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SYSTEM FOR INTEGRATION OF PROTECTION AND CONTROL DEVICES

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SUMMARY

CHESF is one of the largest and most important utilities in Brazil. It is responsible for the generation and transmission of power for nearly 50 million people in Northeast Brazil. CHESF's power system comprises 97 substations and 18,232 km of transmission lines, 96 % in the levels of 230 and 500 kV, covering approximately 1,200,000 km^2. Many substations are located far away from the maintenance centers, bringing difficulties when an immediate action is needed in the field. One of the ideas is to decentralize the maintenance process as much as possible. On the other hand, this involves many organizational difficulties as well as high costs.

Intelligent Electronic Devices (IED) have been largely used for a number of applications in the area of Protection, Control and Automation. IEDs incorporate themselves a number of new features such as the supervision of trip logics and voltage/current analog inputs, therefore contributing for the minimization of hidden failures. New IED features are also important for relay selectivity studies as well as for supervision and post fault analysis.

Accessing information from IEDs is still difficult. In many situations it is necessary to move specialized personnel to the substations for this purpose causing last minute problems and inconveniences like expenditures not previously planned.

Post fault analysis and improvements in relay coordination studies have been performed using the resources available so far, sometimes leading to incomplete conclusions or even reissuing new analyses.

Depending on the situation the response time becomes a very important point of the process of Disturbance Analysis. It is a requirement as per the rules of the Brazilian Grid Procedures that Power Companies respond promptly, and also provide appropriate documentation

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regarding disturbances in the power system. Usually the most important information comes from the protective devices.

CHESF has strongly invested on telecommunication infrastructure, linking all its facilities with high capacity data transport, therefore providing basic conditions for the design and the implementation of the System for Integration of Protection and Control Devices, which will give support to the maintenance and operation of the power transmission system.

This article describes the characteristics of the solution being implemented by CHESF, which aims to integrate all IEDs by providing suitable conditions for remote access of fault data and parameterization. Incorporating new features of investigation and supervision, the basic principle of this System is to provide greater flexibility to the maintenance and disturbance analysis teams.

KEYWORDS

IED, protection, disturbance analysis, database, COMTRADE, integration, WEB, intranet, protection devices

1. SOLUTION

The main purpose of the System for Integration of Protection and Control Devices is to provide a way for remotely communicate with protection devices, so that data will be collected and used for various purposes such as disturbance analysis and post fault evaluation of relay performance. The possibility of changing settings remotely without the onus of sending a crew to the field is another plus. Additionally, the System provides alternative tools for the maintenance such as high definition video transmission data, allowing, when required, video conferences and more detailed discussions. The System incorporates other features like ambient information of temperature and humidity at the relay houses and outside cubicles, making it possible to monitor the environmental conditions to which most important protection and control devices are submitted.

By the time of its conception, four years ago, this project was unique in Brazil. Recently, a similar idea has been reported by another Brazilian Utility.

Considering the variety of IEDs the System has the ability to communicate with all of them despite the different protocols and access modes provided by the manufactures.

Developed under WEB functionality, the System provides data already collected for viewing from any workstation connected to the intranet with the possibility of being integrated with the Internet in the near future. These features incorporate the best techniques for information protection such as user authentication, VPN, Firewall, etc.

The System has an Automatic Module for collection of oscillography and internal events from IEDs, using mechanisms for monitoring and alarming, pointing out possible inconsistencies on the collected data or communication failures.

Through the Search Module, using WEB interface, one can view collected data for the preparation of graphs, statistics and other reports.

There is also the Parameter Audit Module, which is used by the maintenance teams as a supporting tool, which automatically performs a comparison between the internal parameters of the IED and the order of production issued by the protection engineer. This action can be performed after every downloading or changing of parameters in the IED.

Other Modules provide the following features: storage data of protection and control devices, database management, lists of alarms and events, System administration, and SMS and email messages.

2. SYSTEM ARCHITECTURE

The System for Integration of Protection and Control Devices consists of three distinct blocks, installed at the Central Station (Recife), Regional Stations (Salvador, Maceió, Sobradinho, Recife, Fortaleza and Teresina) and Local Stations (substations).

