T&DWorld

EXECUTIVE SUMMARY

Powering the Way to a Decarbonized Future through Utilities Substation Modernization

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Russell Boyer, Global Energy Field Director, Utilities, Dell Technologies
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KEY TAKEAWAYS

- Changes in power grid architecture require a modernized infrastructure to maximize the utilization of renewables at the edge.
- Modernizing the grid consolidates workloads, providing more flexibility for current operations and adaptability for future requirements.
- Dell Technologies and VMware created an "intelligent hub" to lower capital and operation & maintenance (O&M) costs.
- Dell Technologies helps the utility industry accelerate the deployment of technology to meet the challenges of the energy transition.

Powering the Way to a Decarbonized Future through Utilities Substation Modernization

OVERVIEW

Power grid architecture is changing. The incorporation of an ever-increasing volume of distributed energy resources (DER) into the grid and the bidirectional flow of electricity require a more flexible, data-driven substation architecture.

To optimize performance as part of their commitment to accelerating the energy transition and advancing decarbonization of electric utilities, Dell Technologies and Intel Corporation have partnered to create the "intelligent hub" substation using VMware virtualization technologies on a common substation server platform.

The Intel-powered, Dell PowerEdge XR12 server with VMware ESXi virtualization capabilities is certified compliant with the global power industry IEC 61850-3 substation operating standard, bringing modernized security, flexibility, and performance to the power grid.

CONTEXT

Prithpal Khajuria shared the challenges facing the power grid today and described four key pillars for grid modernization to address those challenges. Russell Boyer explained the benefits of Dell's XR12 server for substation modernization, and Kangwarn Chinthammit discussed how virtualization plays a critical role in lowering capital and operation and management costs.

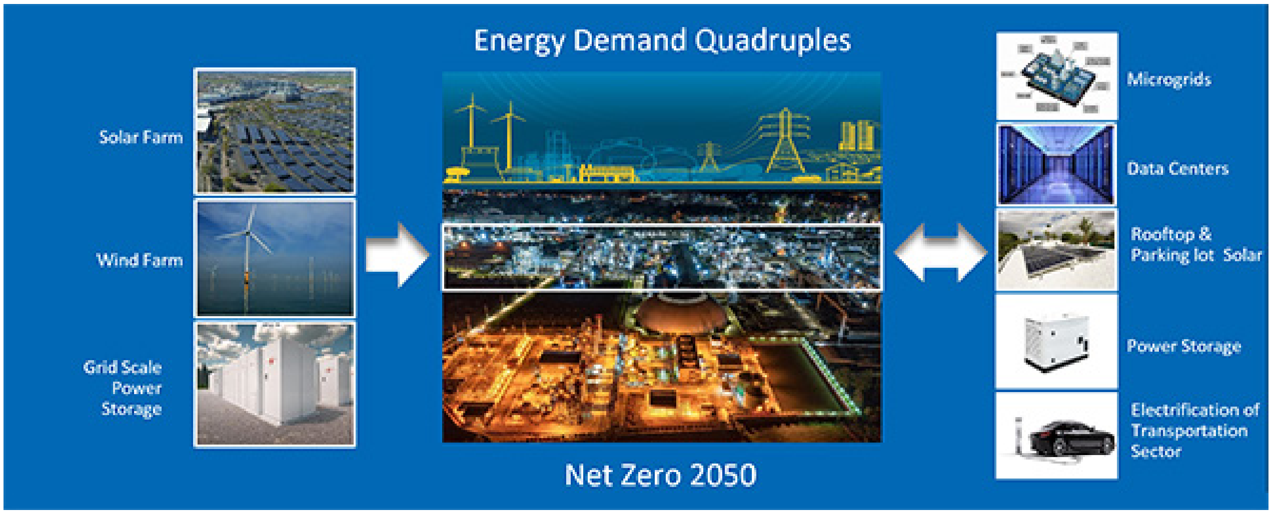
KEY TAKEAWAYS

Changes in power grid architecture require a modernized infrastructure to maximize the utilization of renewables at the edge.

