Decentralization and online monitoring reduce your transformer problems

Power Transformers, essential for transmission and distribution networks and, usually the more important assets of a substation, can have eventual failures diagnosed or predicted through online monitoring systems based on decentralized architecture. This novelty, that can also be applied to the small and medium size models, has been considered an important tool to know the status of the equipment, bringing about a change in the maintenance philosophy: the acceleration of the preventive maintenance to the predictive.

Tipically, these systems consider the measurement of variables by sensors and/or signal conditioners, connected to two architectures: or the one based on a centralizing element on the transformer body in general a PLC or Programmable Logical Controller; or the decentralized, based on IEDs – Intelligent Electronic Devices) in the transformer body. See below the differences between the two architectures:

In decentralized architecture systems, serial communication may be employed in the RS-485 standard, in addition to fiber optics, and also dedicated radio links and Wi-Fi wireless networks, depending on the installation.

If the computer that stores and process data is in the substation control room itself, the connection with the transformers is direct. If it is remote, the transmission can be done also through the company's Intranet, the Internet or GPRS cellular modem.

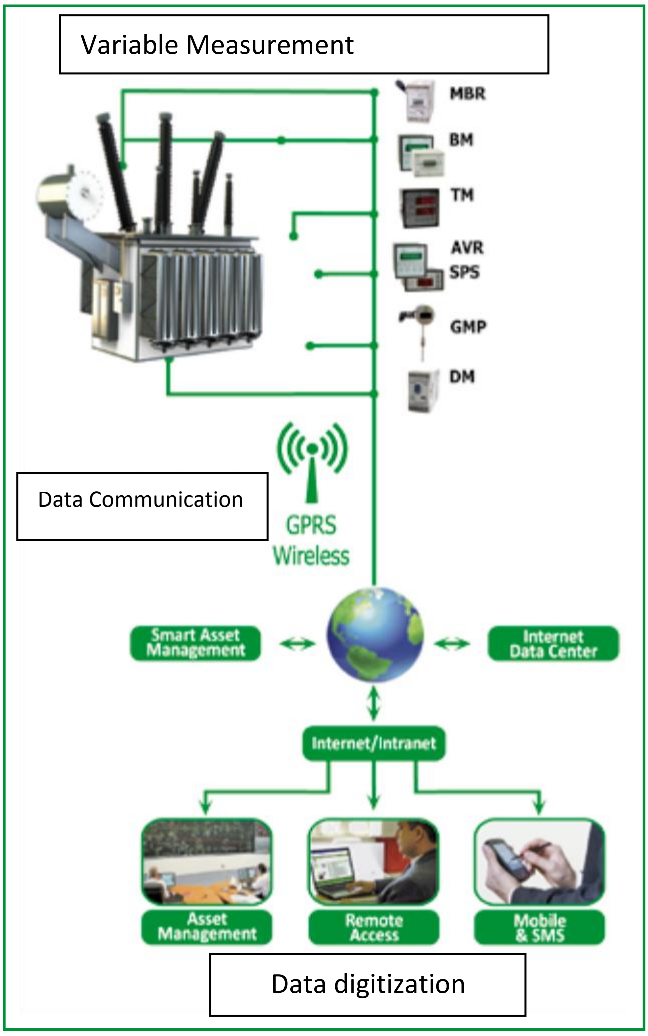
The data provided by the IEDs, including raw measurements and the information resulting from data processing, are received by a computer that runs the monitoring software. A monitoring system must be able to digitize and transform the data in information that are helpful for the maintenance – diagnosis and prognosis of the equipment status and have an "Engineering Module" with the algorithms and mathematical models.

Centralized Architecture	Decentralized Architecture
Centralized System – The PLC concentrates the information of all sensors and sends it.	Decentralized System - The sensors are IEDs that send the information directly.
Expansions and maintenance service are more difficult to do.	Naturally modulated, facilitating expansions and maintenance.
The sensors must have a dedicated connection to the PLC, causing eventual duplications of sensors and additional costs in monitoring systems .	IEDs already existent in control and protection systems can be integrated to the monitoring and data acquisition systems thus avoiding additional expenses with sensors.
The PLC demands additional installation, programming and maintenance costs.	There is no centralizing element - elimination of additional costs.
PLC failure may cause loss of all system functions.	Any failure in an IED causes a loss of only a part of the functions – the other functions still work.
The centralizing element (PLC) is an additional failure point of the system.	The centralizing element does not exist, and therefore a possible failure point is eliminated.
Maximum operating temperature of the PLC is 55ºC. It should not be installed next to the transformer.	Operating temperature is from -40 to +85ºC, adequate for installation in the yard next to the transformers.
Installation recommended in the control room – several cables required to connect it to the yard.	Typical installation next to the transformer – only serial interface required (twisted pair or fiber optics) to connect with control room.
Typical insulation level 500 V – not adequate For the high voltage substation environment.	Typical level of insulation 2.5 kV – designed for high voltage substation environment.
Serial communication doors are not resistant to surges impulses and inductions existent at substation, which makes it necessary to use fiber optics to connect to the control room – high installation cost.	Serial communication ports designed for the substation environment allowing the use of twisted pair to connect to the control room - low installation cost. As an option, it allows the use of fiber optics.
In general, they operate with industrial communication protocols.	Specific communication protocols to be used in power systems (time-stamp, clock synchronicity etc.).

This table summarizes the main diagnostic modules that can be specified for a monitoring system, as well as the measured variables that are needed for its operation.

The adoption of online monitoring systems for power transformers must take into consideration the system specification, the variables to be measured, the measurement architecture and the desired diagnostic modules. With the decentralized architecture based on smart devices (IEDs), it is possible to apply specific diagnostic modules, and still use the IEDs already in the transformer with zero cost for the monitoring system. The architecture still allows the implantation and gradual expansion of the monitoring system, respecting the availability of company resources and the installation of a bigger number of transformers.

Therefore, online monitoring systems can be applied to both small and medium-size transformers, and not only to the large transformers anymore.



Diagnostic Module	Necessary variables
Reduced insulation service life	- Winding temperatures (hot-spots) - Water content in paper (obtained from diagnostic module)
- Future temperature prediction - Cooling system efficiency Cooling maintenance assistant	- Ambient temperature - Top oil temperature - Loading percentage - Operating cooling stage Operating Cooling Stage
- Water in oil and in paper - Bubble Formation temperature - Free water formation temperature	- Water in oil Relative Saturation percentage - Water in oil content in ppm - Oil Temperature at measurement point - Winding temperatures - Ambient temperature
Gas in transformer oil	- Concentration of hydrogen dissolved in the oil - Concentration of flammable gases in oil (off-line or online)
Differential of temperature of the OLTC	- Top oil temperature - OLTC oil temperature - Tap position
OLTC operation time	- Tap position of tap - OLTC in operation /off
OLTC Motor torque	- Tap position - OLTC in operation / off - OLTC motor current - OLTC motor voltage (optional)
OLTC maintenance assistant	- Tap position - OLTC in operation - Load Current
- OLTC moisture in oil	- Water in oil Relative Saturation percentage l - Water in Oil Content in ppm - Temperature of the at measurement point

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