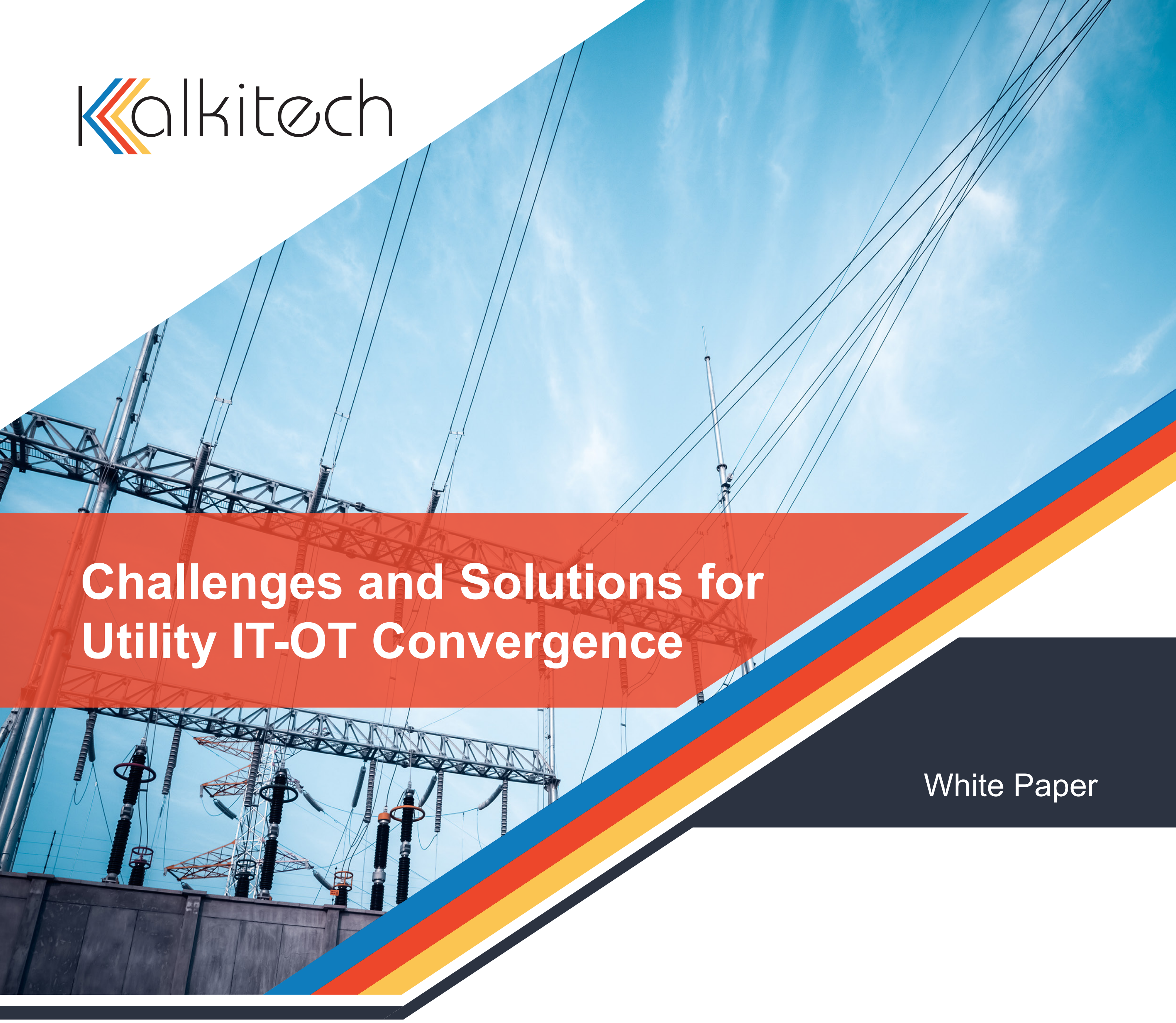

Challenges and Solutions for Utility IT-OT Convergence

White Paper

Introduction

If you are a part of the power industry today, you are likely being challenged with how to keep up with the digital revolution and how to integrate new applications into your existing environment. Distribution automation, distributed generation and integration of renewables are examples of these new automation applications that not only offer new efficiencies and services, but also generate vast amounts of valuable data. Before adapting these new applications or solutions, it is important to understand the nature of the changes that are necessitating these new solutions, and the drivers behind them, as well as how to address these challenges.

