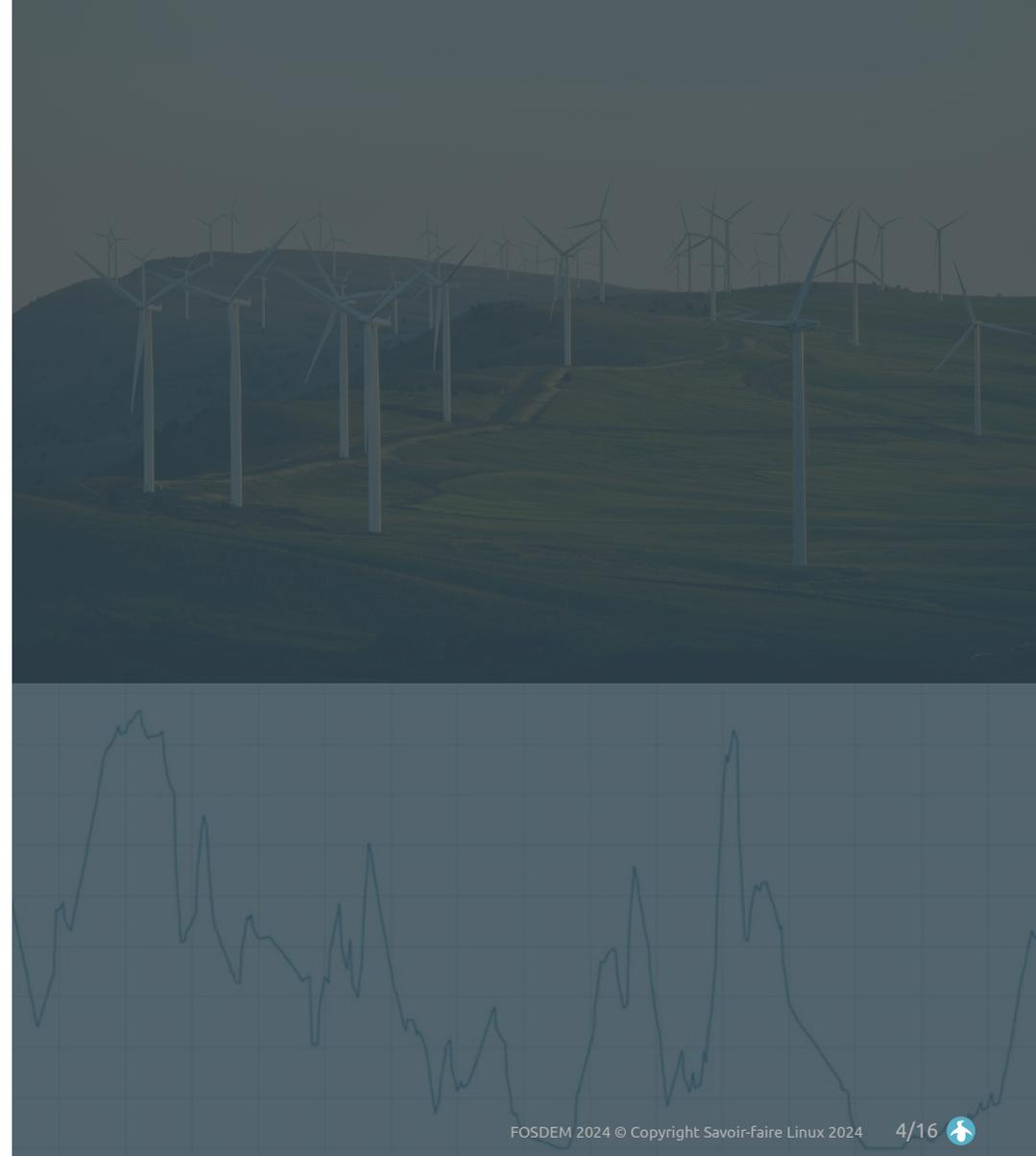
# Context

Energy Transition drives change in power transmission and distribution grids

- Distributed renewable energy sources

- Electric mobility

Need to swiftly adapt grid control architectures

- Multiplication of distributed controls

- Increased data management needs
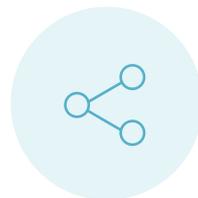
# A quick reminder of the aim of Seapath

