AMERICAN JOURNALS
Open Access, Peer Reviewed Journals

American Journal of Technology and Applied Sciences
ISSN (E): 2832-1766| Volume 11, | April, 2023

SUBSTATION AUTOMATION USING IEC61850 STANDARD

Usmonov Shukurillo Yulbarsovich,
Head of the Department, Associate Professor

Mamadaliyev Musulmonkul Imomali ugli,
Assistant, Fergana Polytechnic Institute, Uzbekistan, Fergana

A B S T R A C T

The interoperability of Intelligent Electronic Devices (IEDs) supplied by various businesses during the growth is currently a challenge for electric power providers. A current electrical substation. Recently, an effort has been undertaken to create a global standard to solve the interoperability issue. For flexible data transmission across IEDs in an electric power substation, the European standard "International Electro-technical Commission (IEC) 61850" is gaining acceptance globally. To enable interoperability amongst the various equipment, this article describes a hypothetical substation automation scheme in accordance with the IEC-61850 standard.

K E Y W O R D S

Communication Protocols, Standards, IEC-61850, Substation Automation.

Introduction

An electric utility can remotely monitor, manage, and coordinate the distribution components located in the substation with the use of a system called substation automation (SA). For substation automation and protection, high-speed microprocessor-based Remote Terminal Units (RTUs) or Intelligent Electronic Devices (IEDs) are utilized. For the automatic protection of the substation equipment and the collecting of system data, these IEDs are placed in key areas. To implement the substation automation features, data connection between the control center and IEDs in remote locations as well as within the IEDs becomes a crucial challenge. For tele-control purposes, a variety of protocols are employed, but none of them fully enable the interoperability among IEDs provided by various vendors in the substation. These protocols are IEC 60870, Modbus, Modbus Plus, and DNP 3.0. Although these protocols are employed at the utility level, they have several drawbacks. Modbus and Modbus Plus are not designed for connection via Ethernet and are best suited for serial data transfer. Data packet context is lost in DNP 3.0. Data context enables the connection between a data packet and a data element. The IEC60870-5 specified frame (FT3) is used by DNP3.0. Utility Communication Architecture (UCA) 2.0, an American standard, has been developed in response to these flaws. To make UCA 2.0 appropriate for substation automation, more domain-specific substation capabilities have been introduced, and IEC- 61850, a new standard, has ultimately evolved [1]. This standard's initial version was released in 2003. This standard's 2008 revision can be found at IEC under "CDV." The interoperability of various substation automation components provided by diverse vendors is ensured by IEC-61850. A superset of UCA 2.0 is IEC-61850 [2]. The comprehensive data transmission standard IEC-61850 is appropriate for a wide range of applications. In this essay, the IEC-61850 standard for substation automation is conceptually modified.

Basic Approach

The Substation Automation (SA) system performs a variety of tasks, including switch control, data monitoring, protection, etc. These functions are divided into low-level ones known as sub-functions in IEC-61850. The IED that is put in the substation handles each sub-function. Each IED has one to many sub functions it can carry out. A substation automation function is realized by integrating a number of subfunctions. Through the substation's local area network, these can talk to one another. Communication between sub-functions is defined with a specific syntax and semantics. In IEC-61850, every conceivable sub-function has been standardized. The IEC-61850 standard contains the information generated and needed by each substation.

Functional Architecture

The primary substation automation (SA) function is made up of a number of correctly interfaced sub-functions. Logical Nodes (LN) are the name for these sub-functions.

The IED, also known as a Logical Device (LD), is where logical nodes are located. As seen in Fig. 1 [3], one logical device (IED1) can carry one or more logical nodes (LN1 and LN2). A class of objects called the logical node class is used to materialize logical nodes. For instance, the logical node class XCBR is used to monitor and control circuit breakers. A collection of data from many classes makes up a logical node class. For instance, the logical node class "XCBR" includes the data "Pos" of the data class type "DPC" [4]. Additionally, each data class contained within a logical node class is made up of a number of data attributes. As an illustration, the data attributes for the data class "DPC" are Control value ("ctlVal"), Operating time ("operTime"), etc. [5]. To carry out the functions, these data properties are employed as imperative parameters. For instance, the close/open status of circuit breaker "XCBR1" is represented by XCBR1. Pos. stVal. According to Fig. 2, the sub functions are assigned at three levels: Process level (i), Bay level (i), Station level (ii), and so forth [6].

