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SLIDE ONE (Title slide)

Testing of protection systems has always required careful consideration of the isolation of the system to allow testing to be carried out without risk of tripping a live circuit, or worse, complete tripping of the busbar causing a large system blackout.

Unfortunately there are incidents around the world in both wire-based and LAN-based systems where this has not been achieved. The question is then learning from both good practice and these bad practices to ensure testing is carried out correctly.

Certainly in a LAN based system, the testing environment is significantly different but we still refer to this as the isolation process.

SLIDE TWO

The CIGRE Australia SEAPAC conference held every odd numbered year had four different proprietary isolation mechanisms presented in 2015! To note this is four years after the release of IEC 61850-7-4 Edition 2 which clarified the intended approach for implementing Isolations.

These papers, and indeed the industry at large, generally refer to "isolating GOOSE", i.e. effectively telling the IED to ignore incoming GOOSE messages or stop sending valid GOOSE messages.

The mechanism for an operator to do this has either been a single push-button on the IED front panel or in some cases the station HMI has a screen to apply the isolation.

However the first thing to note is that the term "isolating GOOSE" is fundamentally wrong!!

IEC 61850 systems are continuously exchanging messages with dozens or even hundreds of pieces of information being sent or being used by the different IEDs.
Isolating GOOSE has the connotation of simply "disconnecting the fibre" – this is definitely not a practice we would use.

In wire based systems we would have an isolation procedure that would selectively open/close the links in a very defined sequence in order to isolate a function from the rest of the system.
The same requirement exists in IEC 61850 based systems but in the sense of controlling how the Device Under Test (DUT) and Function Under Test are going to behave when they receive certain messages, or the contents of messages they publish. Equally we need to instruct how the other IEDs behave when they receive messages from the DUT/FUT.

So we are really isolating FUNCTIONS, not the GOOSE itself!
The GOOSE will continue to be sent and received.

In multifunction IEDs with perhaps dozens of Logical Nodes representing different functions and pieces of information this is far more complex than simply pressing a single HMI push button to apply a global "GOOSE isolation" to that IED.

A simple example is needing to test the operating characteristics of a multistage over current and earth fault Logical Device.
In order to test one particular curve e.g. the IDMT overcurrent curve, we need to leave the first stage overcurrent element OC1_PTOC3 operative in some way. However each of the other Overcurrent and all the Earth fault elements must be switched off so we know we are just testing that one IDMT curve element.

If we then change to needing to test a different element, then we need to turn it on and turn the first element off.

SLIDE THREE

Now we need to consider how other IEDs respond to the messages published by the DUT. And Indeed how the DUT is going to behave in response to messages it receives from the rest of the live substation.

Lets consider a bay with X and Y protection.
The bay CB is closed as is the rest of the substation bays.
i.e. the substation is live, but we want to just test the X protection on one bay

The first thing is that testing the bay X protection must not trip the CB!!

The second thing is that should another live bay have a trip by its X protection, and that CB suffers a CB Fail, our bay's X protection system must still trip our bays CB in order to clear the fault and the CB Fail condition.

On the other hand, the other bays must not trip their CBs if our bay issues a CB Fail signal based on our tests

And then also considering the X busbar protection detecting a bus fault, must allow tripping of the bay circuit breaker.

IEC 61850-7-4 Ed2 Annex A defines the various modes that can achieve this multiple criteria operating state.
However, there are some errors in that table which have been addressed in TISSUE 1331, so please ***make sure*** your IED vendors declare their handling of TISSUE #1331 in their TISSUES Implementation Conformance Statement (TICS) for the IED.

So we can now see that by sending a defined set of commands to the IEDs, and in the right sequence with validation before sending the next command, the IEDs can be set to an appropriate operating state.

The bigger issue is then how the technicians apply these different modes … one method is to use the test set software to pick and choose the settings you need one–by-one. The question is then given the hundreds of functions in the DUT and the thousands of functions in the other IEDs, do you trust the technician, or indeed does the technician trust himself, not to make a mistake?

The logical conclusion, not surprisingly, is not unlike wire based isolations!! The isolation sequence needs to be predefined but taking advantage of the virtual environment this can be automated, either as part of the substation HMI or some other Operator and Test Interface as proposed here: https://ideology.atlassian.net/wiki/x/GoBq