## Develop

a **reference design** and **industrial grade** open source real-time platform

## Host

virtualized **automation and protection** applications

## Share

a platform between **multi-provider applications** (hardware agnostic)

## Combine

**performance** and **safety**

# For a deeper presentation of the Seapath project



https://archive.fosdem.org/2023/schedule/event/energy_seapath/

# Bring functional tests to the Seapath project

# Setting the scene: a simple case study

# Setting the scene: a simple case study



Protection algorithm

Virtual IED under test

SEAPATH cluster

Hardware In the Loop test

Generation of Sample Values (SV) in IEC61850 format

Sample values/goose

# Setting the scene: a simple case study

**So why functional tests ?**

Seapath in designed to work on critical infrastructure
- Protection of people and the infrastructure

In case of a failure, safety protection must react as soon as possible
- Need a low latency transit and process of IEC61850 sample values

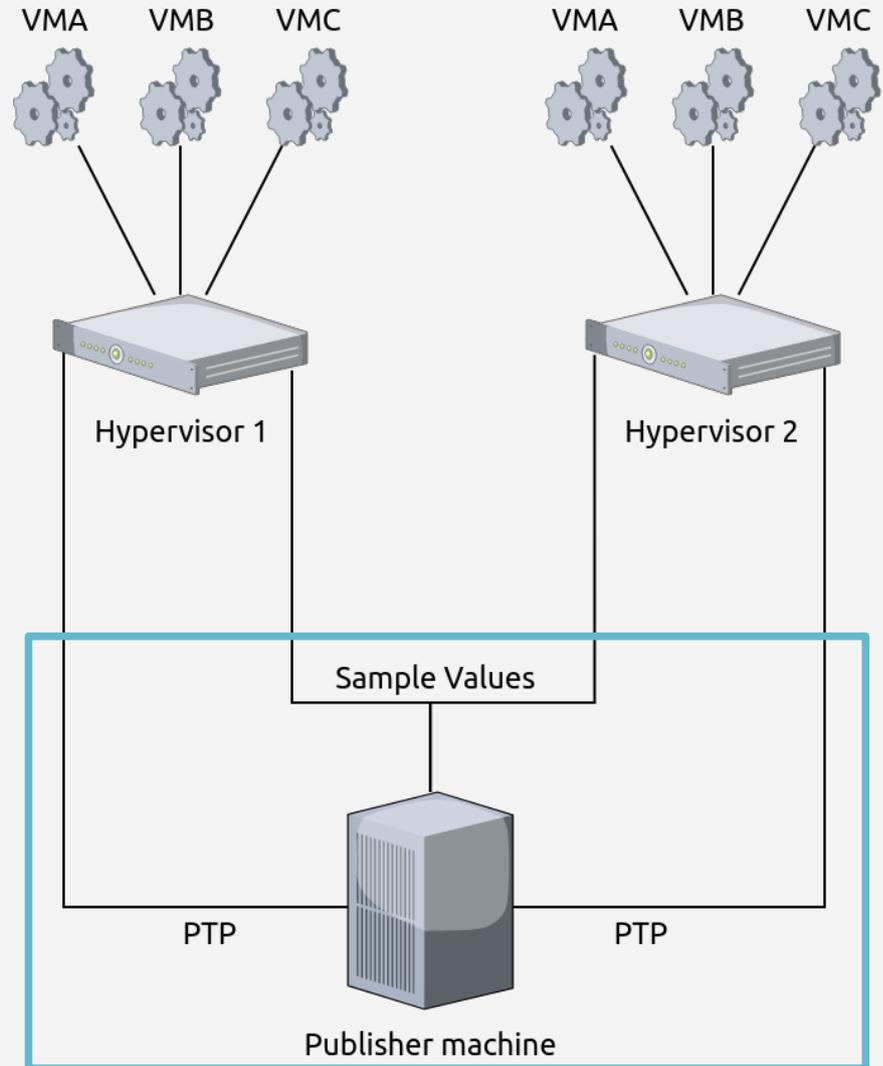At a global scale, system must be the most deterministic
- We have ensure our latencies are as low as possible, in a 24/7 context

