gridspertise

A new paradigm
for Electrical Utilities:

Edge Computing Virtualization Platforms

White Paper

Table of Contents

Introduction to Edge Computing Virtualization Platforms (ECVP)

An Edge computing Virtualization Platform combines two key technologies to optimize and streamline data processing, storage and management at the edge of a network: edge computing and virtualization.

- **Edge Computing**: involves processing data closer to its source or the point of collection, reducing latency and improving real-time decision-making. Edge computing brings computational power closer to devices or sensors, allowing faster analysis and action without sending data to centralized servers.
- **Virtualization**: It abstracts hardware resources and allows multiple virtual instances or environments to run on a single physical device. Virtualization separates software from the underlying hardware, enabling more efficient resource use, scalability and an easier management of applications and services.

The Edge Processing Virtualization Platform creates a unified environment where multiple functions, applications, or services can run on edge devices.

This convergence optimizes the use of resources, accelerates the deployment of new services, enhances security by isolating processes, and enables agile and adaptable infrastructure at the network edge.

These platforms play a crucial role in managing and analyzing data from diverse sources, like IoT devices, sensors, or smart grid components, by efficiently processing and managing the data closer to where it is generated.

This results in improved responsiveness, reduced network congestion, and a more effective use of edge resources for various applications and industries, including electrical utilities.

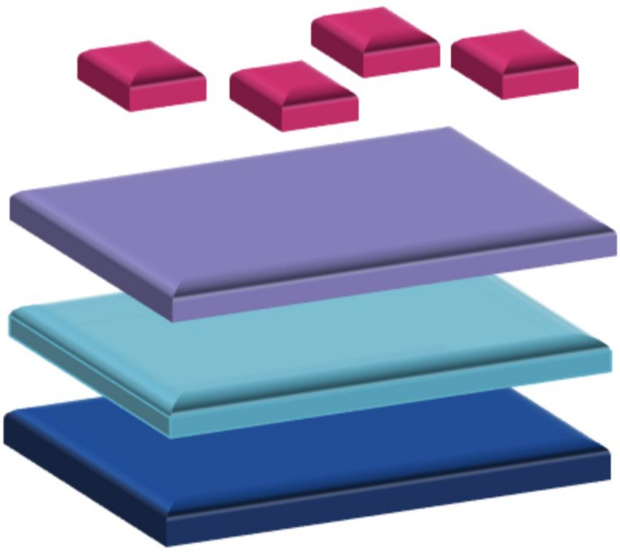
Virtualization concept

Virtualization, a groundbreaking technological concept, stands as a cornerstone in the evolution of smart grid devices for electrical utilities.

This innovative approach fundamentally reimagines the traditional hardware structure by creating multiple virtual instances within a singular physical device. By abstracting computing resources, including processors, storage, and networking, virtualization allows for the efficient use of hardware, empowering electrical utilities with unprecedented flexibility and adaptability.

In the context of smart grid devices, this technology plays a pivotal role in revolutionizing operational efficiency. It enables the consolidation of diverse functions and applications into a unified platform, facilitating seamless integration and enhanced performance. Through the creation of virtual environments, utilities can optimize resource allocation, leading to cost savings and improved scalability.

Moreover, the essence of virtualization lies in its ability to decouple software from the underlying hardware, thereby enabling simplified management, rapid deployment of updates, and the introduction of new services. This not only accelerates innovation but also enhances the overall reliability and resilience of the grid infrastructure.



- Business Applications
- Data Decoupling Layer
- Operating System
- Hardware Platform

From a security standpoint, virtualization enhances the defense mechanisms by segmenting critical processes, isolating potential vulnerabilities, and implementing robust access controls. This ensures a fortified defense against cyber threats, safeguarding the integrity and confidentiality of the grid's operations.

Virtualization represents a transformative force in smart grid technology, offering utilities a dynamic and adaptable framework.

Its implementation fosters a more agile, secure, and efficient infrastructure, enabling electrical utilities to navigate and excel in the dynamic landscape of modern energy distribution.

Virtualization benefits for Electrical Utilities

It is therefore clear that virtualization can provide numerous benefits for electrical utilities by improving reliability, flexibility, security, and cost-effectiveness of their infrastructure while achieving better operational efficiencies and gaining a competitive edge in a rapidly changing energy landscape.

