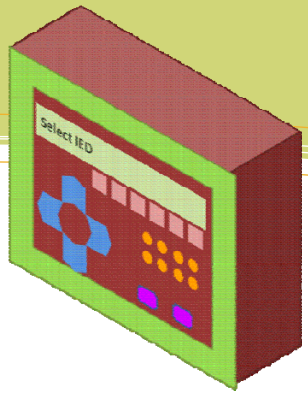

IEC 61850 Operator & Testing Interface (OTI)

- Provide user friendly & familiar controls
- “isolate” GOOSE messages
- Maintain cyber security
- Guarantee critical isolation sequences
- Safely connect test equipment and laptops
- Set IEDs to be ready for testing or replacement
- Secure the substation for maintenance.

OPERATIONAL ISSUES FOR IEC 61850

The implementation of IEC 61850 in a substation draws many views on benefits and methodologies to make the change. However one question which is common to all is:

“How *do* you ‘isolate’ a GOOSE message?”

Fundamental to every substation is the process of interrupting a signal to make the automation system, individual IEDs and individual function of an IED safe for testing, or replacement. It is not safe or feasible to simply disconnect the LAN cable. Facilities must be provided for operators and technicians which:

- **Are familiar in every substation (not confuse operators)**
- **Are safe to use (for personnel and substation operation)**
- **Maintain cyber security**
- **Assist and automate maintenance procedures**
- **Itself be easy to maintain & replace**

The **OTI** is a comprehensive solution to the critical aspects of operability and testability of IEC 61850 automation system.

Substations, wind farms, hydro power plants and distributed energy resources all over the world are now implementing protection, control, automation and condition monitoring functions in the Power Automation System (PAS) with technology according to the IEC 61850 Standard.

Along with the functions of the PAS there must be suitable means for operation and test as a LAN based system.

Conventional “secondary systems” incorporate numerous switches, push buttons, isolating links, test points and indicators for technicians and operators to use when operating, testing or maintaining the system.

The **OTI** provides physical facilities for operators and technicians to carry out their tasks on IEC 61850 LAN based system via the front controls and communication ports.

The **OTI** provides the cyber security validation and generates the necessary IEC 61850 signals to control the automation system IEDs.

The **OTI** Patent can be licensed to be implemented on hardware platforms conforming to IEC 61850. For further information and conditions, or to verify authorized licensing, contact Rod Hughes:

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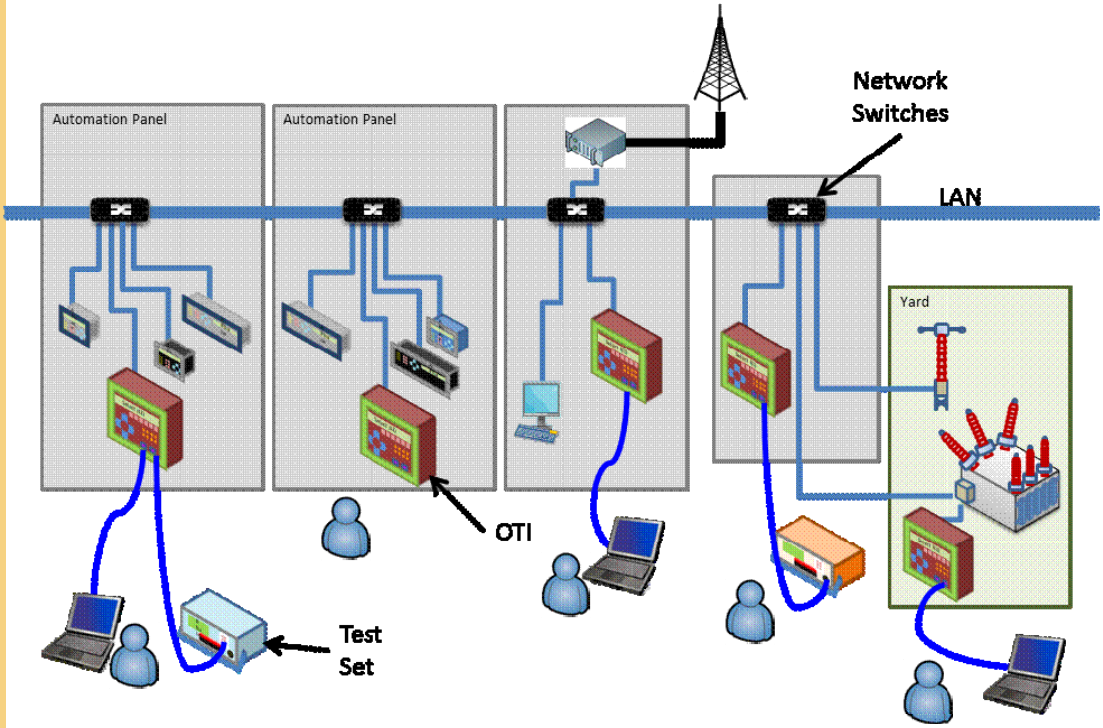
IEC 61850 for Humans
Human Interoperability

