Smart Grid Substation Automation – Enabling Intra-Substation Connectivity with PLC

Telkonet Series 5 is a proven connectivity option, delivering tangible benefits:

- **Reliable** – Protects critical substation equipment
- **Cost-effective** – Quick installation without new wiring
- **Secure** – Protects from Cyber security incidents
- **Robust** – Not impacted by network traffic or changing network conditions
- **Future-proof** – Evolves with technology

Overview

Reliable, secure and cost-effective intra-substation communication in the harsh utility substation environment can be difficult to achieve. Wide temperature ranges, high voltage equipment, and different communication protocols add to the challenge. Enabling network connectivity to proactively monitor transformers, circuit breakers, and other equipment is essential to avoid any potentially damaging component failures and to ensure optimum equipment performance.

Powerline communications (PLC) technology is a proven, viable alternative for intra-substation communication, using the existing low voltage or control wires to provide a communications channel between the Control House and the yard equipment, such as transformers / circuit breakers. PLC eliminates the need for costly, time consuming trenching, and overcomes security concerns that can be encountered with radio and wireless signals. With PLC, there is no need to deploy new wire or to pull cable or fiber.

Telkonet Series 5™ ground-breaking 200 Mbps PLC system provides a reliable networking backbone for IEDs, and IP security cameras. PLC enables data to be collected and transported back to the Control House, including tracking critical fault gasses in insulating oil (DGA), oil temperatures, and load levels, and operational metrics and breaker reclosures.

How PLC Works

The Telkonet AG5 Series PLC Gateway, which converts Ethernet to PLC, connects to the substation network by Ethernet using Modbus or DNP to communicate to IEDs in the substation yard. The PLC Gateway then passes the signal to the substation's electrical wiring by the Telkonet Coupler. The Telkonet iBridge™ picks up the signal at the circuit breaker or transformer cabinet and provides an Ethernet or Serial connection (RS232/RS485) to the IED. Popular IEDs include DGA, transformer monitoring, and bushing monitoring equipment.

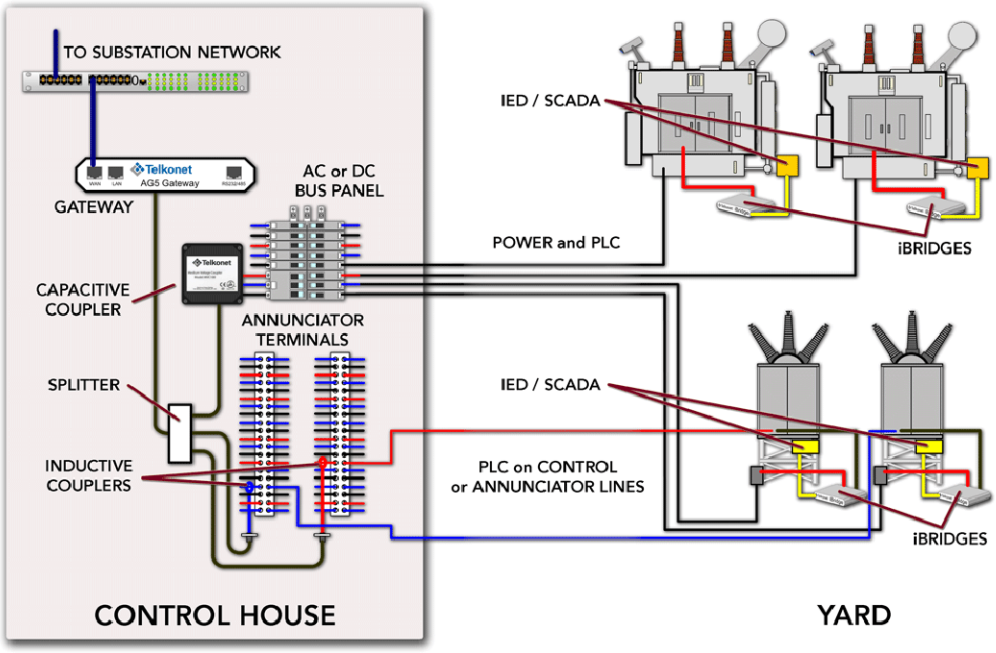

Figure 1. Telkonet Series 5 uses existing wires to provide intra-substation network connectivity.

Simple Installation with Telkonet's Inductive Coupler

- Injects PLC without directly touching the circuit
- Works with any existing wire: power wires, control lines, annunciator lines
- Reduces installation time and costs
- Simple installation without needing an electrician
- Flexible placement: easily move to read signal levels
- Increases throughput levels

