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How French Transmission System Operator, RTE, Leverages LF Energy & LF Edge to Build Next-Gen Substation Monitoring and Controls

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Overview

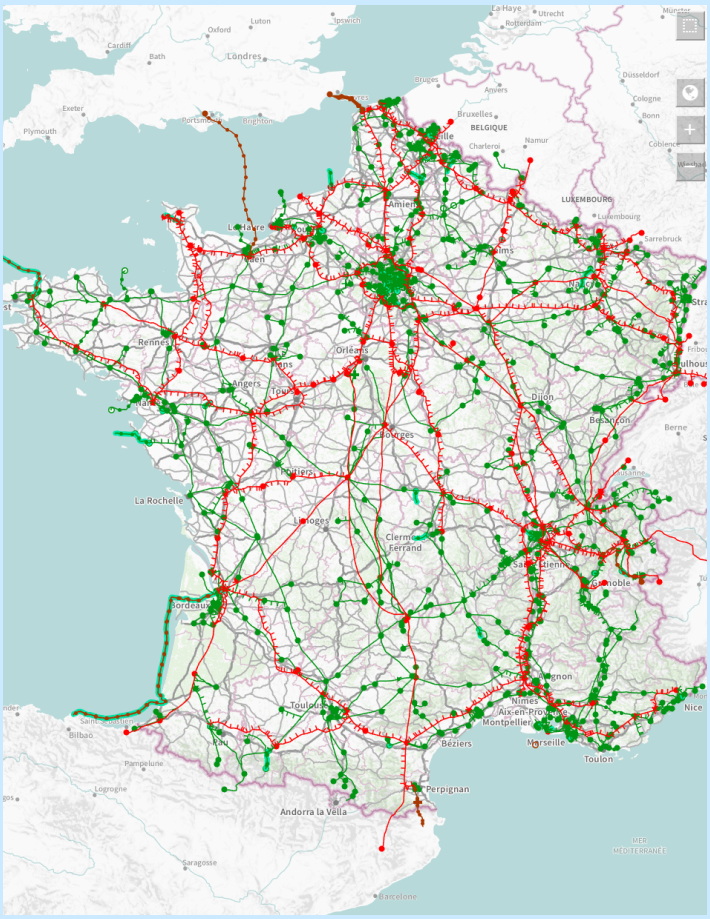
French Transmission System Operator (TSO) RTE is accelerating the energy transition and its digital transformation to build the control system of the future. This requires the development and adoption of new technologies to transform the power grid, starting with solving the problem of multiple protocol translation.

RTE and its partner, Dianomic, determined that **FledgePOWER**, a multi-protocol translation gateway for power systems from **LF Energy** based on the industrial IoT **LF Edge** project **Fledge**, could be used to address this issue.

FledgePOWER provides a toolbox for simulation, data configuration, and checking focused uniquely on power systems' protocols translation and power systems' use cases.

IEC 61850, an international standard defining communication protocols for intelligent electronic devices at electrical substations, was designed to abstract the physical communications layer and ensure interoperability of these devices. FledgePOWER, an open source tool developed by a variety of energy stakeholders including RTE and Dutch Distribution System Operator Alliander, supports IEC 61850 communications with external systems like scanners and data centers in the cloud and substation networks.

To address the challenges mentioned previously, RTE partnered with Dianomic who developed FogLAMP, a commercial distribution of Fledge. The deployment of FogLAMP with FledgePOWER enables RTE to achieve its business objectives while avoiding the high costs and risks associated with local remote terminal unit (RTU) migration.



RTE's transmission grid – Red are 400 kV substations and Green are 225 kV substations. 150, 90 and 63 kV substations are not displayed for readability.

Challenges facing legacy substation systems

RTE's legacy substation systems lacked flexibility and scalability, ultimately demanding complex and expensive maintenance, that often necessitated specific, vendor-locked solutions for each substation.

The TSO determined that it wanted to migrate to more modern control systems which could offer better flexibility, security and scalability with reduced maintenance costs. RTE knew this would require an open and standardized IEC 61850 model to serve as the template model for all substations and facilitate integration of renewable energies.

