

School of Engineering

ALSET Lab

A Laboratory for the Digital Power Grid of the Future

LEAD

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WHY DO WE LOVE RENEWABLE ENERGY SOURCES?

- They provide us energy security. No more oil needed!
- They provide us energy free of charge.
- They are clean. No CO₂!
- Small-scale sources are easy and quick to install.
- Having them close to us helps to have our own autonomous electric grid (aka, microgrid).



WHY ARE WE SCARED OF RENEWABLE ENERGY SOURCES?

- As an analogy, imagine the electric power grid as a water distribution network and the renewable energy sources as pumps injecting water to the network.
- What happens to the water distribution network if we all try to pump water into the network through the faucets at our home?
- Having unexpected uncontrolled water pressure might cause the pipes to rupture!
- Similar problems arise when renewable energy sources are added to the electric power grid.
- They cause unexpected variations in the parameters of the electric grid such as voltage, currents, frequency, etc.
- Leaving these variations uncontrolled causes severe damages to both the electric grid and the consumers.



HOW CAN WE SAFELY USE RENEWABLE ENERGY SOURCES?

We need to transform our current electric power grid to a “smart” grid that:

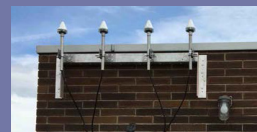
- Monitors and quantifies the impact of renewable energy sources on system parameters such as voltage and frequency.
- Takes appropriate control actions to keep the system parameters within the permissible ranges.
- Takes timely protective actions to protect the grid against possible faults.
- Has the flexibility to accommodate different types of renewable energy sources, while operating normally.
- Is equipped with all technologies and infrastructures required to realize the above-mentioned capabilities.



HOW DO WE HELP TO SAFELY INTEGRATE RENEWABLE ENERGY SOURCES?

- At ALSET, we develop tools to make the current electric power grid “smarter.” We have the required software and hardware platforms for building the tools.
- Development of a tool starts by coming up with an idea, expanding it by mathematical operations, and building the tool in an appropriate software/hardware platform.
- In addition, the built tool has to be fully tested to make sure it works under all different events happening in the electric power system.
- It is NOT possible to test the built tools in the real power system as it would require multiple interruptions on customers’ power supply.
- At ALSET, we have equipment to test the tools in virtual power systems.

WHAT IS ALSET MADE OF?



The four antennas mounted on top of the building provide signals from GPS satellites.



GPS signals from the antennas pass through surge protectors before entering the lab.

GPS signals coming from the surge protectors are fed to the substation clocks and GPS splitter.

A 48-port HP managed switch is the backbone of the communication layer.

SEL RTAC and protection relays that perform monitoring, control, and protection functions.

UPS feeding critical equipment such as the server.

SEL substation clocks and GPS splitter from GPSSource.

Main server with synchronized timing.

Phasor Data Concentrator from SEL.

Four OPAL-RT simulators each having 32 cores of parallel processing.