Each Local Station (Figure 1) has a Concentrator, installed with hardware and configuration compatible to an industrial PC, for communication with various Terminal Servers, which in turn communicate with a maximum of 20 IEDs. Galvanic isolation and electric/optical converters are included. The Terminal Server is installed preferably in the same physical location of the devices being monitored (relay houses or control room). The Concentrator and Terminal Server are connected to the same substation local area network (ethernet). Software, specific to each manufacturer is installed in the Concentrator with proprietary protocols for communication with all devices being monitored.

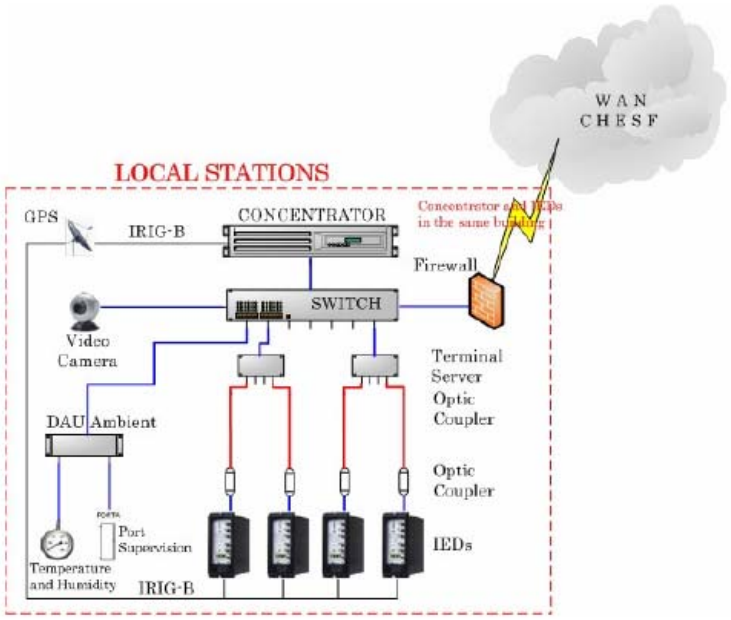

Figure 1

The firewall installed as a gateway for the local network is implemented through hardware (industrial PC), running the application under Linux, and free to migrate to other operational systems but also having tools that facilitate the manipulation of rules.

Parameterization Consoles, which allow for the parameterization of digital devices, are housed in the Regional Stations (Figure 2). From these Consoles as well as from any machine connected to the intranet is possible to access all the data collected by the System.

The main task of the Consoles installed at the Regional Stations is to provide direct connection to all IEDs in their areas of responsibility. This connection is accomplished through the use of an open VPN for communication with a certain IED. This communication is done similarly to that performed at the front door of the IED. For that, specific software is installed for all existing IED models in each Regional Station.

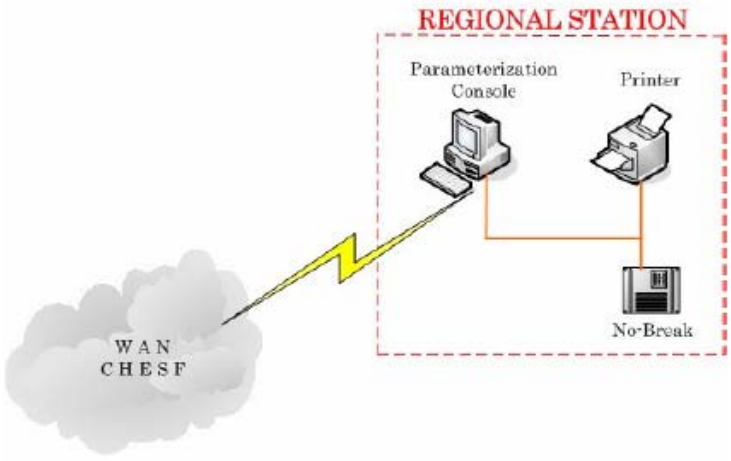

Figure 2

The Central Station (Figure 3) is comprised of four servers: Primary Server, Secondary Server, Web Server and Contingency Server. The Primary and Secondary Servers are mirrored and contain the System Database. The Web Server provides the interface for the user and has the Contingency Server as "hot standby". The Parameterization Console has the same characteristics as those installed at the Regional Stations, but with larger action, accessing all substations of the Power Transmission System.