FledgePOWER as a solution

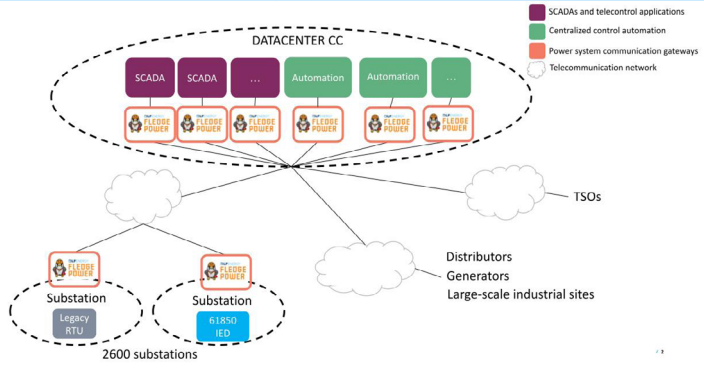
The open source nature of Fledge, the foundation of Dianomic's commercial FogLAMP solution, made it an ideal choice to address RTE's challenge of multiple protocol translation and provide the benefits of an open source multi-protocol gateway. Fledge is hardware-agnostic, industrial-grade, and compatible with industry 4.0 application development and industrial data pipeline challenges. Fledge is already in use successfully across IoT, transportation, food and agriculture, infrastructure, manufacturing, and other utility providers such as JEA and Statkraft. Like other open source technologies, Fledge also offers the benefits of vendor neutrality and the ability to drive one's own roadmap.

Fledge offers open Application Programming Interfaces (APIs) and has an extensible architecture for supporting intelligent industrial data pipelines and edge applications from any industrial data source to any industrial data destination and cloud.

FledgePOWER was found to meet the following RTE requirements:

- Supports intelligent industrial data pipelines from any industrial data source to any, or multiple, industrial data destinations
- Bidirectional for setpoint controls back to the RTUs in the substations
- Extensible architecture capable of supporting home-built protocol used by RTE and EDF - HNZ
- Single Management API for all data pipelines to and from all substations
  - Enables scale, security, and management
- Future-proof
- Edge ML/AI ready

RTE's future power system control architecture



RTE/Fledge roadmap progress matrix (Protocol plugins)

Protocol plugin /Feature	IEC 60870-5-104 client	IEC 60870-5-104 server	EDF HNZ client	IEC 60870-6 TASE.2 client	IEC 60870-6 TASE.2 server	IEC 60870-5-103 client	IEC 61850 MMS client	IEC 61850 MMS server	IEC 62541 OPCUA client	IEC 62541 OPCUA server
Connection management	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED
Monitoring messages acquisition	COMPLETED	NOT APPLICABLE	COMPLETED	COMPLETED	NOT APPLICABLE	NOT YET IMPLEMENTED	COMPLETED	NOT APPLICABLE	NOT YET IMPLEMENTED	NOT APPLICABLE
Monitoring messages sending	NOT APPLICABLE	COMPLETED	NOT APPLICABLE	NOT APPLICABLE	COMPLETED	NOT APPLICABLE	NOT APPLICABLE	NOT YET IMPLEMENTED	NOT APPLICABLE	COMPLETED
Control messages acquisition	NOT APPLICABLE	COMPLETED	NOT APPLICABLE	NOT APPLICABLE	COMPLETED	NOT APPLICABLE	NOT APPLICABLE	NOT YET IMPLEMENTED	NOT APPLICABLE	COMPLETED
Control messages sending	COMPLETED	NOT APPLICABLE	COMPLETED	COMPLETED	NOT APPLICABLE	NOT YET IMPLEMENTED	COMPLETED	NOT APPLICABLE	NOT YET IMPLEMENTED	NOT APPLICABLE
Protocol stack configuration management	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED
Exchanged messages configuration management	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED
Clock synchronisation	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	NOT APPLICABLE	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	NOT APPLICABLE
General interrogation	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	NOT APPLICABLE
Support for redundant connections	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	IN PROGRESS	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED
Exceptions, errors and logs management	COMPLETED	COMPLETED	COMPLETED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED
Security	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	COMPLETED	NOT YET IMPLEMENTED	COMPLETED	NOT YET IMPLEMENTED	NOT YET IMPLEMENTED	COMPLETED

The list of protocols above are used in RTE's 2,600 Substations. A Multiprotocol Bidirectional gateway that supports all of them using the same APIs solves the data interoperability, scale, security, and management problems.