Currently in the power sector, distributed energy resources coming in at the edge of the grid are disrupting the entire industry. Grid architecture is moving from the traditional centralized generation to bidirectional, distributed generation in which the electricity can flow from the edge of the grid. For every renewable energy unit coming into the grid, instability will increase by at least a three-fold factor. As more DERs are added into the grid, the instabilities are going to create more probes such as voltage, frequency, and power factor issues, while traditional technologies used to manage the grid will not be able to address these new challenges.

Instead, seamlessly integrating all renewables into the grid to allow all connected infrastructure to talk to each other will maximize the utilization of renewables at every level and allow net-zero goals to be met by 2050.

Figure 1: How DERs are driving the need for power grid change



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Modernizing the following four pillars are key to providing this solution:

1. **Infrastructure.** Build an intelligent edge inside the substations for analyzing data, resulting in greater visibility and insight, and faster decision making.
2. **Cybersecurity.** As systems become even more distributed, it will be critical to have an infrastructure in which security technologies can be seamlessly upgraded as they continuously evolve.
3. **Deployment.** Build capabilities so that new applications can be deployed centrally from the utilities control center.
4. **Asset health management.** Push software technologies toward the edge to be able to analyze, get results, and take action immediately at the edge.

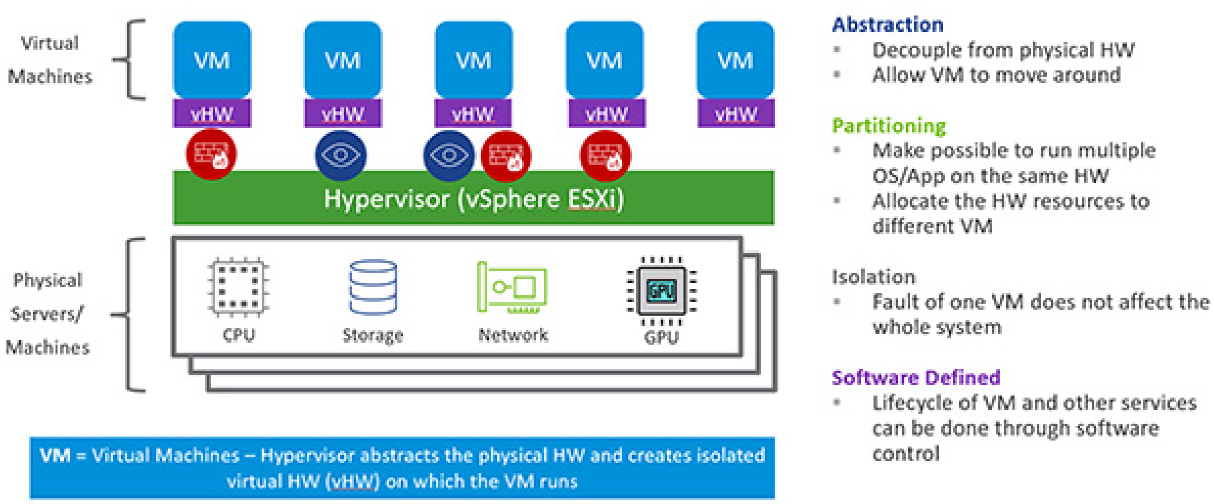
Modernizing the grid consolidates workloads, providing more flexibility for current operations and adaptability for future requirements.

Current substation architecture is siloed, with most of the hardware and software serving a single, specific—and, in many cases, proprietary—function. Many of these communications are serial connections directly to the managed devices, which creates challenges to flexibility and innovation, because in many cases, a more expensive "truck-roll" is required to go out to maintain and upgrade components.

In a modernized digital substation architecture, various workloads are consolidated using virtualization onto a standardized computing platform, allowing for multiple vendor applications on the same platform. Consolidation also reduces the footprint, as it replaces serial communication with enhanced communication protocols.