VIRTUAL SYSTEMS-
OPERABILITY and
TESTABILITY

IEC 61850 has established the basis of interoperability between the devices and the interoperability of the system engineering tools.

Humans play an essential role in the operation and maintenance of these virtual systems requiring specialized facilities.



Operators facilities

The **OTI** provides the mechanism for humans to interact with the virtual systems to undertake a variety of tasks in the substation quickly, efficiently and safely:

- Control the system: e.g. Setting Group selection, Function enable/disable, Switch on/off ...
- Isolate devices and functions
- Test functions, devices and systems
- Replace devices
- Install new devices

The **OTI** is based on the same reliable hardware and software platforms as the automation IEDs they control and can be mounted as part of the fixed installation at the required control location.

The **OTI** can be standardized by asset owners in every substation to establish consistent operating procedures for maintenance providers regardless of the choice of IEDs with different features and controls.

Maintain Cyber Security

ROLE BASED
ACCESS CONTROL

RBAC is a key element in ensuring effective cyber security measures are in place.

Implementation requires corporate strategy, policy and procedure are entrenched from the outset.

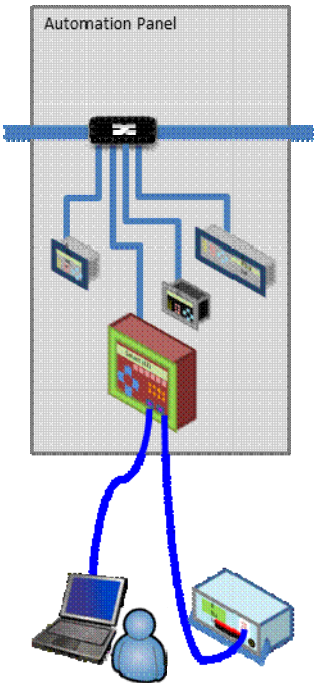
IEDs must individually be configured with RBAC to maintain the integrity of settings and configuration whilst permitting operational control.

This also requires effective RBAC procedures for new and departing employees.

The **OTI** provides the physical facility for RBAC procedures in the automation system.

The **OTI** allows authorized communication and access to the LAN to be established, eliminating the cyber security risk of leaving spare ports on the network switches operational.

Connection of PCs and test equipment to the LAN are made via the ports on the **OTI** front panel.



Before permitting communication with the operating LAN, the **OTI** validates the equipment access to the LAN in accordance with the company cyber security policies and procedures.

The **OTI** can be configured to establish several stages of security without inhibiting the freedom for emergency control of the substation.

Direct operational control is possible using the **OTI** front panel. Role Based Access Password can be used, particularly for maintenance and testing tasks which may affect the operation of the complete automation system.