Benefits	Description	Business Impact
Adapt and Update	Virtualization allows DSOs to quickly and easily add or remove virtual applications as needed to meet changing demand. This means that DSOs can scale down their infrastructure as needed without needing to invest in additional physical hardware.	Medium
Management & Maintenance	Virtualization can make it easier to manage and maintain IT/OT infrastructure by consolidating multiple physical servers into a single virtualized platform. This can reduce complexity and improve staff productivity.	High

Benefits	Description	Business Impact
Reduced installation footprint	Virtualization revolutionizes utility setups by consolidating functions into unified virtual environments, reducing the need for extensive physical devices and intricate wiring. This shift minimizes spatial requirements and simplifies inter-device connectivity, streamlining installation processes significantly.	Medium
Single Supplier	Choosing a single supplier for smart grid devices offers utilities a seamless integration process, ensuring uniform quality and performance across the grid. Maintenance becomes simpler with consistent support, potentially leading to cost savings through bulk purchases. This partnership also fosters tailored solutions and innovations aligned with the utility's needs.	Medium

Edge Computing concept

Edge Computing stands as a reliable ally, particularly when communication breakdowns between the central system (control centers, operation rooms, etc.) and field devices occur. This technology serves as a robust support system during isolations, ensuring that data processing and decision-making continue seamlessly even without direct connections to the central systems.

Picture a scenario where traditional communication channels falter, hindering the flow of information between the utility's nerve center and devices across the grid.

Edge Computing, like a local conductor, steps in to process data at the edge, allowing crucial operations to continue independently of the central system. This capability ensures that real-time data analysis and essential decision-making persist, even amid temporary disconnections from the central nerve center. It is a safety net that maintains operational continuity, even under adverse communication circumstances.

Moreover, Edge Computing is not just a safety measure; it is a catalyst for efficiency.

Its near-zero latency processing empowers utilities to respond swiftly to grid anomalies or fluctuations in demand without having to wait for data transmission to centralized systems. This agility ensures that operations continue harmoniously, just like conducting a symphony with perfect timing.

Furthermore, this technology harmonizes beautifully with cutting-edge advancements like Artificial Intelligence (AI) and Machine Learning (ML). The integration of AI or ML algorithms at the edge allows for predictive analytics, optimizing energy distribution and enhancing grid management. As an orchestra of innovative insights, enhancing operational efficiency and reliability.
Please find below a technology breakdown related for electrical utilities adoption:

Technology	Description	Cost-effectivness
Edge Computing	This model processes data at the edge of the network, reducing latency and empowering devices for faster, local computations, enhancing efficiency.	**High**
Fog Computing	Extending edge computing, fog computing inserts intermediary fog nodes between edge devices and central cloud servers, enabling more resources and complex tasks at the edge.	**Medium/Low**
Cloud Computing	Cloudlet computing introduces localized cloud servers (cloudlets) at the network's edge, bridging edge devices and remote clouds, providing enhanced computed power and lower latency.	**Low**

ECVP : more than a simple virtualization

While virtualization technologies can significantly enhance the operational efficiency of Electrical Utilities, their true impact emerges when applied to elements that usually operate independently.

For instance, consider the case of virtualizing interconnected devices like Protection relays and RTUs. Where is the paradigm shift in this scenario?

The true strength of Edge Computing Virtualization Platforms lies in their ability to break down barriers between unconnected devices, unlocking previously untapped potentials for utilities. Within virtualized environments, heterogeneous data becomes a focal point for exploration where previously segregated data domains now converge, presenting a mosaic of insights waiting to be unraveled.

This capacity for comprehensive data domain analysis is where the real power of virtualization resides.

It transcends conventional boundaries, enabling predictive maintenance, heightened operational efficiency and informed decision-making.

Please find below a short description of the most relevant use-cases addressed by ECVPs:

- **Dynamic Voltage level optimization**: voltage level on LV grid optimized based on near real-time data received from Smart Meters
- **Advanced Transformer monitoring**: accurate estimation of transformer wear-out based on actual environment parameters (temperature, humidity, etc)
- **Advanced Partial Discharge detection**: partial discharge detection based on electrical waveforms and ozone sensors.