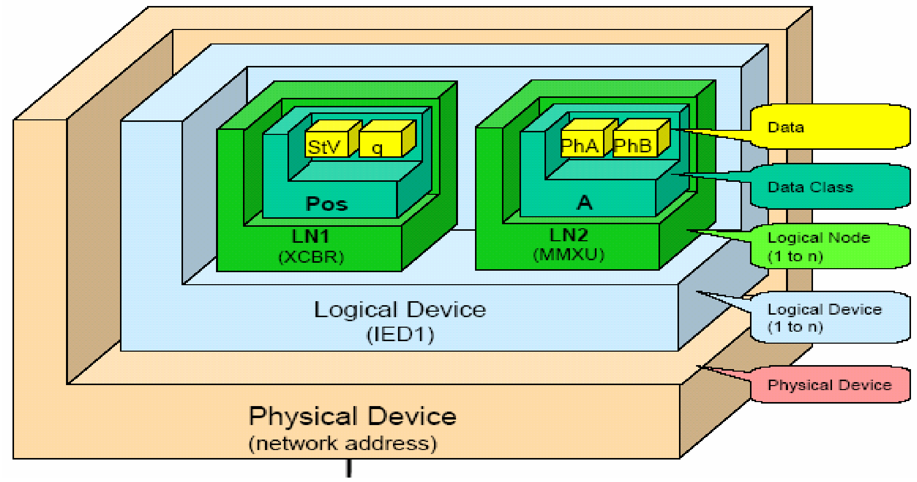

Fig. 1 Devices, nodes, classes and data

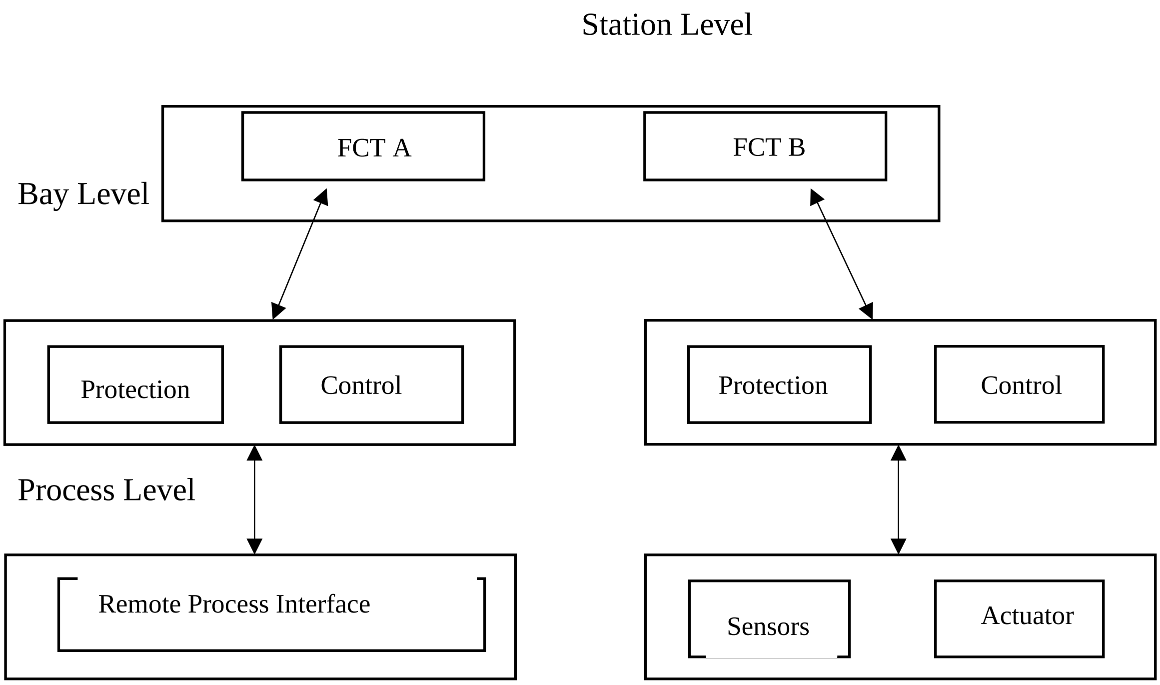

Fig. 2 Levels defined in IEC-61850

Process level function receives the control command from bay level device and executes it at the appropriate switch level. Process level function extracts the information from sensors/transducers in the substation and sends them to upper level device, called bay level device.