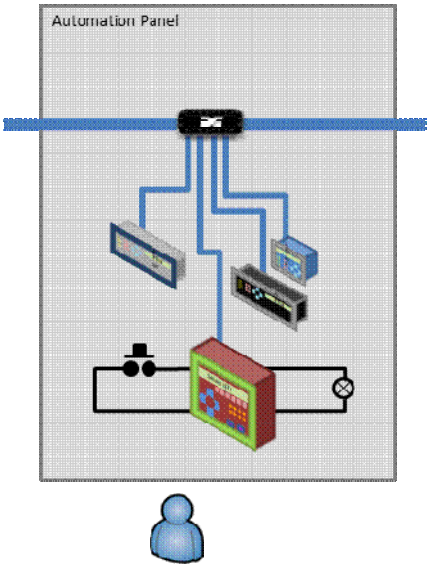
LAN access security is maintained with connections only via the **OTI** front ports. These ports themselves can be subject to Role Based Access Permissions within the device and/or authorization from the User Access Permissions Server and/or from the System Control Centre Operators according to the company's security implementation. The Control Centre Operators can validate the connection in accordance with the Work Procedures lodged for the site work and knowledge of who is in the substation. Once access is granted, the equipment can communicate with the LAN as if directly connected. Security can be further maintained with time-out or log-off systems associated with staff leaving the premises.

Operational Controls

User Friendly, User Familiar

Asset owners and maintenance require standardized control facilities for day to day operation and maintenance of the substation. The **OTI** has the essential characteristics for these controls of:

- Front access
- No special equipment requirement
- Clear individual labeling
- Single function control
- Ease of control
- Independent of choice of IED suppliers
- Independent of the system integrator
- Standardized procedural sequences
- Not dependent on number of buttons/indicators on different IEDs
- Direct function status indication
- Controls directly related to specific panel
- Can be used with conventional controls



The **OTI** provides a standardized control point regardless of the choice of vendors equipment for the automation system. Vendor independence is maintained and consistent operating procedures can be established for all substations.

Buttons, menus, displays and indicators on the **OTI** front plate facilitate direct control of the substation. Separate buttons, switches, links and indicators can be connected to the **OTI** to maintain the possibility of the conventional controls to still be provided, although now operating via the IEC 61850 system.

OPERATING VIRTUAL SYSTEMS

Eliminating wires in the automation system has dramatically

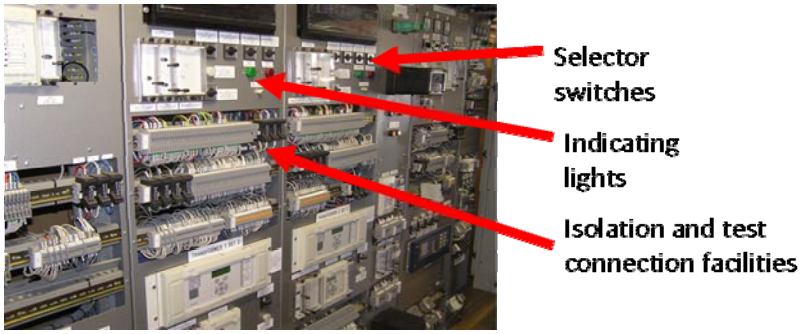
- Eliminated repetitive engineering
- Reduced commissioning
- Increased reliability

However with all signals now passing over a LAN, operational controls require a new approach suited to both the type of technology and the ability for human operation.

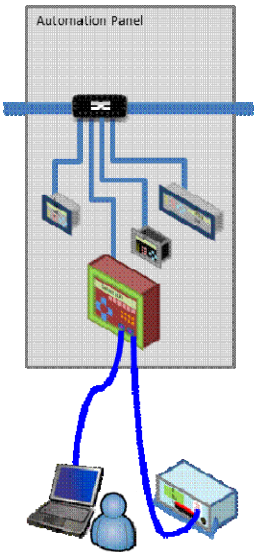
Operators must be able to control the substation without confusion of different IEDs, capabilities, menus and screens.

Systems must be the same in every substation regardless of the choice of IED suppliers for the automation functions and regardless of the System Integrators implementation.

