ORACLE
Utilities

How an Operational Technology Message Bus Helps Operators Scale Their Real-Time Networks

Getting ahead of the accelerating complexity and scale of devices, data, and distributed generation on the smart grid

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INTRODUCTION

The smart grid has the power to transform the utility industry, but utility executives and operations groups are discovering significant challenges to implementing their grid modernization goals, including:

- Smart grid deployments and wide-scale distributed energy resource (DER) integrations are very complex when it comes to interconnecting disparate devices and software applications that are often from different generations of technology.
- Smart grid integrations are riddled with challenges with transforming data from one system to the next and into a form that meets operational and business requirements.
- Silos of IT and OT systems pose difficulties when engineers attempt to incorporate them into smart grid deployments.
- The inability to store and sift through the explosion of raw operational data from utility applications—such as SCADA, AMI, and OMS—makes uncovering useful, actionable intelligence difficult.

This white paper discusses these challenges and provides solutions that can enable complex architectures to communicate to manage, route, and exchange real-time data to:

- Ensure successful automated grid operation
- Aid operators in visualizing the grid's health
- Enable utility management to optimize grid performance
- And, most importantly, protect life, equipment, and the environment

The paper concludes with a discussion of a new class of technology, an operational technology message bus (OTMB) that can help grid operators and generation asset managers quickly take control of massive data loads from grid devices, power generation units, battery energy storage and many types of DERs.

Who can benefit from an OTMB?

The following questions will help you determine if an OTMB can be of value for you and your organization:

- Does your organization spend a lot of time and money custom engineering the integration of OT systems such as OMS, SCADA, DERMS, MDMS and other smart grid systems?
- Are you aware that you can eliminate most consultants, custom code writing, and reduce system integration costs and reduce integration times with field-proven technology?
- Are you unsure of how to bridge the CIP V6 security gap between your CIP and your OT software systems and networks?
- Are you struggling with extraction, transformation, and load (ETL) of your data for your real-time OT analytics projects?
- Do you have a system or plan in place to prevent solutions from becoming obsolete and to adapt to future regulatory requirements?
- Would you like to reduce the flow to and storage growth of your data historian systems?

THE DILEMMA

Operational technology (OT) system architectures have a fundamentally different set of requirements than IT enterprise systems.

Gartner defines OT as "hardware and software that detects or causes a change through the direct monitoring and/or control of physical devices, processes and events in the enterprise."[1] OT typically falls within the engineering domain, and in the context of power systems, it pertains to technology that manages the actual generation, transmission, and distribution of electricity. The devices being managed are a utility's physical assets, such as generators, power lines, circuit breakers, and other intelligent devices.

The disparate systems within OT require a smart grid architecture that will ensure the protection of lives, equipment, and the environment while supporting generations of legacy equipment and protocols along with today's most modern devices and systems. In addition, it is imperative to maintain service reliability in order to meet regulatory quality requirements.

The operational side of today's utility must integrate an ever-increasing number of devices and sources of real-time, process-oriented information for the control and monitoring of key devices, measurements, and subsystems, such as OMS, SCADA, EMS, MDMS, ADMS, and DERMS.

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[1] Operational Technology (n.). In Gartner IT Glossary online. Retrieved from gartner.com/itglossary/ operational-technology-ot

The smart grid model from the National Institute of Standards and Technology, shown in Figure 1 below, shows just how complex the smart grid is today, thanks in part to the high growth of DERs. In order to achieve these integrations, the systems and devices need to efficiently exchange information and interact with one another.