**How can we simulate a protection chain in a laboratory context?**
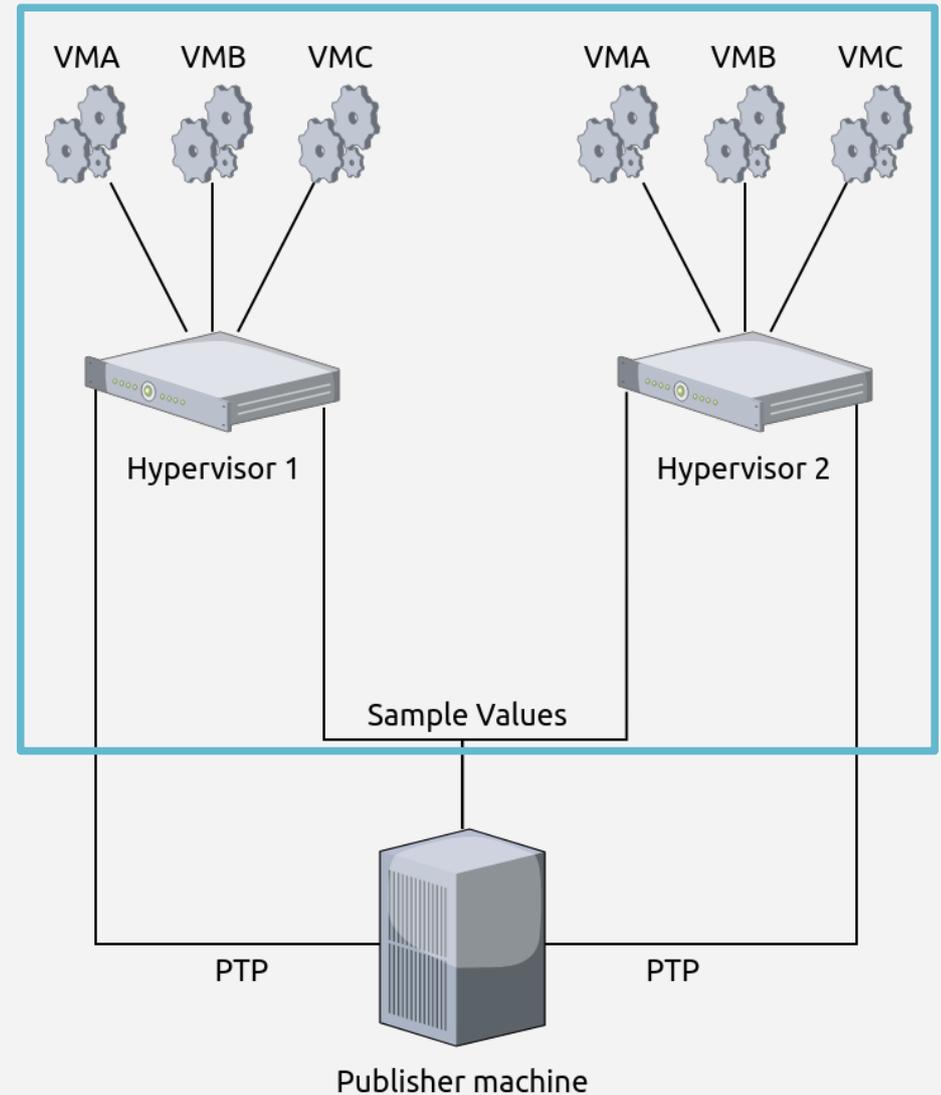
# Simulate protection chain in lab

