NATIONAL GRID ELECTRICITY TRANSMISSION AND GE VERNOVA COLLABORATE ON LF ENERGY SEAPATH TO ADVANCE VIRTUALIZED PROTECTION AND CONTROL

OVERVIEW

National Grid Electricity Transmission (NGET) and GE Vernova teamed up to evaluate the LF Energy SEAPATH project as a viable open source platform for deploying Virtualized Protection and Control (VPAC) in power systems. With digitalization reshaping the energy sector, the team sought to address the twin challenges of engineering resource scarcity and infrastructure scalability. By leveraging SEAPATH's real-time virtualization capabilities, the project delivered high performance, low-latency protection schemes, and proved the feasibility of a fully virtualized substation architecture. The initiative has not only accelerated development of the SEAPATH platform but also set the stage for broader adoption of open source virtualization in grid operations.

THE CHALLENGE

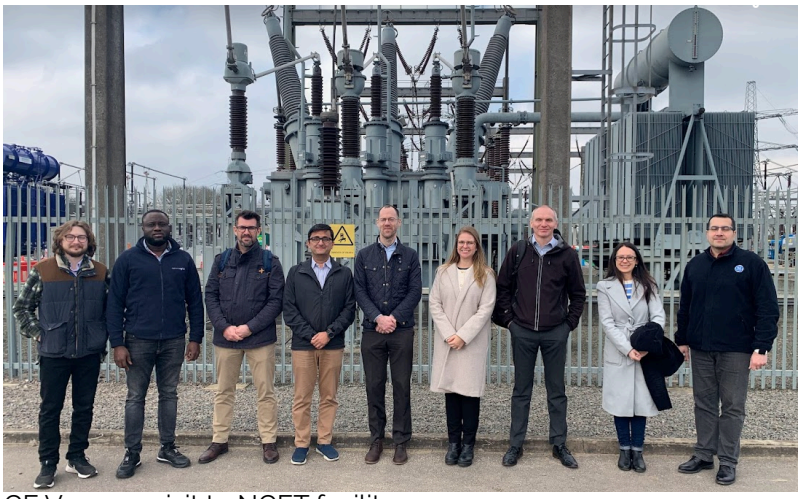
As demands on electricity grids increase, utilities like National Grid are transforming their infrastructure while managing resource constraints by leveraging automation and digitalisation for protection automation and control applications. VPAC offers a pathway to streamline operations and enhance lifecycle agility through:

- Faster deployment and maintenance cycles
- Simplified hardware replacement
- Enhanced scalability and remote management

However, implementing VPAC requires a platform that can deliver real-time performance and mission-critical reliability, something traditionally addressed by proprietary systems. The question was whether an open source solution like LF Energy SEAPATH could meet these rigorous demands.

THE SOLUTION

The collaboration began in late 2022, with NGET and GE Vernova initiating a proof-of-concept project using the LF Energy SEAPATH hypervisor and reference architecture. SEAPATH, which leverages a preemptive Linux kernel with KVM and QEMU, was optimized through extensive performance tuning to meet the demands of real-time substation protection.



GE Vernova visit to NGET facility

THE SOLUTION

Key innovations included:

- Latency Optimization: Achieved 4–5 ms round-trip latency for GOOSE message protection schemes.
- Determinism Enhancements: Techniques such as CPU isolation, IRQ offloading, and PCI passthrough ensure consistent and predictable performance.
- Hybrid Architecture: Combined virtual machines for strong application isolation with lightweight containers for scalable deployment of Virtual IEDs (VIEDs), enabling one VM to host over 25 Sampled Value (SV) streams without degradation.
- High Availability: Clustering and failover testing demonstrated robust redundancy and resiliency, including self-healing applications.
- Remote Management: Deployment, maintenance, and even injection testing were successfully executed remotely, highlighting significant operational savings.

These findings were validated at leading industry events such as CIGRE Paris 2024, LF Energy Summit Brussels 2024, and DISTRIBUTECH 2025.

RESULTS

Specific benefits included a step change in total cost of ownership through extensive reductions in OPEX and CAPEX, driven by lower cost for deployment, maintenance, patching, hardware and spare parts.

The project led to major contributions to the first official LF Energy SEAPATH release in early 2025 and validated the use of the GE Vernova EdgeOS Virtual Machine for real-time protection use cases.

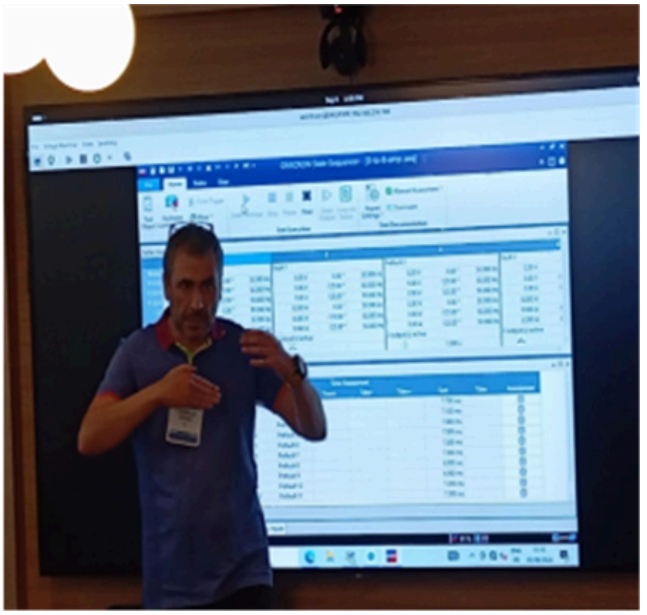
NEXT STEPS

Looking ahead, NGET and GE Vernova plan to:

- Expand the protection functionalities supported within the Virtual IED environment
- Improve scalability across both containerized applications and virtual machines
- Integrate advanced cybersecurity protections into the architecture

This initiative demonstrates how open source projects like LF Energy SEAPATH are not only viable for mission-critical energy applications, but also foundational to the digital transformation of grid infrastructure.

Demonstrations at LF Energy Summit



Learn more about **LF Energy SEAPATH**,