SUBSTATION OPTIMIZATION USING IEC61850 WITH HARD FIBER IN SUBSTATION AUTOMATION SYSTEM

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Abstract- Substation has a critical role in power stability. The equipments in conventional substation have been work for several years and problem in one of them make disruptive in power network. Optimization of conventional substation increase reliability but usually these substations are online and working in critical point of the power network and changing device in offline mode is not accessible.

This paper proposes to replace online substation automation system for optimizing conventional system in parallel mode with previous system with Hard Fiber because it is the best way for connecting old device to IEC61850 network.

Keywords: Substation Optimization, IEC61850, Substation Automation System, Hard Fiber.

I. INTRODUCTION

Development in power network with increase substation in different voltage level beside high demand for electricity, need improving reliability. One of the important blocks out reasons is related to device in conventional substation, Also lacking of data in substation makes wrong decision especially in critical time. Therefore another way besides replacing new equipment is reduce human error to decrease block out in power network.

Changing in automation system is the best way to increase reliability in online conventional substation because the new system can work beside old system as subsidiary system in parallel mode.

A. Intrude to optimize conventional substation

Conventional substations have two important problems. The first is related to equipment because every device has cycle time and after that its performance reduces until stop it.

The next problem is related to quality of service. Incompetent protection and control system beside low metering accuracy make problem in control of power network.

Optimization of substation means replace new device in substation according to access more reliability and it needs minimum offline time that is possible with implant DCS (Distributed Control System) in substation automation system. Because this system can work as a subsidiary system and after test it can work as a main system.

So because of some important emerge reasons that mention in below it is need to optimize conventional substation:

- solve conventional substation problems
- communication between new substation and control center
- Impossible to ignore conventional substation
- Increase reliability in power network

In this paper the authors describe implementation of new technology (IEC61850 Standard) in conventional substation for increasing reliability that lead to optimize conventional substation. [5, 6, 9]

B. Background to SAS application

The SAS (Substation Automation System) is a system that provides the automation functions for monitoring, control and protection within a substation and utilizes recent improvements in the fields of electronics, information and communication technologies. Application of SASs has increased to fulfill a market requirement to decrease the total cost, including the life cycle costs of substation equipment, provide highly effective operation or near-limit operation of substation equipment, and the optimization of maintenance costs etc. Application of SASs to substations began in the 1980's, and systems applied in accordance with international standard specifications such as Ethernet and TCP/IP, etc. as well as systems that utilized proprietary methods from different manufacturers have been applied from the early1990's. IEC 61850 based on Ethernet, the

International standard for communications within substations was established between 2003 and 2005 and has become very popular and its application has increased very rapidly in recent years. The objective of the standard is to design a communication System that provides interoperability between the functions to be performed in a substation but residing in equipment (Physical devices) from different suppliers, meeting the same Functional and operational requirements. [13]

It is expected that the system will be easier to configure in response to the market requirements by having the necessary flexibility in system configuration. The new standard continues to have a large impact on the design and implementation of SASs and very positive active discussion has continued based on the practical experience gained by manufacturers, system integrators and end-users. In addition to the efforts to provide an advanced solution for substation automation Systems, there is also a need for extending the automation that is possible with this standard. In the IEC61850 architecture model, the protocol are based on communications over Ethernet networks and on client-server type models, additionally allowing horizontal communication between different devices, Figure 1 shows 7 standard layer (OSI Model) of this protocol.[1]
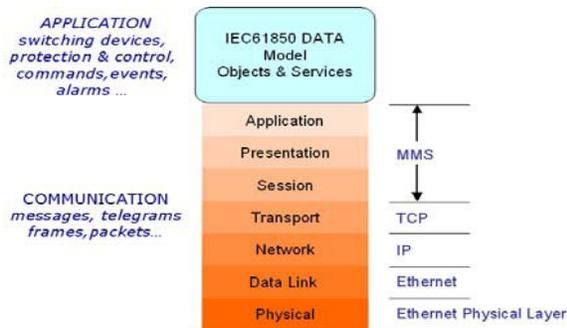

Figure 1 IEC 61850 based on Ethernet

Main features of IEC 61850 are as follows:[7, 8, 12]

- Interoperability by various manufacturer
- High data transfer among IEDs or peer to peer communication model instead of master-slave Communication model in recent protocols.
- Object-Oriented Model which contains whole data specifications Instead of single-oriented model with each data Definition by numeric addresses.
- Supporting functionality of devices to provide better Communication.
- Communication extend ability and data integrity
- Providing integrated communication system.
- Providing robust management of substation automation system.

And its new edition (IEC61850 Edition 2) is establishing for inter-substation communication especially in smart grids application. [2]

Therefore the advantage of substation automation system with IEC61850 are: [10, 11]

- Decrease the area of control system
- Utilization of control and protection function near switchgear devices
- decrease human error
- Decease maintenance cost
- Increase reliability
- Emit fault recorder equipment

IV. IMPLEMENT IEC 61850 IN TRADITIONAL SUBSTATION

All new devices that replace old devices support IEC 61850 protocol, but there is a problem with old devices, because they don't support IEC 61850 protocol. Hard Fiber solves this problem, which makes IEC 61850 process bus solution in a substation.