Major Drivers for Change

Improved operational reliability: Increasing asset health and efficiency while reducing downtime and cost has always been important for the energy industry. With increased intelligence of energy systems and availability of better data, the investments in improving operational health of the grid can now have a greater positive impact on reliability, thus increasing the popularity of such technologies.

Consumer and community participation: This offers potential cost saving opportunities for industrial users and consumers with services such as varied rates based on time of use or tuning of consumption during periods of high demand to reduce consumption. This also helps the energy provider to better utilize and monetize the available energy infrastructure. Enabling this requires the bidirectional flow of data between utility companies and consumers, making this a major technology driver.

Renewables and the new energy landscape: Solar and wind power generation have experienced substantial growth during the past few years along with adoption of electric energy in transport through electric vehicles. Effectively integrating these power sources into the existing energy infrastructure requires capabilities that go well beyond those of existing technologies.

With distributed power generation, the bidirectional flow of power to and from the grid needs to be carefully monitored, measured and controlled. This exchange of power also requires an exchange of data for the systems and parties involved to ensure that appropriate decisions are made in a timely manner.

Data governance and security: The greatest complexity arises from the different kinds of data that come from different devices. Handling data for all the different systems requires a structured approach. As a result, the communication infrastructure that carries the data leads to the fourth driver which is the need to secure data, devices and systems. With an increasing amount of information traversing the network, including critical control data, the need for strong data security is critical. The possibility of a hacker gaining control over energy control systems exists and occurrences such as Stuxnet malware [1]; if not immediately detected and addressed, can have catastrophic results from power outages to damaged equipment and even death. In addition to protecting data, it also needs to be made securely accessible to authorized applications and systems that need the data. Hence there is a need for technology that helps meet both these ends.

Type of Data	Devices
Protection data	IED's
Operational data	IED's and RTU's
Health data	IoT devices, Sensors
Billing, Usage and Load Profile data	Smart Meters
Schedule data, limits, fees	Electric vehicle charging infrastructure (charge / discharge limits)
Generation data	Rooftop Solar units, Windmills

Table 1: Examples of Types of Data Generated by Utility Assets

Complexities Added by Technology Around Four Major Drivers

The table below summarizes the complexities arising out of technologies related to the four drivers of change.

Improved Operational Reliability • Adding to existing devices that feed systems like Supervisory Control and Data Acquisition (SCADA), Energy Management System (EMS), Data Management System (DMS) and Automated Metering Infrastructure (AMI), there are more devices that feed data, such as sensors or 'things' that are part of IoT. • More devices imply the need for the ability to scale the number of connections. This will also increase the volume of data generated and requires applications to manage the data for analysis and decision making.
Consumer and Community Participation • Enabling bidirectional flow of energy data requires smart meters as well as grid edge devices that feed information into the system for energy providers to make usage and pricing data accessible to end users through consumer portals or other means. • It is typically expected that such information is available to end users on a wide range of devices including smartphones, to enable them to easily access the data and take participatory actions.
Renewables & New Energy Landscape • Handling different power generation sources and efficiently managing energy flows into and out of the grid, with multiple consumers and multiple energy sources with varying capacities. • Managing energy storage infrastructure for intermittent energy generation, charging for electric vehicles, making store/sell decisions for generated energy, etc.
Data Governance and Security • Handling different kinds of data flowing through the various devices, ensuring that it is accessible to the right systems in a timely manner. • Having enough security to account for the fact that devices and assets can be remotely and automatically controlled.

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How Can Complexities of the Digital Grid be Managed?

To effectively manage the complexities, it is helpful to consider an approach that addresses together all the elements that produce and consume data, rather than solving the problems in silos. The latter approach will most likely lead to a wide range of operational inefficiencies and higher costs. Most of the devices or systems can be divided into two major categories: sources of data and consumers of data. Devices and systems such as IED's, RTU's, sensors, smart meters, distributed generation systems and EV charging stations are sources of data, while systems such as SCADA, ERP, asset management, predictive analytics applications and head end systems are consumers of data.