> The goal here is to have a single platform that is consistent, not only in the data center, but also in the substation, and that can run your real-time and non-real-time workloads, containerized or as just a regular virtual machine workload.
>
> *Kangwarn Chinthammit, VMware*

Figure 2: How virtualization consolidates multiple physical machines into fewer hardware resources



Virtualization utilizes software to represent hardware through virtual machines. Hypervisors such as VMware's vSphere ESXi host multiple virtual machines on a single server. Those virtual machines, complete with their own CPU, memory, storage, and networking, can run applications separately, as though they were disparate pieces of hardware. The hypervisor is able to allocate the right level of resources for each virtual machine, depending on the applications being run (e.g., HMI/SCADA versus protection applications have different needs in terms of processing power, which is managed accordingly by the hypervisor).

Because virtual machines are essentially software, when upgrading an application, users are able to take a snapshot of the state of the machine before deploying an upgrade. If anything goes wrong, the snapshot can be used to quickly revert to the previous state. Virtualizing infrastructure brings control of the virtual machine lifecycle into a consolidated web UI or API for remote management, with no additional physical appliance installation required.

Virtual intelligent electronic devices (IEDs) can be delivered with a virtualization platform such as the ESXi without sacrificing latency. Whether installed on the same hardware alongside non-real-time applications or on a different box, the standardization of the platform across the grid supports the same low latency guarantee and deterministic latency of IEDs today.

In addition, servers can be clustered to meet requirements for isolation automation and protection and control from one another. Digitalizing the substation allows for separation and isolation of processes (e.g., one cluster of servers running automation workloads and another cluster running protection and control workloads).

> For this energy transition, [utilities are realizing that] they're going to have to make a significant amount of investment, and it's going to exceed their capabilities as far as amount of labor, time, capital, etc., in order to modernize a lot of these architectures in the substation. What Dell has been trying to do is come up with an innovative approach on how we can help utilities to innovate that architecture, and accelerate deployment and adoption.
>
> *Russell Boyer, Dell Technologies*