The Hard Fiber process bus system represents a true breakthrough in the installation and ownership of protection and control systems, by reducing the overall labor required for substation design, construction, and testing. This innovative solution addresses the three key issues driving the labor required for protection and control design, construction and testing:

- Every substation is unique making design and drafting a one-off solution for every station
- Miles of copper wires needs to be pulled, spliced and terminated
- Time consuming testing and troubleshooting of thousands of connections must be performed by skilled personnel

The Hard Fiber system was designed to address these challenges and reduce the overall labor associated with the tasks of designing, documenting, installing and testing protection and control systems. By specifically targeting copper wiring and all of the labor it requires. [3]

V. IMPLANT HARD FIBER INTO SAS

Bricks (Hard Fibers) are the input/output interface to the copper world. Their function is to acquire the AC current and voltage waveforms and contact input status from a primary power system element and transmit this information to the control house via optical fiber. Bricks also apply commands received from the control house to the associated switchyard elements.

To facilitate design, construction, testing and maintenance, Bricks are designed to be as simple as possible. They have no settings; the system is fully configured via the relays.

Figure 2 hardier (GE product)

All process inputs are always sent to all connected relays and all valid commands are accepted from the connected relays.

The copper cables are intended for generally short runs such as between a Brick mounted on the outside of a breaker mechanism cabinet and terminal blocks inside the cabinet. However, cables for longer runs can be ordered to connect to more distant apparatus.

Figure 3 copper cables

The underlying driver for the Hard Fiber System is the reduction of Total Life Costs of protection and control through labor and resource optimization.

This optimization is achieved by replacing individual, labor-intensive, individually terminated copper wires with standardized physical interfaces and open digital communications. Some key benefits of the Hard Fiber system: (see also figure 4 and 6). [3]

❖ Reduces up to 50% of labor for protection & control
❖ Replaces extensive copper wiring with pre-terminated copper and fiber cables
❖ Reduces specialized on-site labor by shifting spending to readily available materials
❖ Improves employee safety by leaving potentially dangerous high-energy signals in the switchyard
❖ Reduces the chances for operational mistakes made during isolation and restoration for routine maintenance
❖ Built on the Universal Relay (UR) family, allowing for fast transition into most protection and control applications including:
  • Generator protection
  • Transformer protection
  • Transmission Line protection
  • Bus protection
  • Feeder protection
  • Motor protection
  • Capacitor bank protection
  • Wide area network protection
  • Distributed bay control
  • Digital fault & sequence of event recording
  • Substation automation

Figure 4 Hard Fiber advantages

Figure 5 Optical Fiber advantages

The HardFiber System provides an unprecedented level of diagnostics and self-checking, allowing critical protection and control systems to do something that they have never done before, operate without routine maintenance.

Internal diagnostics and self-tests within each Brick monitor dozens of critical internal subsystems and provide this information several hundred times per second. Duplicate Bricks can be provisioned to acquire each input signal twice, allowing protection and control devices to continuously crosscheck critical protection measurements before executing commands via fully redundant outputs. (See figure 6 and 7)

With the HardFiber redundant architecture, it can be possible improve reliability and also each protection and control device can be configured to maximize dependability and security, addressing specific application requirements. The application of redundancy depend on substation that important substations need robust and reliable topology. Reference [14] classifies substation and propose suitable architect on process level.
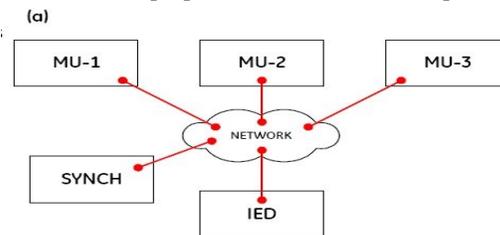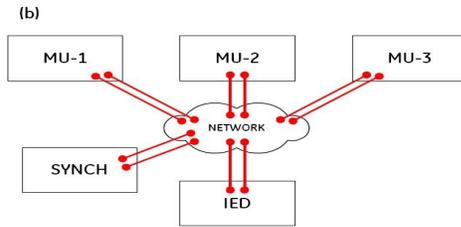

Figure 6 Without redundunt

(b)

Figure 7 with redundant Hard Fiber

VI. CONCLUSIONS

Increasing reliability in power network has significant role. The conventional substation reduces it with increase block out. Therefore optimization in conventional substation is the main step to improve quality of electricity. Replacing automation system is the best way to optimize of substation because it is possible with minimum offline time and maximum economical and performance advantages where as new system can work in parallel mode with conventional system. All new devices that replaced in SAS (Substation Automation System) support IEC61850 standard, for connecting old devices into this bus (IEC61850 standard), Hard Fiber is the best equipment that is product of General Electric company. For increasing reliability in important subsation, spare communication bus are used by redundant Hard Fiber.

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