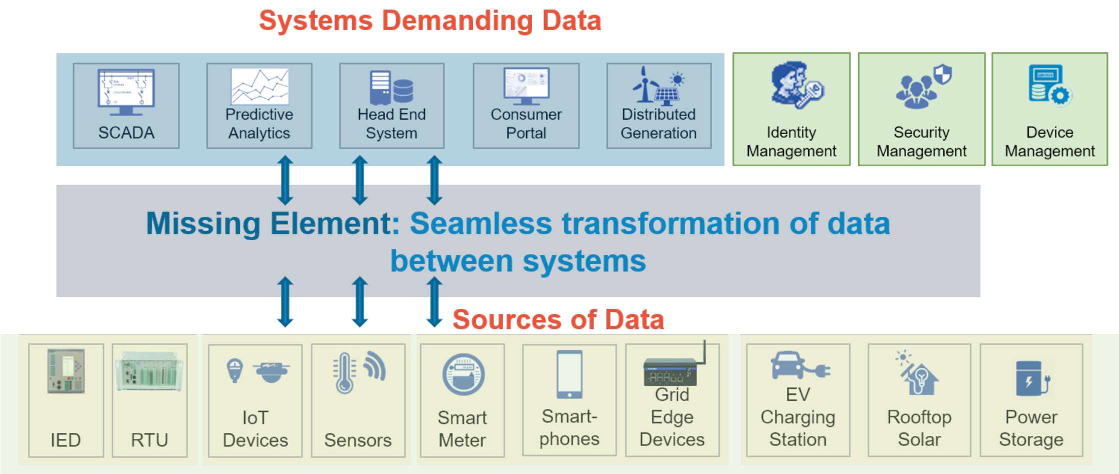

Figure 1: Need for Data Transformation

One of the fundamental requirements is data acquisition - collection of data from the multitude of systems and devices. Different systems and devices send data in multiple formats and protocols. These devices/ systems need to be centrally managed so that they send the desired data when it is needed. Hence device management is another required element. All devices may not be capable of communication, and communicate indirectly through device communication enablers and so these too should be considered in building a solution. Once the data is collected, it needs to be processed and converted into viewable information. Beyond visualisation, it needs to be securely shared with other applications to be processed and analysed – applications such as predictive analytics, health monitoring, billing or CRM, for example. These applications may run as part of the platform or may be external applications that utilize data from this digital grid management platform. All this must be done securely without exposing the system to threats such as data theft or unauthorized remote access.

By addressing all these challenges, a utility is automating Operations Technology (OT), using Information Technology (IT) resulting in IT-OT integration – a necessity when it comes to managing a digital grid. Thus, to summarize, the elements to consider are data acquisition, protocol conversion, device management, device communication enablers, analytics applications, security and ultimately, IT-OT integration.

Data Acquisition & Protocols

Collecting data from millions of field devices and supporting an array of communication protocols commonly used in the energy industry
Data acquisition involves collecting data from multiple devices and systems. Typically there exists a data acquisition layer for systems like SCADA, but this data cannot be shared with others systems easily. Thus, an ideal energy solution should be able to acquire data independently, so that it can be flexibly used for any purpose. To address the data acquisition from varied types of data, utilities must adopt a data acquisition platform approach instead of multiple silos such as SCADA, AMI (Automated Metering Infrastructure) or proprietary asset monitoring applications offered by asset OEMs.

Communication for energy IoT is a bit more complicated than other IoT deployments where the focus is to use as simple a communication protocol as possible. In conventional IoT, protocols like MQTT are popular and systems are designed to work with these low data capacity protocols. However, when it comes to energy systems, legacy protocols are widely deployed already and are much more complex to use. Both legacy as well as standards-based protocols have requirements that cannot be adequately met if they were to be replaced with simple general purpose IoT protocols. Thus, you need to verify that your platform provider has the capability and experience in protocol conversion technology specific to the energy industry.

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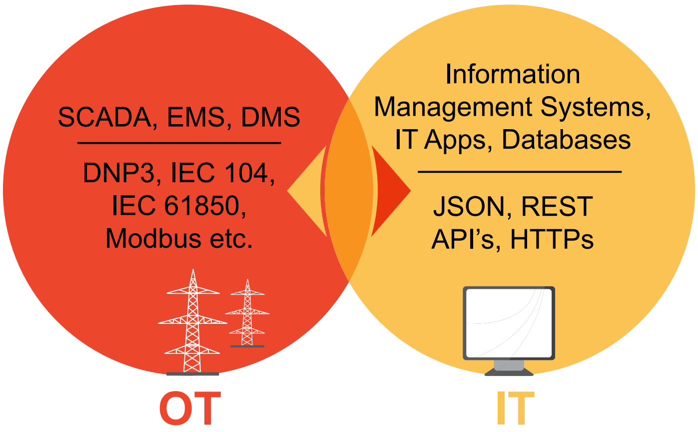
IT-OT Integration