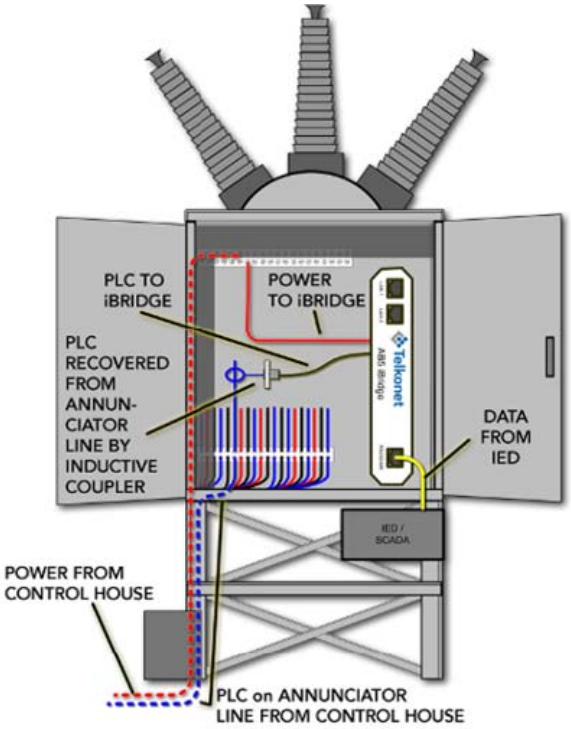

Figure 2. Quick installation with Telkonet Inductive Coupler and DIN Rail Adapter for the Telkonet iBridge.

Benefits of Telkonet Series 5

Physical

- Low cost compared to fiber without trenching or new wires
- Installed within hours without towers or antennas
- Withstands extreme temperature ranges
- Continuous communication without interference issues
- Safe: complete isolation between the electrical power and the network; power surges / spikes cannot damage monitoring equipment
- Robust: network performance is not impacted by difficult network traffic or changing network conditions, such as full load or half load transformers

Operations

Supports connectivity to any Ethernet device in communication interface location

- Enables monitoring of gas analysis (DGA), gas breaker monitors, circuit breakers, temperature sensors, SCADA, security cameras
- Supports 48-250V DC and 100-240 AC applications
- Dual Ethernet ports with separate VLANs per port
- Additional interface, RS232, RS485, ZigBee

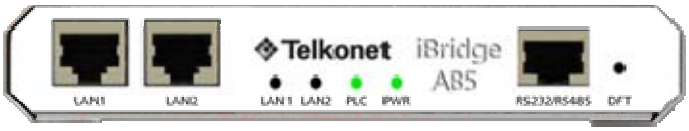

Figure 3. The Telkonet Series 5 System can support over 500 Telkonet iBridges.

Protocol Support

- Backhauls data to the Control House via common communications protocols
- Interoperable multiple protocol support – works with existing and future IED equipment
- Supports all necessary protocols: Modbus, DNP3, ASCII, IEC 61850, GOOSE
- Supports protocol conversion of Modbus ASCII to Modbus without the need for expensive serial to Ethernet converters
- Support for 802.1Q for VLAN tagging
- Native QoS support with up to 8 specific connection rules
- Converts RTU to TCP
- Simultaneous RS-232 and RS-485 communications

Throughput

- Delivers up to 200 Mbps bandwidth
- Supports payload speeds of up to 65 Mbps TCP and 90 Mbps UDP
- Enables quick downloading of embedded Web pages from monitors
- Ability to create multiple network segments to support a greater number of end devices and move even more data

Security

- PLC signal on the wire never leaves the substation
- Requires encryption key to control and access the network
- Provides128 AES encryption, eliminating data eavesdropping and unauthorized control commands
- Uses SSH and SSL for remote management access for secure configuration, status, file transfer and upgrade
- Allows pass through for VPN tunneling and multiple re-encrypted tunnels
- Can set new passwords and change port numbers
- Enhanced QoS with up to 8 priority levels, 8 independent rules with independent classifications, and rate limiting for bandwidth management per user

Figure 4. Telkonet Series 5 has proven performance with reliable network connectivity in various types of substations.

Flexibility

- Works on AC and DC wiring, as well as Delta and WYE phase configurations
- Provides Ethernet-to-Ethernet, Ethernet-to-Serial and Serial-to-Serial connections via Point-to-Point or Point-to-Multi-point
- Flexible configuration options for Telkonet iBridge units
- Hybrid architecture supports any equipment in the yard
- Multiple options for point-to-point, point-to-multi-point, bandwidth throttling, VLAN structures
- Serial port configurations for protocol, data and stop bits, parity and Baud, half or full duplex
- DIN Rail Adapter overcomes limited space in equipment cabinets, vertically mounts Telkonet iBridge

Proven Performance Based on Actual Installations

Below are a few examples illustrating where Telkonet Series 5 PLC platform has been installed in utility substations. These installations demonstrate the effectiveness of using PLC for reliable, secure networking communications.

Implementation in the Southwest

Type of Substation	Step down: 230KV to 69KV, 3 transformers
Installation Date	May 2006
Installation Crew	2 people
Installation Timeframe	4 hours total
Telkonet Equipment	PLC Gateway, Capacitive Coupler, iBridges
Equipment Monitored	IED temperature sensors on transformers and Serveron DPAs; network connectivity for laptops for substation crew
Results to-Date	Solid performance with consistent connectivity in extreme summer desert temperatures of 115 degrees

Implementation in California

Type of Substation	232KV, 138KV, 69KV; 24 circuit breakers, 8 transformers
Installation Date	November 2008
Installation Crew	2 people
Installation Timeframe	10 hours total
Telkonet Equipment	PLC Gateway, Inductive Coupler, iBridges
Equipment Monitored	Circuit breakers, transformers, TCP devices
Results to-Date	Reliable, consistent connectivity without any downtime or service calls