Figure 3: Benefits of software-defined virtualization in the substation

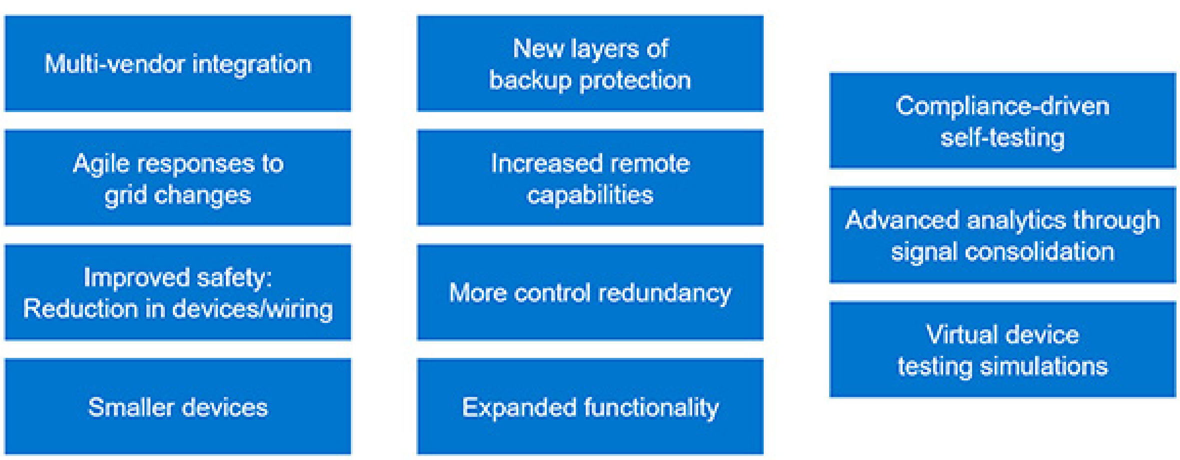


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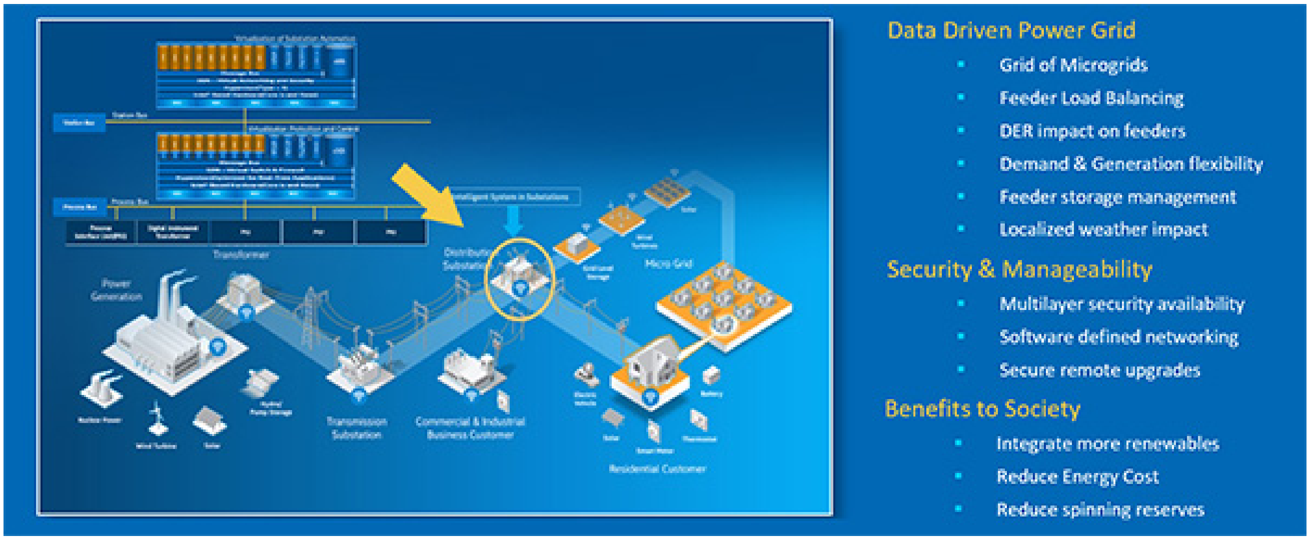
Figure 4: The role of "intelligent hubs" in the modernized grid



The grid of the future positions each substation as an intelligent hub. Virtualizing the substation model and implementing next-generation edge device management technologies allows the substation to optimize itself by making local decisions and taking action such as feeder load balancing and feeder storage management. Through this approach, the power grid becomes, in effect, a grid of micro-grids.

Dell Technologies and VMware created an "intelligent hub" to lower capital and operation & maintenance (O&M) costs.

The Dell PowerEdge XR12 is a ruggedized, powerful server built and marketed in collaboration with large utility companies. The XR12 is compliance-certified for utilities, meeting IEC 61850-3 requirements. XR12 services in substations with VMware technologies deployed provide utilities with a flexible, scalable, and secure platform on which to build fixed feature function devices. Virtualizing fixed feature function devices using this standardized hardware in a "data-centric approach" eliminates the need for utilities to deploy fixed feature function boxes, minimizes security management, and lowers capital and O&M costs in field devices.

Incorporating intrinsic cybersecurity solutions on all platforms is critical. Dell Technologies ensures an automated capability in its solution to continuously and remotely maintain systems at required security levels. Working with various partners they created a standard platform that facilitates automated deployments instead of having to replace or upgrade each individual capability, one at a time. With the rise of AI and ML, the Dell XR12 is optimized for new algorithms to generate additional insights into the operations of the grid.

> In the work that we did with the utilities, it showed 50% reduction of devices and around 76% reduction in operational and maintenance costs.
>
> *Prithpal Khajuria, Intel*

Internal and partner testing was conducted on a testbed configuration of three XR12 servers with ESXi hypervisor, with multiple applications such as virtual protective relaying (VPR) and test workstations installed into virtual machines. In tests, the substation virtualization platform developed by Dell Technologies, Intel, and VMware was shown to deliver almost identical latency to the bare metal environment of regular appliances.