**System overview**

- Publisher machine:

  - Generate and send IEC61850 sample values

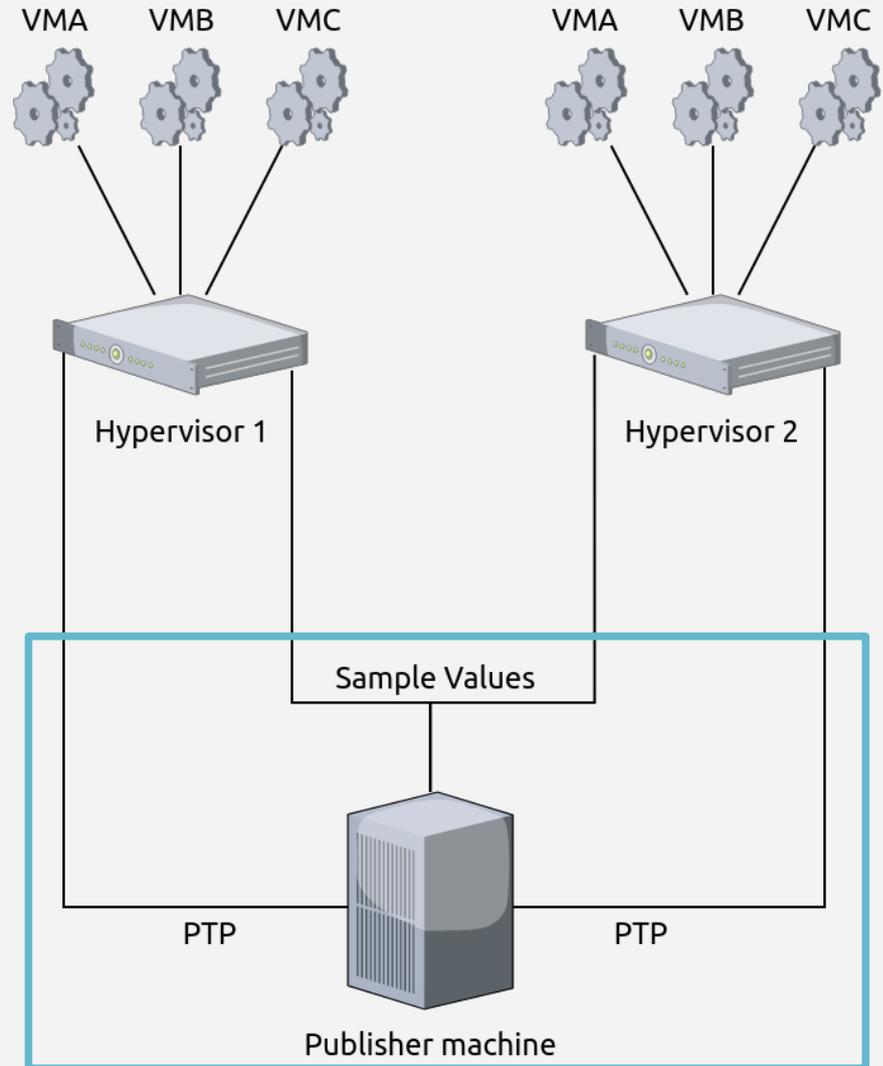# Simulate protection chain in lab

**System overview**

- Seapath cluster:
  - Hypervisors:
    - Host VMs, ensure redundancy
  - VMs:
    - Run SV client receiver and protection algorithm

