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SUBSTATION AUTOMATION SYSTEMS

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Abstract- Substation automation has critical role in power systems, Substations are responsible for many protection, control and monitoring functions.

Nowadays with the latest technology development many intelligent electronic devices (IEDs) available in substation it need to use new technology in control system.

In this paper consider Distributed Control System (DCS) in substation automation and application in Control , protection power system and improve the monitoring.

Keywords: Substation Automation System, DCS, IED .

I. INTRODUCTION

Nowadays with increase IEDs and develop the software program and consider to hundreds of new functions available every year for example the function that find fault in power system. And requirements for automated fault analysis functions that may be performed in substations in the future, it is important to review in substation control system.

In this paper consider compare between the two conventional system and DCS substation ,and it illustrate DCS structure, and control, protection and monitoring system .

II. COMPARE BETWEEN CONVENTIONAL AND DCS

Conventional substations are equipped with a centralized event recording system. It has multiple inputs that are connected to outputs of different primary or secondary substation equipment.

Distributed event recording is based on the features of individual multifunctional IEDs in the substation

The advantage of this distributed event recording is that it provides very detailed information for any event in the substation or the power system. It can be used by the IED itself or within a distributed analysis system.

Addition of convention automation system, the DCS has more ability, for example calculate the harmonic surface in power system, fault failure and new control function and protection function.

Also the DCS has more initial cost(3138572040 Rials Iran currency more than conventional [3]). But after some years the cost pay back , and it is because of some reasons for example lower maintain cost in DCS ,another example is lower operational costs are achieved by remote system management, where personnel doesn't spend time by travelling between substations, and can work all the time from his office. So The DCS has benefit.

Pay back in Iran is about 11 years [3], Compare as lifetime is difficult because there are no experiences about the DCS system that so far.

But after consider lifetime of a substation is up to 50 years and payback's time so the DCS is economic.

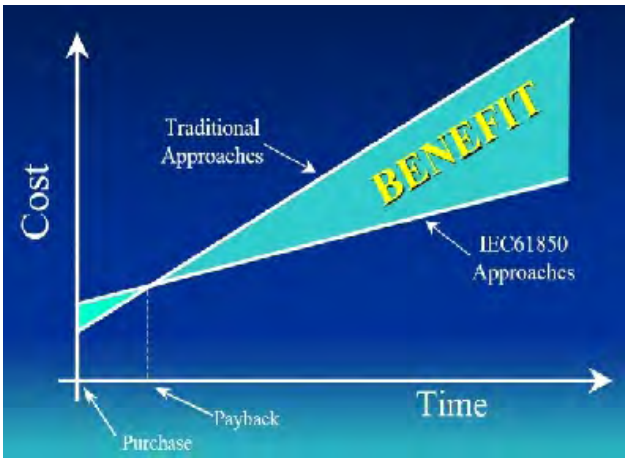

Figure 1.

III. DCS STRUCTURE

There are three levels in DCS structure

- Station level
- Bay level
- Process level

Station level is the upper level where centralized system computers, Human Machine Interface (HMI) and gateways for connections to Network Control Center (NCC) are located.

Bay level is the middle level where the protection distributed control equipment is located.

Process level is the lowest level where the switchgear equipment is located including the sensors and actuators that are necessary to monitor and operate the switchgear.

Example of sensors is the current and voltage transformer, and example of actuators is drive mechanism for breakers and isolators.

Tree levels in substation control and protection system in DCS system instead of two level systems. There are two bus for communicate between this three levels.

The station bus provides communication between station level devices and bay level devices and the process bus provides communication between bay level devices and primary equipment.

Both structure conventional and DCS substation show in Figure 2 ang Figure 3.

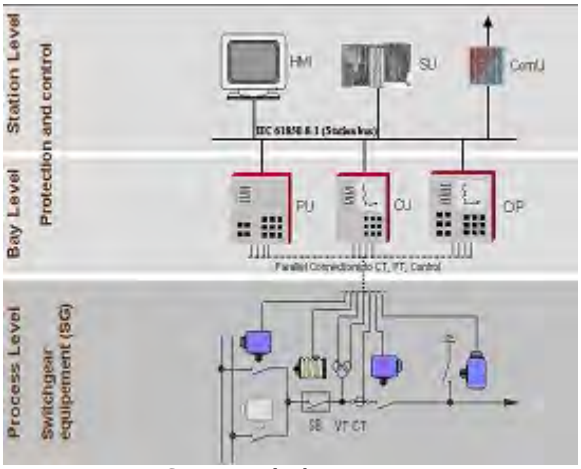

Figure 2. Conventional substation automation system

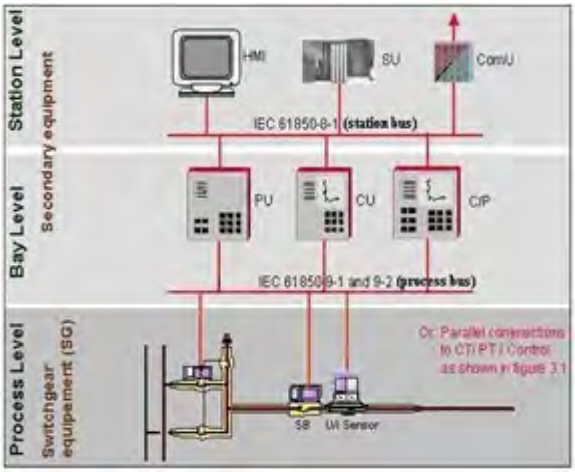

Figure 3. DCS substation automation system

Management of data for decision is important in automation system, and communication in these levels is by special protocol that discuses in next part.