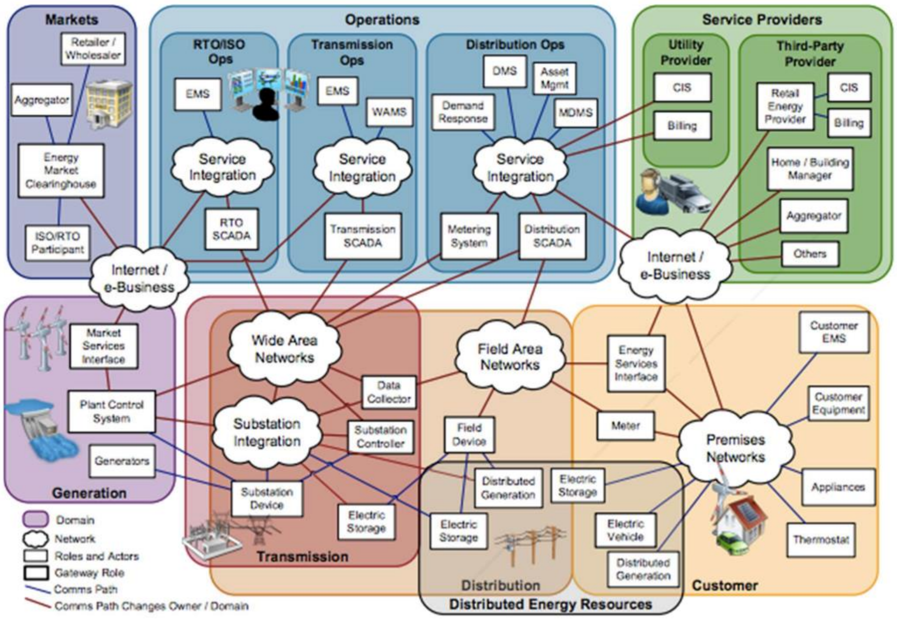

Figure 1. A logical model of legacy systems mapped onto conceptual domains for smart grid information networks. Image sourced from the National Institute of Standards and Technology.

As utilities begin integrating disparate OT systems and preparing data for real-time analytics, system architects have found that an enormous amount of time is spent on name mapping, converting data types, filtering data, directing data, coalescing data, and translating data to meet the communication expectations among systems, and to ensure that data arrives at its destination in a timely manner.

Utilities that have attempted to allow their OT systems to share data and applications with one another—as well as those who need to push communication between their OT and IT systems—have engaged in some well-intentioned attempts to accomplish the tasks:

Hiring a consulting firm to write custom code

This was once thought to be the go-to solution, but utilities have learned this practice is risky. Writing code is a laborious and complex undertaking. It is expensive; there are invariably over-runs or additions to contractual budgets, and projects are rarely delivered on time. Custom integrations are also very difficult to implement the first time, and they become even more complex if they have to be replaced. Utilities cannot afford to reinvent the wheel for each project, time and again.

Using SCADA in the middle

When everything has to connect to the SCADA system, this creates a great burden on the system to do more than what it was designed to do. A SCADA system is intended to be the supervisory control system and not a real-time middleware solution functioning without operator input. Using a SCADA system in this manner can work to a certain extent, but it is an expensive solution because the system must be overbuilt to both run the grid and also be the engine that connects all other applications. SCADA systems also lack the ability to manage complex data routing and to manage metadata between systems.

The Complexity of the Smart Grid

Operations teams at utilities are required to tie together many disparate systems, including:

- Advanced distribution management systems (ADMS) provide a single interface for all systems within the distribution and transmission network.
- Automated meter reading (AMR) systems automatically collect consumption and status data from meters.
- Distributed energy management systems (DERMS) aggregate distributed solar and storage to provide grid services and help balance supply and demand.
- Energy management systems (EMS) optimize, supervise, and control the transmission grid and generation assets.
- Meter data management systems (MDMS) store and process the data delivered by a smart metering system.
- Outage management systems (OMS) assist electric utilities in restoration of power.
- Supervisory control and data acquisition (SCADA) systems monitor and control a plant or equipment.

Using an IT-oriented middleware solution or enterprise service bus

An enterprise service bus (ESB) is an IT software architecture model for designing and implementing communication between mutually interacting software applications in a service-oriented architecture (SOA). Although an ESB can ably serve the IT needs of the utility, its web-based functionality falls short when it comes to the real-time and fine-grained requirements of OT. The more fine-grained and real time the data, the less likely an IT-oriented middleware solution like an ESB will be functionally successful. The latency, throughput, integrity, and reliability constraints will likely be violated. Also, ESBs do not support native protocol translation or the data filtering operations required for a robust OT solution.