# Simulate protection chain in lab
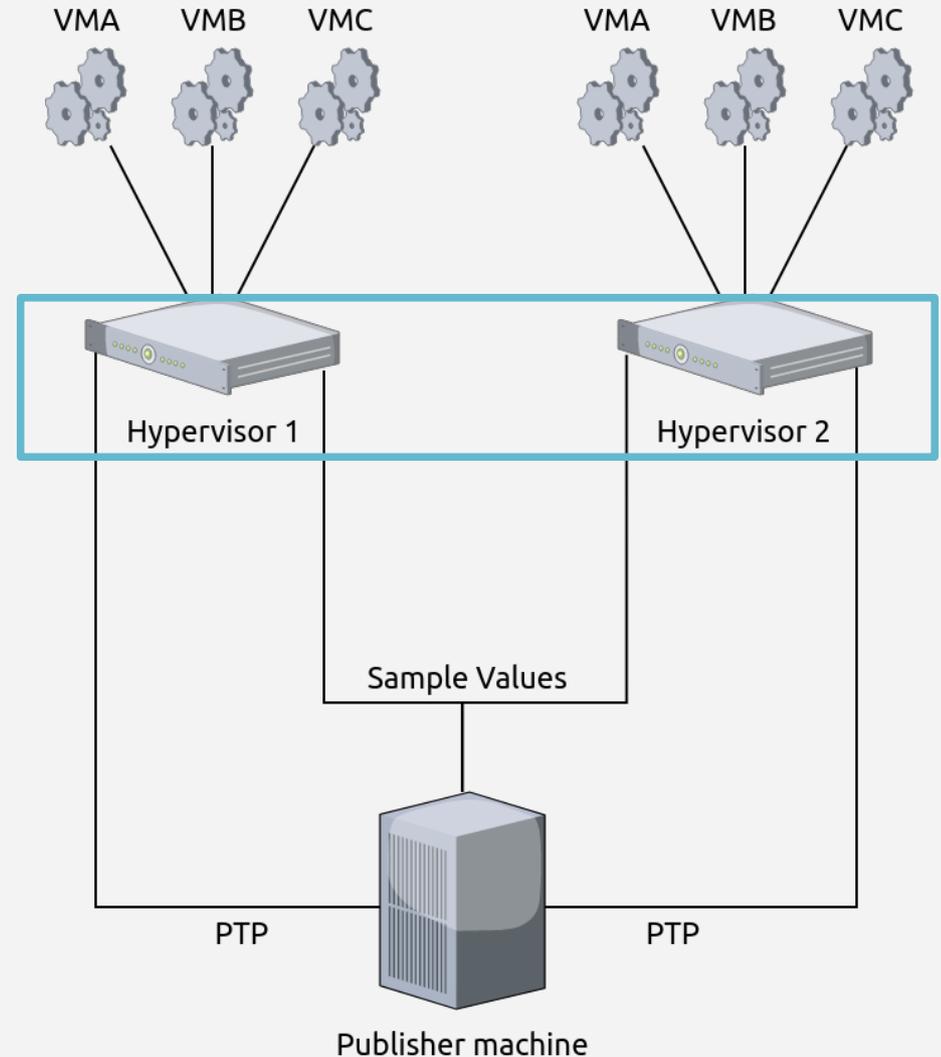
**Tools**

- Publisher machine:
  - First, generate PCAP sets of data
    - Simulate IEC61850 samples values
    - Ex: A 50Hz electrical signal
    - Replay them with tcpreplay or trafgen
    - Send PTP packets (software PTP)
  - PTP is required if you wish to use Seapath VMs migration
    - Used to synchronize VMs and hypervisor
    - No need for a grandmaster clock

# Simulate protection chain in lab

**Tools**

- SEAPATH cluster:
  - Hypervisors:
    - CPU core's isolation
      - Dedicate some core for the system and other for the VMs
      - IRQ and process isolation
    - Deal with process priority
    - BIOS optimization