With the development of modern technology, especially in the areas of microprocessor and control, the performance of the protection relays has been significantly improved.

And implant new technology such a client server and Agent. For communication

IV. SUBSTATION AUTOMATION SYSTEM COMMUNICATION

IEDs in bay level communicate to each other and upper level for control , measurement and protection by special protocol .so it is necessary use standard protocol for communicate different IED from different manufacture had different protocol .IEC 61850 defines a comprehensive standard protocol for communication in substation since 2004 and it has high-speed peer-to-peer communications between multifunctional Intelligent Electronic Devices (IEDs) in IEC 61850 based substation automation systems allow significant improvements in the functionality of the system without the need for installation. [1]

The objective of IEC61850 is to design a communication system that provides interoperability between the function to be performed in a substation. Interoperability protocol means the capability of two or more intelligent electronic devices (IEDs) to exchange information to use it in the performance of their functions for correct co-operation.so residing in equipment from different suppliers, meeting the same functional and operational requirements. So the main goal of IEC 61850 is interoperability.

IEC 61850 is based on Ethernet so it allows different physical variants. Since the standard and Ethernet is supporting both client-server relations and peer-to-peer communication, any communication topology connecting all related IEDs fulfills the functional requirements. [7]

Both the station and process level communication are covered by IEC 61850.

V. POWER SYSTEM ANALYST IN DCS

Power system analyst is important for detect the fault and fault diagnosis, especially in critical time, DCS software help system to correct decision.

These function software usually contains neural network and fuzzy logic function and new disign robust controller such a design with H inf method, also predict algorithm function for fault prediction in power system.

Another characterize in DCS is implement the GPS system to common base time in deferent substation so achieve exact analyze by compare respond from power system and it is suitable for same event in future and in predict algorithm.

VI. IMPROVE MONITORING IN DCS

Data management and analyze are important in substation monitoring and they are achievement with new software function. Because of replacement optical fiber instead of wire for transfer signal, DCS can transfer a lot of signal. There is a sample of substation monitoring in Figure 4.

VII. CONTROL AND PROTECTION IN DCS

Power systems development need to optimization in control system, DCS is able to update control and protection function so it is suitable in power system development.

In the past, Protection and Control (P&C) systems consisted of numerous Electromechanical relays. A line protection system would typically contain ten or so Primary relays, many priced the same as an automobile. Later, solid-state relay

Technology emerged where by two measuring units (phase and ground), each in the same price range, replaced the ten primary relays. Now, a single microprocessor based relay costing a fraction of the price

of a solid-state measuring unit, performs all the measuring functions, incorporates auxiliary relay functions, and provides fault and event recording.

In addition, microprocessor based relays support serial communication technologies originally in DCS developed for business applications and industrial automation is simple with this new relay.

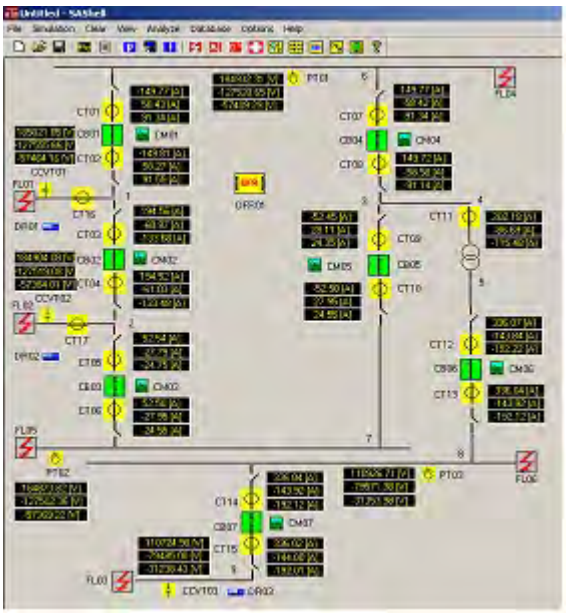

Figure 4. Substation monitoring

VIII. CONCLUSIONS

One of the conventional substation problems is Factory Acceptance Testing (FAT) and Site Acceptance Testing (SAT) . But in DCS those are simply with software function .

FAT test is contract between the supplier and the user before it leaves the factory .missing part like switchgear has to be simulated. Therefore, IEC 61850 is tested implicitly on system level.

SAT test is contract between the supplier and the user before it goes into operation, on site all parts are normally available and no part has to be simulated any more.

IEC 61850 simplifies the SAT since by assuring a correct connection of all external interfaces, the data consistency and the logical behavior of the functions can't deviate from the known FAT state.

More DCS advantage in substation automation are

- decrease the operator fault
- simple control in dispatching
- speed fault diagnosis and economize time
- optimal and continues monitoring
- developed control, protection and monitoring
- achieve exact information from substation
- self healing systems (this is ALSTOM patent)
- decrease wiring in substation(it is shown in Figure 5 and Figure 6)

Figure 5. Convention substation wiring

Figure 6. Optical fiber in DCS

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BIOGRAPHY

Saeed Roostaee was born In Shiraz, Iran, 1985. He received the junior and the B.Sc. degrees in Power Electrical Engineering, in 2005, 2008 in Fars Higher Training and Research Complex. He is a M.Sc. student in control engineering in Islamic Azad University, Najaf Abad Branch, Iran from 2009. His research interest is in the application and implement of new control technology in power system control design.