Data from the bay is collected by bay level functions, which then primarily affect the principal (power circuit) equipment of the bay. In Figure 3, the various conceptual subparts of a substation are bounded by dotted lines. As depicted in Fig. 3, these subparts are known as bays and are numbered from Bay1 through Bay7. For instance, a transformer and the switchgear that goes with it between the two busbars that represent the two voltage levels make up one bay, known as Bay3. For the purposes of monitoring, managing, and safeguarding the transformer, Bay3 is not complete without the Current Transformer (CT) and Potential Transformer (PT). The merging unit connects the CT, PT, and actuator to the protection and control unit. A device known as a merging unit is used to sample and communicate the instantaneous current and voltage readings from CT and PT to the protection and controls unit. Devices at the bay level include protection unit and control unit. Devices at the bay level gather information from the same bay and/or from various bays and operate on the principal equipment in its own bay.

There are two sorts of station level functions.
(i) Process-related operations operate on databases at the substation or several bays levels. These tasks are used to gather substation data from the bay level devices, such as voltage, current, and power factor, and transmit control directives to the primary equipment (circuit breakers). Each bay has one principal piece of equipment, such as transformers, feeders, etc., as previously mentioned.
(ii) Interface-related functions allow the substation automation system to interact with the local station operator via the HMI (Human Machine Interface), a remote-control center via the TCI (Tele Control

Interface), or a remote monitoring center via the TMI (Tele Monitoring Interface) for monitoring and maintenance.

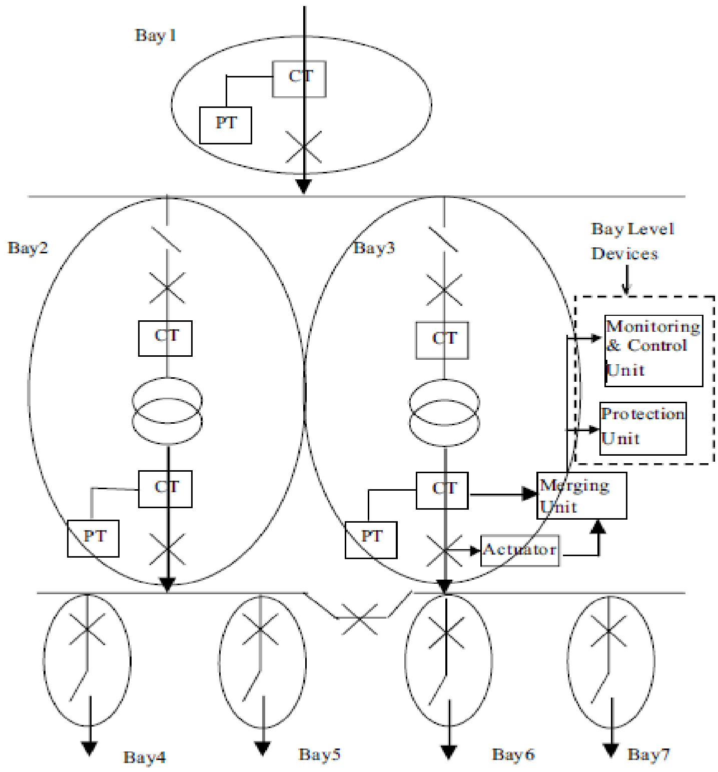

Fig. 3 Conceptual Substation Bays

IEC 61850 defines a total of 90 logical nodes or sub-functions, and all of them are distributed at these three levels based on their functionalities: (i) Process level, (ii) Bay level, and (iii) Station level. To exchange data, logical nodes are linked to one another via specific virtual links, also known as a logical connection. Physical connections enable logical connections to be made. The physical connection between IEDs is made possible in the hypothetical substation automation scheme by Ethernet wire and computer networking switches. Such network switches each constitute a network node.

Conceptual data Class Model

Data have been divided into many groups, as was mentioned in the part before this one. Data classes represent useful data from applications that are housed in automation devices. Common Data Classes (CDC) have been defined for the fundamental substation communication structure, per the classification. These classes keep track of the logical node's services (connected to variables) and member variables. A data class model and its conceptual adaption are shown in Fig. 4. The IEC 61850 classes are represented by the rectangle on the right in this diagram, while the instances or objects for each class in the conceptual substation automation are represented by the rectangle on the left.

As depicted in Fig. 4, The object of the logical node class MMXU is MMXU1. In a three-phase system, currents, voltages, powers, and impedances are calculated using the MMXU logical node. The WYE is the data class for the phV data in this logical node. Similar to this, logical node MMXU defines fourteen data kinds. WYE class is a group of measurements made simultaneously in a three-phase system to represent the voltage from the phase to the ground. WYE class contains data of the fundamental type Complex Measured Value (CMV), called phsA. One of the member variables of basic type Vector, cVal, is defined in the CMV. The magnitude "mag" and angle "ang" of the attribute type Analog value are both contained in the vector. Voltage of phase A is measured using an attribute of an analog value of type float. Voltage of phase A is measured using an attribute of an analog value of type float.