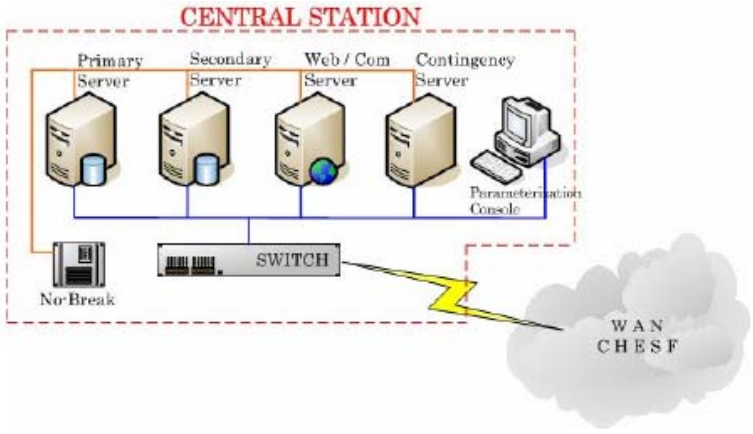

Figure 3

3. FUNCTIONAL DESCRIPTION OF THE SYSTEM

The System for Integration of Protection and Control Devices provides information collected from substations in a centralized fashion and offers several features for supervision, where the main ones are described below:

AUTOMATIC DATA COLLECTION MODULE

This module is responsible for the automatic collection of oscillography, list of events and parameterization of the devices being monitored and environmental information (temperature and humidity) of relay houses. The set of applications is installed in the Local Concentrator computer, making use of specific software from the manufacturers of the IEDs.

The automatic communication with the IEDs is accomplished through a script ("robot-software") that automatically opens the communication software and send commands (sequence of clicks) to perform the desired action. A command for an automatic data collection may be performed by a scheduled scan or by an immediate request from the IED right after its operation, indicating the existence of new events.

Oscillography is converted to the IEEE COMTRADE format and then sent to the Central Station. The events are available in the form of text file or CSV (Comma Separated Values) and then sent to the Central Station. The parameterization is provided in the form of text file for use in the Audit Module and also as proprietary file format. Temperature and humidity data are available in spreadsheet format, which allow for the creation of graphs and statistics to monitor the environment where IEDs are installed.

All data collected from the IEDs are sent to the Central Station via a FTP server installed locally.

AUDIT MODULE

This module runs at the Central Station and aims to compare parameters of the devices being supervised with the official Orders of Production (IED settings) stored in the database server. If differences occur, an alarm message is sent to a pre-defined list of people. As a result, a text file is displayed pointing out the differences one by one.

VIDEO TRANSMISSION SYSTEM

The System for Integration of Protection and Control Devices incorporates features for video transmission with the primary goal of supporting the maintenance crews in the field so that images may be used in real time for discussions and technical definitions. Image transmission uses a private communication network that allows limiting the bandwidth used, thus avoiding the collapse of the telecommunication systems.

4. CONCLUSIONS

The System for Integration of Protection and Control Devices is designed to help the maintenance crews and the disturbance analysis team, allowing them to access and to use data from the IEDs, thanks to the development of digital technology. Fault data (oscillography and events) and environmental data (temperature and humidity) will be available in a centralized fashion. Also periodic audits on the parameterization files will be performed

The primary function is to access devices, providing in a centralized fashion, fault data (oscillography and events), environmental information and parameter files audit.

The architecture of the System (Figure 4) provides various forms of supervision of the process and operation not yet fully explored. Currently the System integrates 41 substations comprising about 1000 IEDs but is still growing due to new IEDs that will be incorporated into the power stations as a result of an on going process of retrofit and also by a continued growth in the power sector.