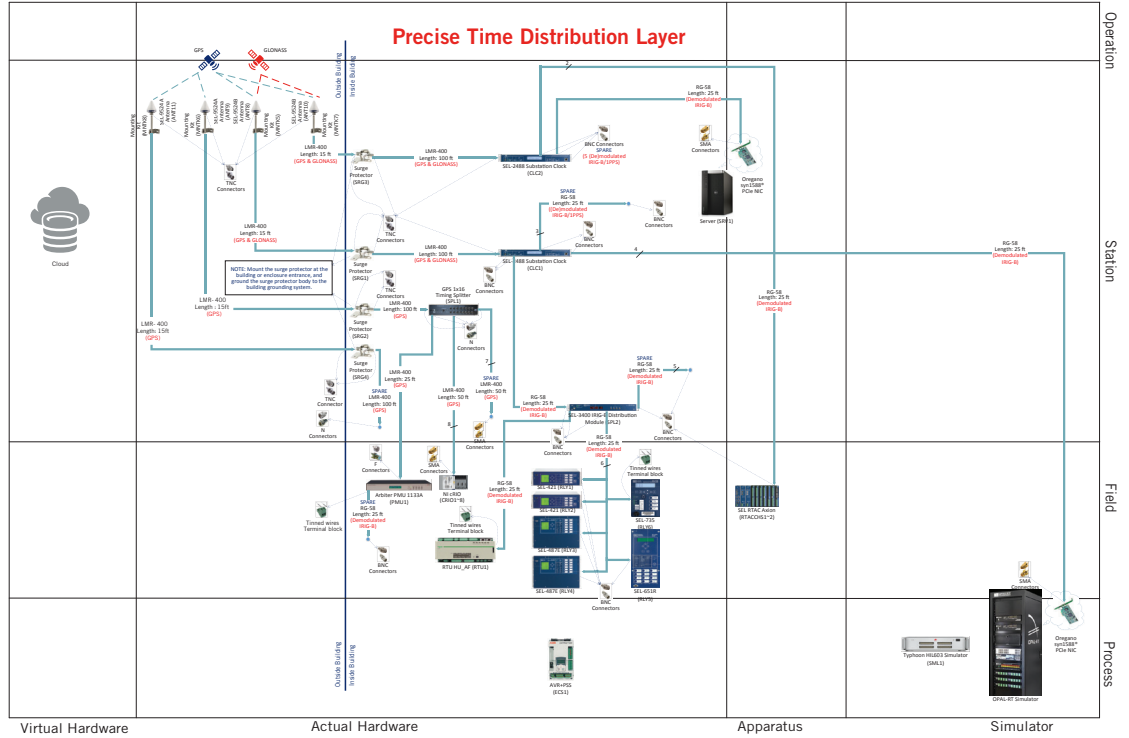




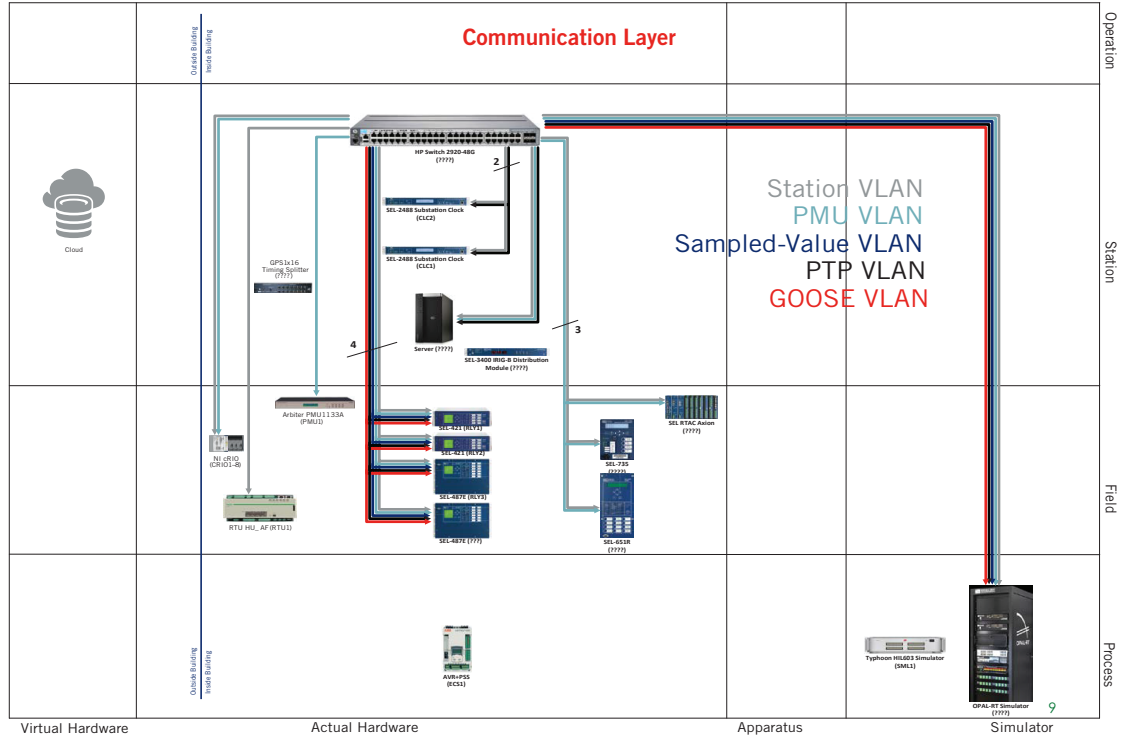
HOW DOES OUR EQUIPMENT CONNECT TO EACH OTHER?



This figure shows how the accurate time signal is routed through the equipment.



This figure shows how we manage our local area network. We have virtually divided Ethernet cable capacity into multiple pipes, each conveying particular information.



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