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Figure 5: How Dell XR12 servers are configured as substation platforms

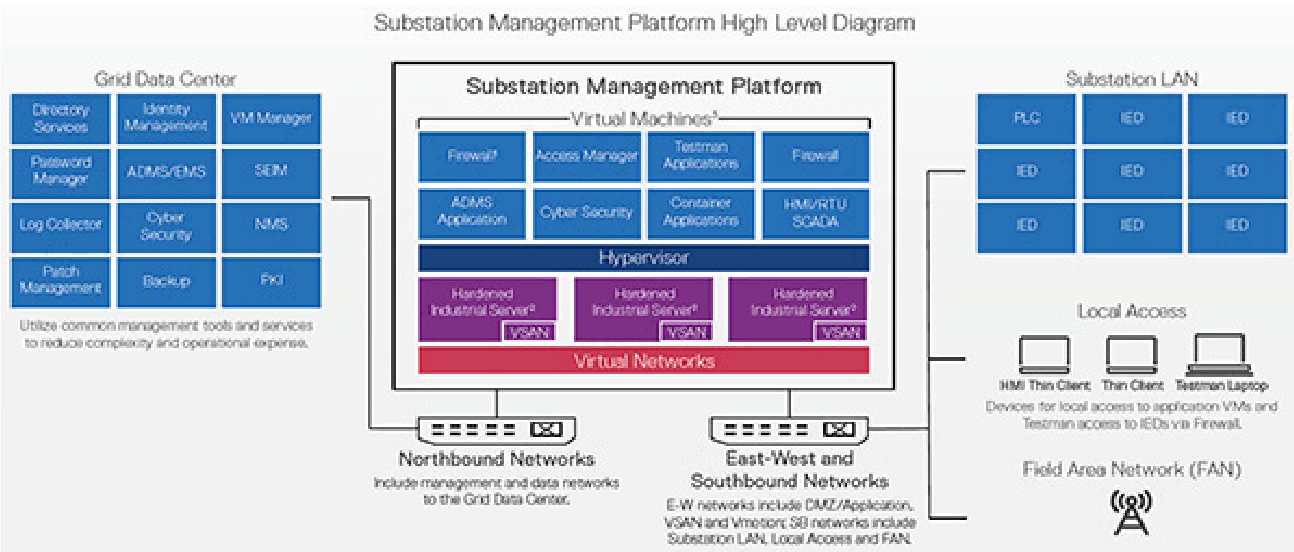

Figure 6: Testbed configuration for the VPR application

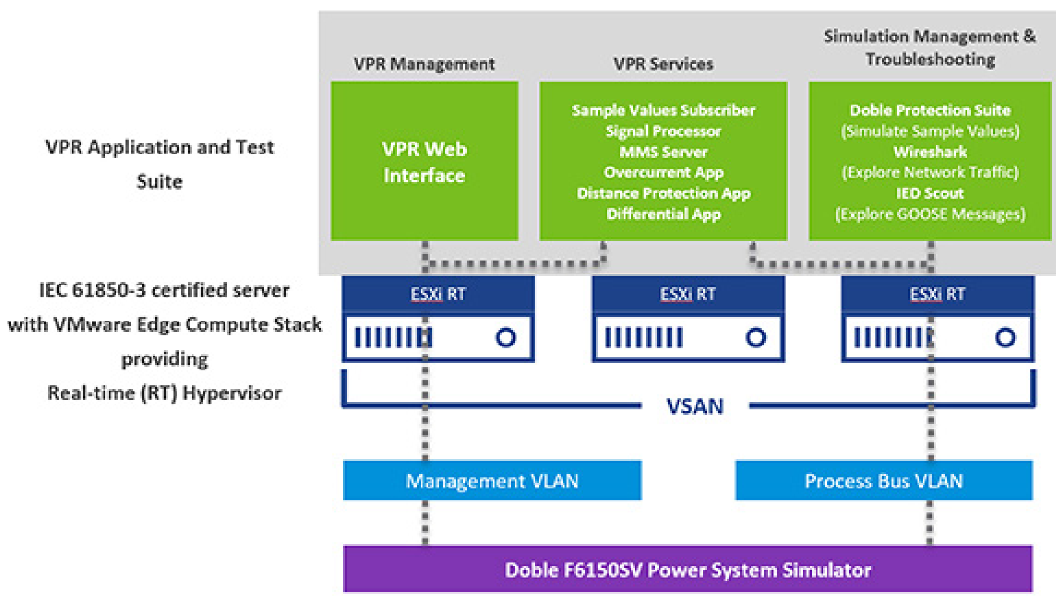

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Figure 7: Dell Technologies drives digital transformation and prioritizes innovation in a digital workplace

Dell Technologies helps the utility industry accelerate the deployment of technology to meet the challenges of the energy transition.

In the future, there will be new digital platforms across the entire utility value chain. Delivering intrinsic security and ensuring cyber resilience for those platforms; supporting digital transformation, especially around grid monetization; and innovating through AI- and ML-powered platforms are Dell's priorities for creating utility industry solutions.

ADDITIONAL INFORMATION

- Dell Technologies infrastructure solutions provide intelligence at the edge, offering more insight to better manage output and minimize downtime and bringing data into an integrated control center for real-time optimization of grid operations. To learn more, visit www.dell.com/en-us/dt/industry/energy-utilities/index.htm

BIOGRAPHIES

Prithpal Khajuria

Global Segment Leader – Power Sector, Industrial Solutions Division, Internet of Things Group, Intel

Prithpal Khajuria joined the Internet of Things Group (IOTG) of Intel Corporation as Global Segment Leader – Power Sector to drive IOT product and solutions for the utility industry. The vision of Energy IoT is to help OEMs develop solutions for utilities in managing traditional and next-generation infrastructure in a seamless, secure way, ready to deal with all kind of cyber and physical threats. The scope of Energy IoT solutions includes generation, transmission, distribution, and consumption of electricity.

Prithpal is working with the ecosystem of equipment manufacturers, automation, and software vendors, as well as utilities and service providers to develop and deploy connected devices, edge platforms, and cloud architectures for operational excellence and transformative businesses.