Enabling OT systems to easily communicate with IT systems
Methodologies and conventions used for OT differ from those used in the IT domain. The OT domain in the energy sector uses protocols such as DNP3, Modbus, various IEC protocols and proprietary protocols from a wide range of energy device vendors. Working with IT requires use of protocols / technologies such as https, REST and information management systems. Thus, the platform that you choose should be able to acquire data from existing operations systems and interface with IT systems to enable the data to be easily accessed, viewed and analyzed, with the goal of improving reliability and operational efficiencies.



Devices and Device Management

Working with different device types through a single pane of glass
With increasing automation, the need to centrally manage, monitor and control field devices is essential. Coupled with that, the number of devices like protocol gateways, RTU's, modems, etc. used in the energy grid is increasing at an unprecedented rate – a simplified view into health and status of devices is needed. In addition, the explosion of IPv6 based low watt IoT devices has resulted in a phenomenal increase of CPU, memory, and connection management resource needs at head end system and created the urgent need for device management downstream. This requires creation of a secure backhaul with advanced connection management to monitor the CPU, power and memory resources of many units downstream. Since rollout of such devices is in thousands, it is imperative for the utility to have diagnostic and preventive maintenance information immediately accessible.

Legacy systems typically have their own rudimentary proprietary diagnostics system for alerts, often based on older standards. But in newer smart grid scenarios, where sensor installations multiply across equipment, a basic and unscalable diagnostics system is insufficient. Also, the scale and complexity of systems make it difficult to depend on manual tasks for updating configurations, firmware and for tracking the health and performance of devices. Hence, the need is a system that can monitor and manage many devices centrally and that can generate an alert when things start going wrong.

Device Communication Enablers

How can we make disparate types of devices capable of using power industry protocols?
Making devices work with a communication network or platform may look like a small part of the overall effort of smartening energy systems. However, the complexities of operational data and protocol conversion taken together with network communications and security, make it a daunting task unless you have a structured path and enabling tools to achieve this end. Devices such as upgrade cards that can enable meters or RTU's to communicate using power industry protocols are one way of doing this, and your IoT platform would then be able to support such devices.

Applications

Putting data to use
An ideal IoT platform for energy systems should offer a rich set of analytical tools and applications that can be easily deployed by users to transform collected data into actionable intelligence. Each application should scale up if required, to process huge datasets and handle increased connections or sudden increase in the activity profile of users. Linkage to other data sources, data transfer to third party applications, and the ability to support REST APIs, are some key features required for being able to leverage your data.

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Security

Protecting critical data, devices and assets
With increasing remote access to both devices and data, security becomes an important aspect of the system. Even if data at rest is secured adequately, risk may arise when it is shared externally with other systems or users. We need an all round security in terms of data encryption, role based access, secure communication and effective authentication mechanisms to protect the data and systems from unauthorized access.

Conclusion

Using different platforms for data acquisition, protocol conversion, device management and other applications discussed above, increases complexity and reduces efficient and timely accessibility to the data for analytics. The ideal solution is a unified platform that incorporates each of these disparate solutions.

An example of a robust energy-centric IoT platform is kalki.io from Kalkitech. This solution bridges the gap between existing systems while seamlessly embracing industry standards. It offers a foundation for extending future applications and requirements, supporting legacy systems and devices, while simplifying complexity and ensuring scalability as well as security.

Overview of kalki.io

Kalki.io is an energy IoT platform that is specifically designed to address the challenges of smart energy data convergence. It has **data acquisition capabilities** to communicate with systems and devices that are sources of data as well as systems that consume this data. The platform has in-built capability to handle varied sets of protocols that are typically used in the energy industry. By **making data securely available** to systems that need the data, kalki.io helps in meeting the requirements discussed above, simplifying use of smart energy and enabling different technologies to work together to ultimately harness smart energy data intelligence.