Implementing open standard interface connectivity technologies

Many cooperatives and municipalities have used these solutions, but MultiSpeak—a standard, not a product—is a web services protocol that suffers from the same limitations as other IT-centric solutions such as an ESB. There is no active management of complex data flows, no filtering, and no native protocol support. MultiSpeak may be good enough for a small utility; however, a utility with more than 50,000 metered customers can usually benefit from the implementation of an active, intelligent OT middleware solution to help scale their OT grid systems.

THE SOLUTION

An operational technology message bus (OTMB) describes a class of technology that links legacy applications and disparate OT systems via the exchange of real-time, bidirectional messaging, including those that need to interface with an ESB on the IT side of the utility. An off-the-shelf, OT-centric middleware solution, the OTMB reduces development costs, technical risk, and time-to-market for customers. More importantly, it ensures the protection of life, equipment, and the environment.

OTMB uses operational protocols that existing operations applications already speak, and it speaks to each application with the correct latency, throughput, integrity, and reliability. Instead of relying exclusively on web technologies, it uses high-performance communication protocols already in place across the grid and actively manages the flow and form of data across OT systems. It utilizes an organizing architecture to overcome the challenge of point-to-point integrations, so a utility does not have to solve the same problems again and again to get systems to communicate. Additionally, it delivers complex data integrations in weeks instead of months or years.

An operational technology message bus (OTMB) describes a class of off-the-shelf middleware technology that links legacy applications and disparate OT systems via the exchange of real-time, bidirectional messaging.

OTMB Architecture Requirements

An OTMB platform must be architected to:

Protect life, equipment, and environment

This is an underlying fundamental OT architectural requirement for utilities and industrial companies alike.

Maintain service reliability

The smart grid has to work—always. There is no tolerance for the electrical grid going down because a single component, such as a server, fails.

Operationalize real-time, bidirectional control

The interconnection of OT systems must meet the same latency and control requirements necessary to control the overall operation of the grid.

Support lossy and messy radio networks

The smart grid is operational across thousands of miles in remote locations and noisy urban environments under conditions hostile to reliable communication. An OTMB must be architected to manage, at times, very low bandwidth and high-latency lossy networks.

Support legacy equipment and protocols

Utility systems and hardware could be decades old. There is no financial or safety return on replacing old systems that are still functioning. An OTMB must support legacy equipment natively and allow for easy inclusion of custom proprietary protocols.

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Respond to regulatory requirements

North American Electric Reliability Corporation critical infrastructure protection (NERC CIP) requirements, including CIP V6, on quality and security are an obligation that every stakeholder in the smart grid infrastructure must adhere to. An OTMB solution needs to be compliant with NERC CIP requirements and help utilities to bridge the gap between secure (CIP compliant) and IT networks.

OTMB Architecture Attributes

To meet the above imperatives, an OTMB architecture should have the following attributes:

SCADA-class, in-memory processing

An OTMB engine must be optimized to manage complex data flows in memory to maintain data latency requirements.

Configurable data flows

Mappings, statistical functions, filtering, coalescing, translations—integrating smart grid systems and/or extracting data from them requires significant real-time data manipulation. An OTMB should natively support functions such as dead-banding and other filtering operations as part of a GUI-based configurable data flow.

Data flows configured from templates

An OTMB should understand hundreds of thousands of data points could transact through it. A methodology to abstract data types into a templating environment is critical to break down complex data flows into a manageable set of data abstractions.

Populated at run time

Graphical or script-based tools to develop templates must be complemented with the ability to populate and update templates at run time in order to enable the addition, deletion, and modification of data points. Mission-critical systems cannot be halted to reload data files. An OTMB should be adept at integrating and managing data definitions from various sources, including CIM and GIS models.

Network scalable, high availability

A single server represents a point of failure. OTMB must include high-availability (HA), dual-server support.

Seamless integration with an ESB

OTMBs frequently bridge the gap to IT. An ESB or other web services interface is required to securely transact data from OT to IT networks.

Tag management/metadata support

Data dictionary alignment between OT systems saves time for OT system administrators.

An OTMB manages real-time configurable data flows from templates to solve commonalities of metadata issues, naming, types and network sharing. OTMBs dramatically reduce ETL time for real-time analytics projects and reduce storage and transactional load on historians and other databases. OTMBs also future-proof systems since they provide a rich environment for future integrations which cannot be replicated by complex in-house systems or simple protocol communication relays or gateways. Because it supports a wide range of modern and legacy protocols as well as a wide range of web interfaces, an OTMB implementation is cost efficient because of reduced project timelines since existing applications are not disturbed, and legacy applications do not have to be rewritten.