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Prithpal has 15 years of experience in providing advanced solutions to the global energy industry. Before joining Intel in May 2015, he was consulting with electric utilities worldwide on grid modernization strategies and emerging technologies. Prior to his consulting activities, Prithpal led the Smart Grid Product Management teams at SK Telecom, Onramp Wireless, and Silver Spring Networks.

Prithpal holds an MBA in in Global Business Management and BS degree in Computer Sciences and Engineering.

Russell Boyer

Global Energy Field Director – Utility IoT, Dell Technologies

Russell Boyer is the global energy field director for the utilities industry at Dell Technologies where he leads the development of the grid modernization strategy and edge solutions. He has 22 years' experience working for and with utilities to help them leverage technology to achieve specific business outcomes. His previous roles include marketing, sales, product development, industry principal, presales, and consulting. He graduated from Texas A & M University with an MBA and a Bachelors in MIS.

Kangwarn Chinthammit

Sr. Director, Solution Architect – Edge Computing, VMware

Kangwarn has the responsibility for driving solution development and architecture for VMware Edge Computing across multiple industry verticals. His team works with both end customers and ecosystem partners to develop and take to market innovative solutions leveraging edge compute technologies to help end customers transform their business to improve agility, operation efficiency, and meet their sustainability goals.

Kangwarn has over 20 years of IT experiences in building and taking several new and innovative solutions to both Service Providers and Enterprises. He held various positions in engineering, products, marketing, and sales at technology companies including Cisco, FireEye, VeloCloud, VMware, and Pensando Systems. Kangwarn holds a Master of Electrical Engineering from Cornell University.