Use-case	Data domains
Dynamic Voltage optimization	LV grid operation, Smart Metering
Transformer Monitoring	MV grid operation, Environment monitoring
Advanced Partial Discharge detection	MV grid operation, Environment monitoring

A new scenario: Developer Communities

Virtualization platforms are designed as multi-purpose environments in which several applications are intended to be run simultaneously. This results into the creation of a community of developers that collaborate sharing knowledge, resources and expertise to achieve a common goal and deliver a reliable final product.

Some of the most relevant benefits of that approach are:

- **Interoperability**: Interoperability within virtualization platforms is greatly enhanced through the utilization of open standards and protocols. This approach facilitates a seamless integration with prevailing IT/OT infrastructure and various open-source tools and platforms. The adoption of open standards ensures compatibility across different systems, allowing for smoother communication and data exchange between diverse components within the infrastructure. Furthermore, the reliance on open standards promotes flexibility and adaptability, as it empowers organizations to leverage a wider array of tools and platforms without encountering compatibility issues. Interoperability not only optimizes the performance of virtualization solutions but also lays the groundwork for future scalability and innovation.

- **Innovation**: An open methodology fosters an ecosystem where developers and contributors collaborate, leading to the enhancement and evolution of virtualization platforms.
This community-driven model stimulates accelerated innovation, introducing a multitude of novel features and advancements within these platforms.

- **Customization**: The inherent nature of an open virtualization platform facilitates a robust framework for users to modify, enhance, and expand functionalities, ensuring a bespoke fit for their individualized needs. Moreover, the flexibility of customization within an open virtualization platform liberates organizations from the constraints imposed by rigid, standardized solutions.
By providing the tools and mechanisms for customization and extension, these platforms enable a more agile response to evolving demands and technological advancements.

ECVP deployed pilots projects

Location: Spain
ECVP installed: 5 out of 170 planned
Use cases: Smart Meter management + Transformer monitoring + MV grid remote control + FLISR automation.

The devices, placed in some secondary substations in Seville by one of the most important local DSO, enable smart meter management as well as advanced transformer monitoring. Leveraging on advanced hardware component, the EVCP can act as data concentrator carrying out all the tasks with performances above the standards. At the same time, customer-designed FLISR has been implemented to ensure high-level SAIDI performance.

Location: Romania
ECVP installed: 3 out of 13 planned
Use cases: Smart Meter management + MV grid remote control + FLISR automation.

The devices, placed in some secondary substations in Bucharest by one of the most important local DSO, enable remote smart meters management as well as MV grid remote control. Next steps will be integration of FLISR automation with existing IEDs and MV SCADA.

Location: Italy
ECVP installed: 51
Use cases: remote metering management + Transformer monitoring + MV grid remote control + FLISR automation.

Most important DSO in Italy decided to heavily invest into ECVP to optimize maintenance-associated OPEX and get a future-ready installed base to tackle upcoming challenges of the grid. The implemented use-cases are related to Smart Meter management and MV remote control, with a seamless integration with central system (AMI and SCADA). Moreover, a super fast FLISR automation has been implemented achieving <1 sec supply restoration time: this huge result has been possible thanks to virtualized Router integrating MV Protections and virtual RTU.

A unified environment where multiple functions can run on edge devices

Gridspertise

Gridspertise offers grid intelligent devices, end-to-end cloud-edge platform solutions, and services to accelerate the digital transformation of electricity distribution grids across three main areas: metering and grid edge digitalization, network infrastructure digitalization, field operation digitalization.

The Company's portfolio is designed as an open ecosystem, easy to integrate with Distribution System Operators' existing infrastructure, combining intelligent and automated grid devices with ready-to-use modular applications, running at central level as well as on the edge.

The company was set-up in 2021 as a carve-out of Enel's twenty-year-long experience in developing, testing, and scaling up digital technologies to transform legacy distribution networks into smart grids.

Gridspertise is today jointly controlled by the Enel Group and the leading global alternative investment manager CVC Capital Partners.

Author

Damiano Bracci
Grid Solutions Marketing Manager