Benefits of an OTMB

- Manage real-time configurable data flows from templates.
- Solve commonalities of metadata issues, naming, types, and network sharing.
- Reduce ETL time for real-time analytics projects.
- Reduce storage and transactional load on databases.
- Future-proof systems by providing capabilities and space for future.
- Gain support for a wide range of modern and legacy protocols and web interfaces.
- Improve cost efficiency with reduced project timelines.

OTMB PROJECT EXAMPLES

Web-Based Distribution Automation at Evergy

Evergy, formerly Kansas City Power and Light (KCPL), architected its new distribution automation system by integrating solutions from three different vendors—a third party data collection network, Oracle Utilities Live Energy Connect (Oracle Utilities LEC) configured as an OTMB, and Oracle Utilities Network Management System. The system controls more than 3,000 automated devices transacting 90,000 data points of information, and the OTMB manages and manipulates the data flow from thousands of field devices. Taking advantage of Oracle Utilities LEC's templating system, the 90,000 data points were reduced to 30 templates. The system was integrated in less than six months without a traditional SCADA system, and functioned flawlessly when the worst storm in 15 years hit the Kansas City area just three days after the system went live.

Fault Location Analysis at Southern Company

Grayson Mixon, senior IT analyst at Southern Company, was challenged with implementing infrastructure for supporting fault location analysis (FLA) on the utility's smart grid. The FLA code resides in the OMS, and data from the distribution automation system—such as fault indicators—was collected by the distribution SCADA system. Configured as an OTMB, Oracle Utilities LEC was used to link the SCADA system to the network management system.

Mixon notes that when they "…started digging into the data from the SCADA, we found that it wasn't always perfect or it wasn't always what we were expecting. There were a lot of 'gotchas.'" Mixon used the OTMB's native environment to manipulate the data and work around the 'gotchas' using native filters with some powerful, but minimal, custom Python scripts on the OTMB.

Future-Proofing OMS Integration at a Major Utility

Back when he was the CTO of system integrator UISOL, Scott Neumann led a multi-year engagement to help a major U.S. utility with an upgrade of its OMS, transmission SCADA, and distribution SCADA systems.

Neumann's firm, worked with the utility to architect Oracle Utilities LEC as an OTMB in its new architecture because the OTMB "eliminates the need for custom software development and allows [the system integrator] to quickly manipulate OT system data to meet the operational and business requirements of the organization." Neumann advocated for an OTMB solution because with it, the company could more quickly deliver a robust solution for the utility. This is a strong validation of an OTMB because shorter implementation cycles typically yield smaller contracts for system integration providers.

Today, the utility uses its OTMB across six operating companies, several million meters and a variety of systems, including an Oracle Utilities Network Management System.

"The Oracle Utilities LEC platform eliminates the need for custom software development and allows UISOL to quickly manipulate OT system data to meet the operational and business requirements of the organization."

Scott Neumann

Former CTO, UISOL

HOW ORACLE UTILITIES CAN HELP

Oracle Utilities Live Energy Connect (Oracle Utilities LEC) is a field-proven OTMB solution. By leveraging its off-the-shelf, OT-centric middleware development expertise, Oracle delivers a framework that ensures the protection of life, equipment, and the environment, while reducing development costs, technical risks, and integration timelines. Oracle Utilities LEC is architected to use operational protocols that existing operations applications already speak, enabling it to implicitly communicate with each application with the correct latency and throughput. With native protocol support, more than 50 embedded filtering operations, and built in templating, the Oracle Utilities LEC platform bidirectionally delivers validated operational intelligence reliably, securely, and in real time.

Oracle Utilities LEC is deployed at more than 100 utilities worldwide. It enables utilities to efficiently integrate and manage the proliferation of disparate OT systems, devices, and data. If you need to manage a big uptick in your OT and system data loads; are considering a new SCADA, NMS, EMS, MDMS integration; or want to learn more about OTMBs, please contact Oracle Utilities.

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