DISCUSSION CONTRIBUTION

NAME: Paulo Sergio Pereira Junior

COUNTRY: Brazil

REGISTRATION NUMBER: 1071

PREFERENTIAL SUBJECT: 2

QUESTION N°: 2.11

A) How should we structure in a best way all tests necessary to secure reliable operation of a complete Digital substation:

Depending on the tests objectives different tests structures can be used. One of the best's choices can be the bottom-up, start testing separated parts and came to a test with all together after.

Certainly there will be different proposes and options to carry on the tests, however the easier way is based on the idea of diving the overall systems into small objects and initiating by carrying on the tests of each individual object and only after that it is suggested the tests on systems integration.

This approach will mitigate the problems and makes the job a little bit easier. It can be initiated by testing the NCIT and IT+SAMU firstly. The connection by the LAN to the IED secondly (checking if the messages are arriving to the IED'S place flowing correctly on the LAN and switches) and at the next step test the IED and if it is out going GOOSE messages are flowing and arriving to the XCBR object. The checks of all power switching equipment are considered to have been done before this proposed tests sequence.

B) Wich are the most important requirements on modern testing equipment to be used.

By definition, the modern test equipment has to allow all kind of simulations that the system can be submitted. The test set has to check all the steps of the process that occurs in a digital substation. Have to deal with IEC 61850 signals interacting with frames and be a bridge between the classic system with analogue signals (Current and Voltages) and binary I/Os and the full IEC 61850 digitalized world the Sampled Value and GOOSE messages.

Some of these requirements can be spotted as follows:

1- High analog current and voltage do simulate primary signal to conventional and non conventional instruments transformer.
2- Measuring of the Sampled Values that arrives from these instruments and comparing with the injected signal in order to confirm if it is working within the expected requirements.
3- Injecting voltages and currents with secondary levels to check Merging Unit type SAMU. Checking expected requirements accordance to IEC 61869-9.
4- Provides network capability able do filter out SV messages originated from MU, trip or logical message like GOSSE messages travelling in the substation LAN.
5- Able to: sending and receiving Sampled Values. In accordance with IEC 61850-9-2LE and IEC 61689-9.
6- Sending and receiving GOOSE messages.
7- Resource for transformation of GOOSE into contact and contact into GOOSE to performs some logics during the integration tests.
8- Others....
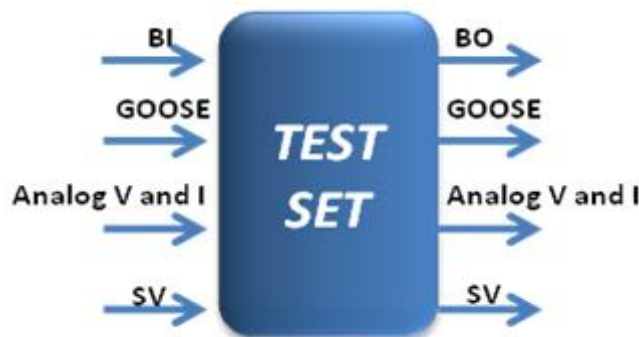
Summarizing, the figure above shows the most important requirements that the modern testing equipment has to have.

C) How should we test complex protection, connected to different feeders in digital substation like transformer differential protection, Bus bar protection and line current differential protection.

The core of this question is concerned with several NCIT or several MUs. Many complex protections uses to measure more than one feeder to make the decision, so, the testing tool must to simulate more than one feeder, in other words, more than one MU.

The physical location where the MUs are installed can influence the how to do the test. What kind of signal will be injected is another issue. There are two fronts: if the test will

be done injecting the Analogue signal on the MU inputs or if the test will be done injecting SV messages on the Switch and IED, this answer will addresses the last one.

Test injecting SV messages is less affected about distances, if the distances are small like in the same substation, the approach can be to use one equipment having the synchronization of the generated signals inside of it, and it will need to have several channels to do the test.

However if the distances involved are not small (like line protection) there will be the need of several instruments, distributed (one near each feeder/bay), in the station grid all synchronized by GPS, IEEE-1588 or other sync solution.

Synchronize two or more testing tools is not the first choice, because, makes the work harder and expensive. But, in some case it has to be made.

The sheet below makes a connection with the Protection Function and the test location showing how many test tools will be necessary to accomplish the test.

Protection / Local	Lab (FAT)	Field (SAT)
87 T	One Tes Set	One Test Set
87 B	One Test Set	One Test Set*
87 L	One Test Set	Two Test Sets

* Depending on the physical distance and the Number of MUs (feeders)

With the capacity to inject several signals (SV), simulating several Merging Units the testing tool will be able to test complex function on a fully digitalized substation.