Substation designs have entrenched various facilities for human operation of the facility on a panel -by-panel basis



Physical Safety and Security



The **OTI** provides two vital components for physical access to the automation system:

- Operator physical safety
- Avoiding LAN disruption

The **OTI** eliminates the need to access the rear of the panels where all the electrical and LAN connections are made.

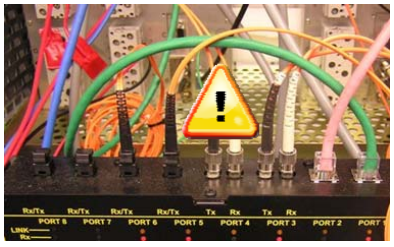
AVOIDING HAZARD AND RISK

Network switches are often located or have their connections in the rear of the cubicle. Whilst the switches may have spare ports for connection of equipment (refer "Maintain Cyber Security"), opening the cubicle exposes the electrical terminals to a variety of staff needing to connect to the network.

LAN based automation systems rely on continuity of the communication system between all IEDs. As the LAN has connections in each cubicle and plant equipment, inadvertent disruption to the LAN during any operator task in any part of the system must be prevented.

The rear panel has a variety of terminals and live wires in a confined space which should only be accessed when absolutely necessary for physical modifications to the system. Connections for testing of the system should be done via the **OTI** front panel to minimize operator difficulty and electrical hazard.

Temporary connections to the LAN can be made through the **OTI** front plate eliminating the risk of inadvertent LAN disruption. The LAN itself is formed by numerous connections between the LAN switches and the IEDs as well as from one switch to another. Unlike screw terminals which are well identified and require tools to disconnect and make connections, LAN connections appear similar (as shown below), can be readily removed by hand and are easily confused. The **OTI** front ports avoids the possibility of disconnecting the wrong cables in the rear of the cubicles.



Function Modes and Isolation Sequencing

The **OTI** is the physical facility for operators to control the operation and performance of the automation system according to the power system requirements and/or the maintenance and test program to be carried out.

The **OTI** converts the operation of buttons and switches into the IEC 61850 commands to enable/disable functions, configure operating modes, select setting groups or turn equipment on/off.

If the procedure involves testing, the **OTI** can issue the required commands to control how the IEDs issue or respond to certain messages — effectively isolating the function and/or IED.

For each task to configure the system for test, or reinstate it to normal operation, the **OTI** will send the sequence of commands and verify the response of each IED. Standardized sequences reduces the risk of critical steps being missed which would otherwise lead to inadvertent power system outage. This has the added advantage of increasing operator confidence with complex integrated systems.

Every IED on the network at some time will need testing, maintenance, upgrade and/or replacement for one reason or another. The **OTI** provides the mechanism for operators to place the automation function IEDs into the correct configuration to enable those tasks to be carried out safely and reliably. As an IED itself, the **OTI** unit also may need to be maintained and hence has to be able to be removed from service without affecting the SAS operation.

The **OTI** is not part of the real time communication between automation functions and so can readily be disconnected from the LAN completely at any time—the one device where disconnecting the communications cable without reconfiguring the automation system is not catastrophic. Any resulting alarms that a device has ceased to communicate raised in the system control center are non critical alarms and can be cross-referenced to the work procedures associated with staff being on site.

Even failure of the **OTI** in service does not constitute a failure of the automation system to function correctly. At the next opportunity for maintenance staff to arrive at site, the first task can be to replace the faulty unit to reinstate the full controls they need for their tasks.