# Simulate protection chain in lab

**Tools**

- SEAPATH cluster:
  - VMs:
    - Also CPU core's isolation for IRQs and process
    - Direct reception of SV with PCI pass-through
    - SRIOV can be used for better results but is optional
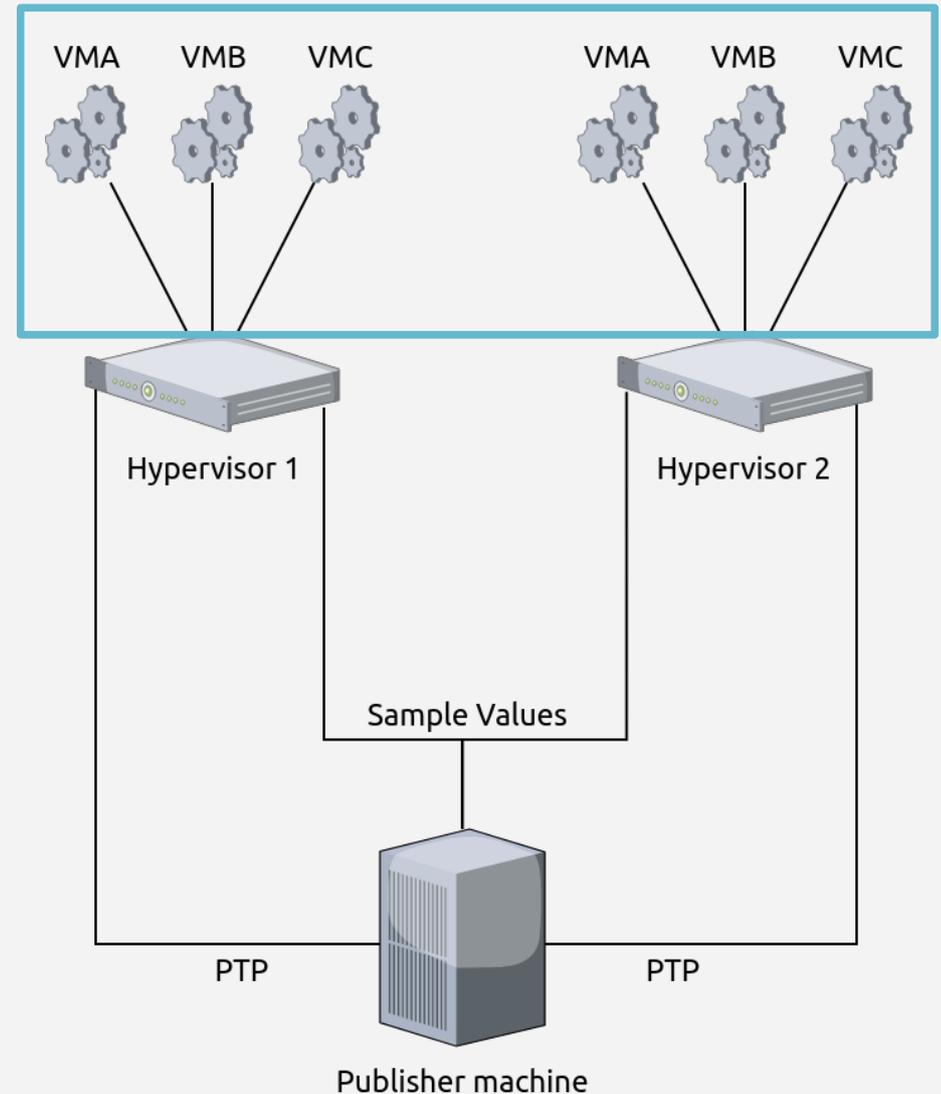
# Thank you for your attention

Savoir-faire LINUX®

LF ENERGY
SEAPATH

Paul Le Guen de Kerneizon

paul.leguendekerneizon@savoirfairelinux.com

https://savoirfairelinux.com/

contact@savoirfairelinux.com

https://lfenergy.org/projects/seapath/

https://github.com/seapath

https://wiki.lfenergy.org/display/SEAP/SEAPATH

https://lfenergy.slack.com  #seapath