As seen in Fig. 4, IEC-61850 has its own syntax for accessing the data. A specific value can be reached in the conceptual model using hierarchical dot notation. We first choose the logical node MMXU instance provided by MMXU1, and then we choose the phase voltage MMXU1.PhV. Next, MMXU1 is used to represent the voltage of phase A with respect to ground.PhV.phsA. The fundamental type of the vector phsA in class WYE is represented by cVal. The magnitude "mag" and angle "ang" characteristics of the vector are chosen, and the float value of magnitude is MMXU1.PhV.PhsA.cVal.mag.f. A message is passed from one logical node to another using the aforementioned syntax.

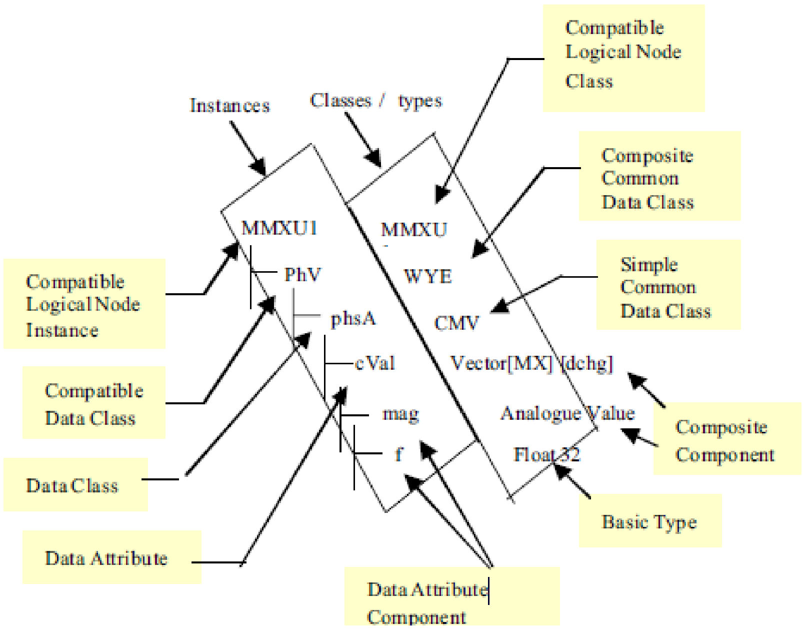

Fig. 4 Conceptual Data class model

Conclusion

One of the main issues for utilities is interoperability.

IEC-61850 is achieving interoperability by dispersing logical nodes among diverse IEDs. This standard is a comprehensive data transmission protocol that works for a variety of uses. In this article, the IEC 61850 standard for substation automation is conceptually modified.

In this envisioned paradigm, substation automation is better controlled and monitored because the context of the data (such as MMXU1 in Fig. 7) is maintained while the data packet is sent from one place to another. This makes it possible for IEDs or other HMIs to easily obtain data about the power system. As a result, interoperability between diverse components (IEDs) provided by various vendors is guaranteed. Both the vendors and the utilities gain from this.

REFERENCES

1. IEC 61850: Communication Network and System in Substation, Part 1, August 2003.
2. K.N. Clinard "Comparison of IEC 61850 and UCA 2.0 data models" in proceedings of IEEE Power Engineering Society Summer Meeting, Volume 1, July 21-25 2002 pp 289-290.
3. Holger Schubert and Gordon Wong, "IEC 61850- The Way to Seamless Communication in Substations", in the proceedings of the 3rd IASTED International Conference on Power and Energy System, Sep. 3-5 2003pp 252-256.
4. IEC 61850: Basic communication structure for substation and feeder equipment – Compatible logical node classes IEC 61850-7-4.
5. IEC 61850: Basic communication structure for substation and feeder equipment – Common data classes IEC 61850-7-3.
6. B.Shephard, M.C. Jannssen, H. Schubert "Standard Communication in Substation", in proceedings Seventh International Conference on Power System Protection, April 9-12 2001, pp 270—274
7. R.P.Gupta N. Srivastava , "Substation Automation Communication Protocol" in the proceedings of ICSCI 2004 vol. 1, Feb. 12-15 2004, pp 499-503.
8. R.P. Gupta, M. Pandey and N. Srivastava, "Data Communication Architecture using IEC 61850 Protocol for Substation Automation", in the proceedings of International Conference on Distribution India 1, April 15-16 2004, pp 113-121.