ISOLATING GOOSE

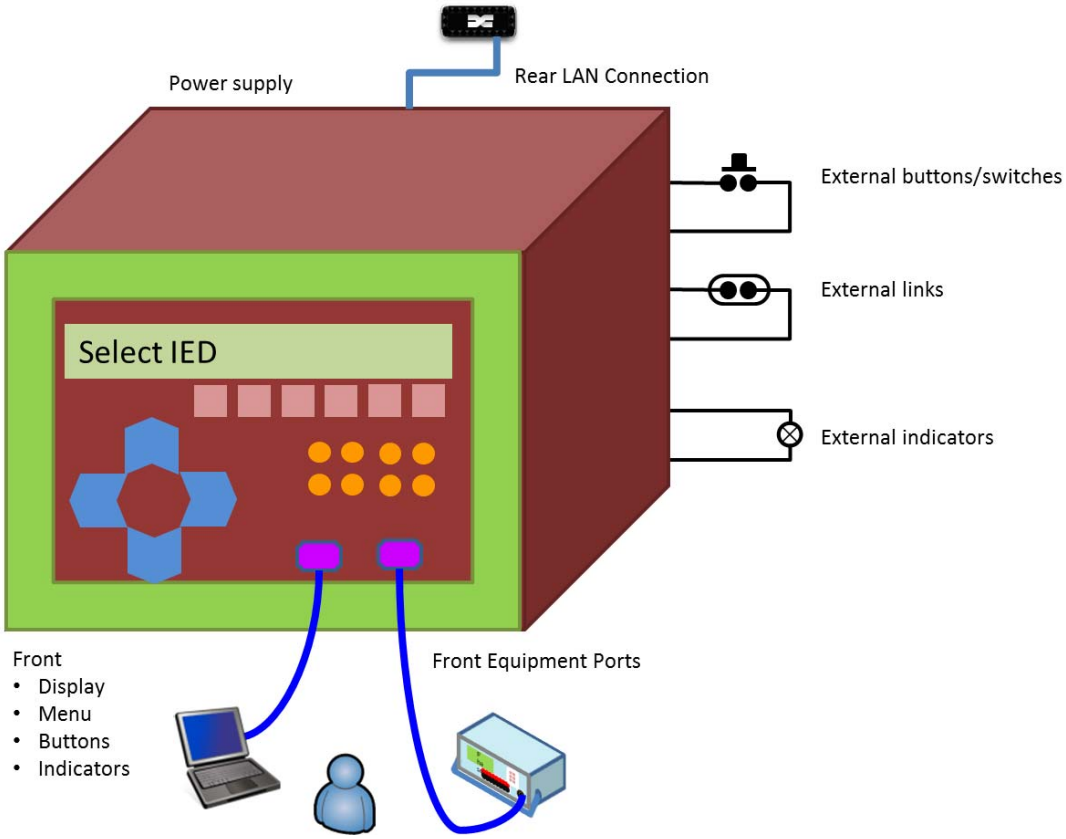
Functions in a virtual system cannot be isolated in the conventional sense of physically disconnecting the cable.

The LAN is carrying a multitude of GOOSE messages, Sampled Values, commands and status signals essential for the total operation of the automation system.

IEC 61850 Edition 2 provides enhanced commands for testing IEDs:

- If the IED data object Mod is set to Test, and a message is received with the test flag set to True, the device will issue its output.
- If the IED data object Mod is set to Test-Blocked, although it may receive a valid signal from another device, it will not issue an output from the IED
- If the data object is set to Sim, the IED will now accept a sampled value from a test set instead of the normal margining unit source.

Operator & Test Interface License



The OTI Patent is a unique solution for the essential facilities to operate and test IEC 61850 systems.

The OTI Patent can be licensed to be implemented on hardware platforms conforming to IEC 61850. For further information and conditions or to verify authorized licensing, contact Rod Hughes:

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Operator & Test Interface

What mechanisms provide the physical controls on each panel independent of the choice of IEDs?

Who is allowed to connect laptops and test equipment to your SAS LAN?

How do you isolate a single function on a single feeder?

What device issues the Edition 2 “Test”, “Test-blocked” and “Sim” commands to the various devices in the SAS to allow testing?

How do you automate correct isolation procedures?

Are the operator controls independent of the devices they are controlling?

Can the operator controls be replaced without disrupting the rest of the SAS?

Are technicians making temporary connections in the rear of the panel reserved for permanent and electrical connections?

Do panels provide the same operator facilities regardless of the IEDs and consistent in every substation?

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