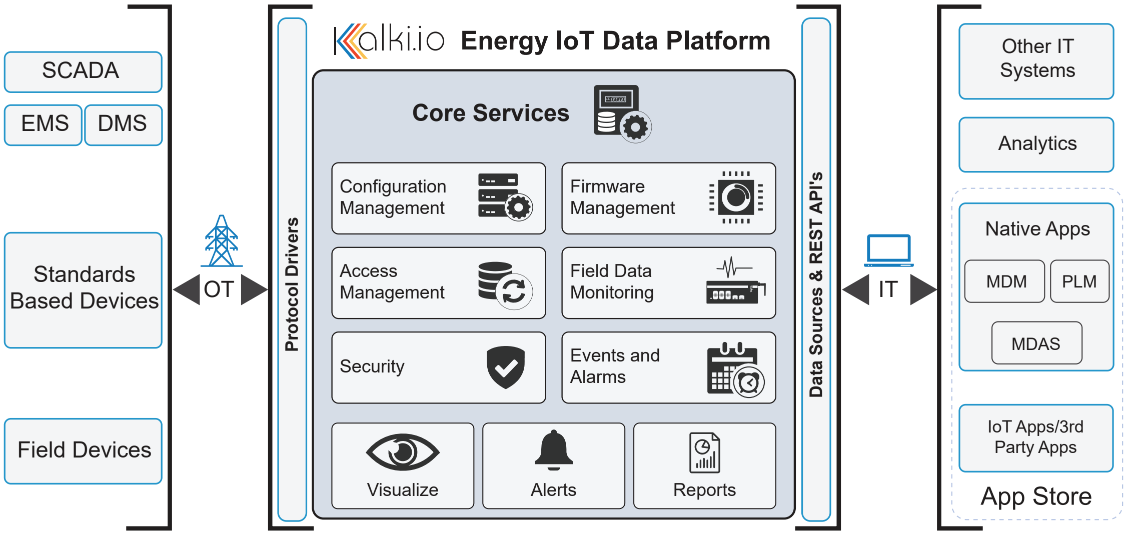

Figure 2: Kalki.io Architecture

Kalkitech has been specializing in the field of utility protocol conversion libraries and has integrated its technology into this smart energy platform. Thus, whether dealing with the operations technology domain, where you have to work with legacy as well as proprietary energy protocols, or with the information technology domain, where you need to work with https, REST or cloud, kalki.io can do it all.

Kalki.io has a great advantage over other IoT platforms due to the long legacy and strong technology foundation underpinning the SYNC product portfolio from Kalkitech, which is designed to seamlessly work with the platform. The SYNC line includes products such as protocol converters, RTU'S, gateways and data concentrators, as well as device communication enablers such as boards for OEM vendors to integrate into their devices to enable communications using standard protocols.

Device management is inherently part of the kalki.io platform. In addition to a centralized view of different device parameters, it offers the capability to manage updating of configuration files and firmware for devices remotely. The data collected by kalki.io can be viewed easily, using the Device Data module. Graphs and widgets can be configured to create a dashboard to visualize data that is important and requires ongoing monitoring. Alerts and notifications can be set to notify you when specific parameters no longer meet user specified tolerances. Kalki.io includes an app store with several Kalkitech-created applications including Meter Data Acquisition System (MDAS) and Meter Data Management (MDM).

The app store also enables third-party application developers to offer their own apps to kalki.io customers after they have passed compliance testing. The ability of the platform to securely share data with third party applications through REST API's enables existing or custom-built applications to use the extensive data stored in kalki.io. The Developer Zone helps with resources required to develop applications for the platform.

Kalki.io is a highly secure platform and uses OAuth2.0 for applications authenticating themselves against the platform, including for external apps and widgets. Using role-based access, the platform allows control of the permissions and access given to different sets of users and systems to ensure minimum and need based secure exposure of data and systems. PKI based authentication is used for device secure tunnels and desktop applications (two-way SSL). All systems use at least TLS 1.2 level of security.

About Kalkitech

Kalkitech helps energy utilities around the globe in enabling and transforming grid communications, improving reliability and energy efficiency. Its solutions enable customers to implement mission-critical applications ranging from advanced metering and distribution automation to wide area monitoring, substation automation and power plant optimization. Kalkitech invests extensively in research and development in areas such as power systems engineering, thermal engineering, control theory and communication and information technology. By building expertise, the company creates robust standards-based communication and optimization solutions and products for modernization of utilities, helping them to harness the power of grid data.

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References

[1] https://www.csoonline.com/article/3218104/malware/what-is-stuxnet-who-created-it-and-how-does-it-work.html

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