Implementation Process (with challenges and solutions)

The implementation process was seamlessly facilitated by the Fledge plugins architecture. This framework enables the implementation of each protocol or data processing feature within its own independent workstream.

While the Fledge plugin architecture facilitated implementation, its loose coupling required meticulous attention to ensure compliance with Fledge core services interfaces. Conducting regular compliance testing against new Fledge core versions is crucial to ensure that the plugins consistently operate within the latest iteration of the Fledge core.

Results of Fledge & FledgePOWER Implementation

The initial deployment of a FledgePOWER-based gateway in the first substation confirms that leveraging FledgePOWER to update these substations results in significant cost reduction and complexity vs migrating the existing RTUs to more recent versions. By enhancing the local, older generation RTUs with features such as multi-center capacity and secure communication via transport layer security (TLS), FledgePOWER has enabled RTE to achieve business objectives while avoiding the high costs and risks associated with local RTU migration.

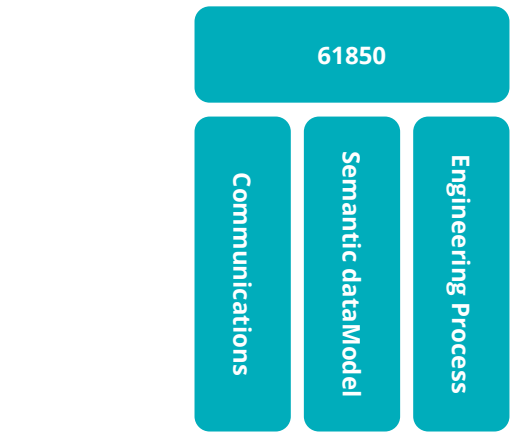
Energy Industry Implications

Like many operational technology (OT) environments, the energy market uses numerous protocols from various vendors, lacking a standardized way to map, transform, secure, or understand data. Some of these protocols include IEC103/104, Modbus, DNP3, TASE2, Open Platform Communications Unified Architecture (OPC-UA), S7, Message Queuing Telemetry Transport (MQTT), and IEC 61850.

Suppliers to the energy industry have started to support and promote IEC 61850. IEC 61850 is not only used at the design and engineering stage of substation construction, but also provides a communication layer and semantic data model for sharing data context.

Fledge supports IEC 61850 and other complex data types including vibration, video, acoustic, radiometric, and transactional. By using Fledge-based FledgePOWER, RTE has experienced a smooth migration from outdated technology and equipment to the new era. This evolution is critical considering that capital-intensive equipment, such as substation transformers, can have longer than 20-year life spans.

61850 Fundamentals



The IEC 61850 standard ensures interoperability of data across all types of devices across energy systems.

Moving Forward

Open source solutions such as Fledge and FledgePOWER are crucial for seamless integration and data management. By supporting IEC 61850 and other complex data types, FledgePOWER enables RTE to smoothly transition to modern technologies, ensuring grid reliability and sustainability for years to come.

RTE is one example of open source impact. The Fledge project has expanded into LF Energy's FledgePOWER with 67 energy companies and suppliers and OSDU (an Open Group Project) with 167 oil and gas companies and suppliers, all working toward a common goal.

Fledge cements LF Edge's commitment to an open, modular framework for edge computing. Notably, Fledge has expanded its applications, reflecting its growing influence in edge computing ecosystems.

Learn more about Fledge at **https://lfedge.org/projects/fledge/** and FledgePOWER at **https://lfenergy.org/projects/fledgepower/**.