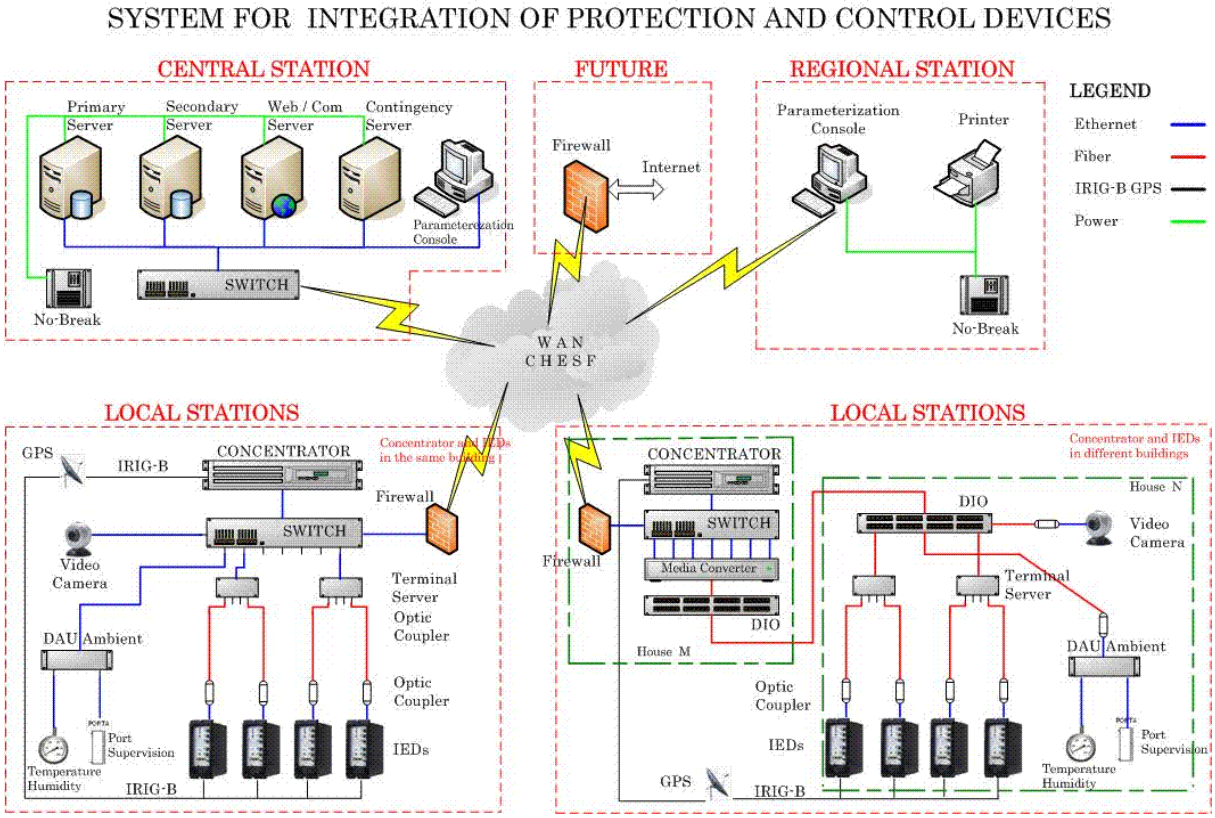

Figure 4 - Architecture

Prompt responses required by society regarding disturbance analysis and difficulties of accessing records from IEDs prevented us not to use such information in a number of situations, consequently leading to incomplete reports and making it difficult to visualize improvements on the protection practices, setting calculation studies and new functions that could be implemented on these devices.

Moreover, the possibility to access IEDs remotely has contributed for the speed of action of the maintenance crews during programmed or urgent interventions, especially for distant substations from the maintenance centers.

A new feature that has been incorporated to the System is the ability to provide live images from the relay houses, allowing conditions for long distance conferences during maintenance.

The System for Integration of Protection and Control Devices became an important tool for diagnosing protection performance during disturbances in the Power Transmission System and also for offering tools to optimize the work performed by the maintenance crews.

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